Cardno
Shaping the Future

Audit of Water Savings

Shepparton and Central Goulburn 1-4

Prepared for Department of Sustainability and Environment

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Summary of Findings

This report details the findings from Cardno's audit of the estimates of the water savings achieved through the Shepparton and Central Goulburn 1-4 irrigation modernisation projects for the 2009/10 irrigation season. These water savings estimates have been prepared by Goulburn-Murray Water (G-MW). A separate audit report has been prepared for the water savings achieved by the Northern Victoria Irrigation Renewal Project (NVIRP).

Audited Water Savings Estimates

The audited Phase 3 water saving estimates for the Shepparton and Central Goulburn 1-4 areas are summarised in the following table.

Audited Phase 3 Water Savings Estimates

Water Savings Intervention	Shepparton	Central Goulburn 1-4
Channel Rationalisation		
Seepage (ML)	625	22
Bank Leakage (ML)	221	19
Evaporation (ML)	410	8
Total - Channel Rationalisation (ML)	***1,255***	***49***
Channel Automation		
Outfalls (ML)	11,765	218
Bank Leakage (ML)	66	87
Total - Channel Automation(ML)	***11,831***	***305***
Service Point Replacement		
Meter error (ML)	3,322	1,636
Leakage through service points (ML)	2,394	941
Leakage around service points (ML)	522	207
Unauthorised Use (ML)	594	185
Total - Service Point Replacement (ML)	***6,833***	***2,969***
Service Point Rationalisation		
Leakage through service points (ML)	468	105
Leakage around service points (ML)	99	22
Unauthorised Use (ML)	140	25
Total - Service Point Rationalisation (ML)	***707***	***152***
Channel Remediation		
Bank Leakage (ML)	1806	1942
Seepage (ML)	16	258
Evaporation (ML)	4	0
Total - Channel Remediation (ML)	***1,825***	***2,199***
TOTAL - All sources (ML)	**22,451**	**5,674**

Systems and Processes

Our review of the systems and processes used by G-MW has found that they are generally sufficiently robust to generate data and inputs that are accurate as could reasonably be expected for the purpose of calculating water savings.

We found the great majority of the assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. The exceptions were a single service point site and nine channel rationalisation sites. While there were some minor discrepancies over commissioning dates, these do not impact upon the water savings claimed.

We conclude from our review of outfall volume data that the majority of outfall volumes used in the water savings calculations can be readily reconciled to the flows recorded online in SCADA.

We found that G-MW sources outfall volumes from operator logsheets but intends to move increasingly to using SCADA as the primary source of flow measurement data. We found that some irrigation areas treat outfall flow volumes differently but that these practices do not have a material impact on the water savings estimates.

We believe that G-MW should make every effort to utilise SCADA as the primary source of outfall flow volumes in future years. Operator logsheets should only be relied upon for unmetered outfalls.

For deliveries through customer meters, we found 2 small discrepancies out of the 41 records we reviewed. These errors do not have any significant effect on the water savings estimates.

For the season length data sourced from Irrigation Planning Module (IPM), we identified no discrepancies in our samples for data trailing. We also found that the procedures in place for extracting data from this system for the purpose of water savings are sufficient.

Water Savings Protocol Reporting Requirements

The Department of Sustainability and Environment's *Water Savings Protocol* 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. Our finding against each element is also addressed this below.

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 found that G-MW had determined water savings generally in accordance with the *Technical Manual*. For a number of instances (e.g. bank leakage from channel remediation) G-MW had to modify the methodology to suit the available data. We found that the alternative approaches used were reasonable and only applied to a small fraction of water savings estimates. We discuss the application of water savings calculations 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.

Our review of the systems and processes used by G-MW has found that they are generally sufficiently robust to generate data and inputs that are accurate as could reasonably be expected for the purpose of calculating water savings. Our detailed findings are outlined in Section 5 of this report.

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

We visited a selection of sites in the Goulburn Murray Irrigation District where irrigation modernisation works have been completed. This visit provided assurance that works have been implemented as documented in the water saving calculations. We discuss the site visits undertaken in Section 3.3 of this report.

> Checking that water savings have been calculated based on the nature and the extent of all modernisation works completed prior to 15th May in the year of the audit.

To address this requirement, we have visited a selection of works sites as noted above and we have cross checked asset commissioning certificates against the dates used in the water savings calculations. While we noted a number of discrepancies between the commissioning dates for service points and those used in the calculations, these were not significant. We discuss these issues further in Section 3.3, Section 5.1 and Section 6 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.

Our corrected estimate is provided in the Summary of Findings and in the sub-sections of 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 that will improve useability and accuracy of water savings.

We make recommendation for improving the water savings estimation process and *Technical Manual* in Section 8 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 have reviewed the progress of NVIRP and G-MW in achieving the recommendations from the 2008/09 audit and found that significant work has been undertaken through various working groups. To avoid repetition, we detail our findings in the 2009/10 NVIRP area water savings audit report only.

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1 INTRODUCTION

Cardno has been engaged by the Department of Sustainability and Environment to undertake an independent audit of the water saving achieved through irrigation renewal in the Goulburn Murray Irrigation District during the 2009/10 irrigation season. The water savings referred to in this report have been achieved in the Shepparton Irrigation Area and Central Goulburn Channels 1-4. These areas are outside the Northern Victoria Irrigation Renewal Project (NVIRP) and are the responsibility of Goulburn Murray Water. A separate report has been prepared and released concurrently for the water savings achieved by NVIRP for the 2009/10 irrigation season.

More detail on the irrigation modernisation works undertaken in the Goulburn Murray Irrigation District is provided in Section 4.

The Victorian Government has developed the Water Savings Protocol for the Quantification of Water Savings from Irrigation Modernisation Projects (the Protocol).

The *Protocol* is a series of documents, which together, aim to provide transparency and consistency in the estimation and allocation of water savings derived from irrigation modernisation projects. It has been developed based on the key principles of the draft Northern Region Sustainable Water Strategy and is applicable State-wide. The Protocol includes a *Technical Manual for the Quantification of Water Savings* (the *Technical Manual*).

The Protocol defines the scope of the independent audit of water savings to include:

1. 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.

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

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

4. Checking that water savings have been calculated based on the nature and the extent of all modernisation works completed prior to 15th May in the year of the audit.

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

6. 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 that will improve useability and accuracy of water savings.

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

This is the second audit of annual water savings achieved following the first audit which was completed for the 2008/09 irrigation season. One internal and one external audit of baseline water balance and water loss data have been completed. Baseline year water balance data is an important input into the water savings calculations. Given the two audits completed, this audit has accepted the baseline year parameters without additional scrutiny.

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);
- Murray Valley (MV);
- Pyramid-Boort (PB);
- Rochester (RO);
- Shepparton (SH); and
- Torrumbarry (TO).

Goulburn Murray Water (G-MW) 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 districts.

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

The *Our Water Our Future website*[1] 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 water on demand.

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 per cent 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 8 per cent. They fail to meet the new metering standards introduced by the Australian Government that specify a maximum of plus or minus 5 per cent measurement inaccuracy. There are also occupational health and safety risks associated with using Dethridge wheels.

2.3 Water Savings Protocol

The Victorian State Government has committed to clear and transparent processes for the calculation and verification of the water savings achieved through irrigation modernisation and accordingly requires the water savings estimates achieved to be independently audited.

A *Water Savings Protocol* has been released by the Government which sets out the processes for calculating, applying and allocating water savings generated from irrigation modernisation projects. Supporting the Protocol is the Water Savings Protocol *Technical Manual* (the *Manual*) which sets out the calculations to be used in determining water savings. The Protocol and Manual are available on the *Our Water Our Website* at this location: http://www.ourwater.vic.gov.au/programs/irrigation-renewal/water-savings-protocol/water-savings-protocol-technical-manual.

[1] http://www.ourwater.vic.gov.au/programs/irrigation-renewal/about. Note - minor edits have been made to this text to clarify its meaning.

3 AUDIT METHODOLOGY

3.1 Audit Process under the Audit Protocol

The *Water Savings Audit Process*[2] is a document under the *Water Savings Protocol* that sets out the approach to be taken to the independent audit of water savings. Under the *Audit Process,* the scope of independent audit work relating to irrigation modernisation is to include the elements detailed below. Under each element we set out how the requirement has been addressed in this report:

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 0 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 3.3 of this report.

Checking that water savings have been calculated based on the nature and the extent of all modernisation works completed prior to 15th May in the year of the audit.

We address this requirement in Section 3.3, Section 5.1 and Section 6 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 that will improve useability and accuracy of water savings.

We address this requirement in Section 8 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.

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

We address this requirement in Section 0 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 following:

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 6
Full tabulation of water savings estimation against Project Proponent's Business Case targets.	Section 6
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, 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 8

The following subsections of this report details the audit process undertaken.

3.2 Overview of Audit Methodology

The Cardno approach to auditing water savings is based around structured interviews with key authority staff. These structured interviews allow us to scrutinise the water savings calculations and assess the veracity of the supporting information. Our audits focused on three areas:

- Checking that the audit calculations had been performed correctly;
- 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; and
- Verifying that the works claimed are complete and commissioned through review of works handover and commissioning documents, as well as site visits.

Figure 3-1 provides an overview of our audit methodology. We completed the audits of the savings from the areas Goulburn Murray Water is responsible for and the areas that NVIRP is responsible for in parallel given that many of the systems, processes and key staff are common to both.

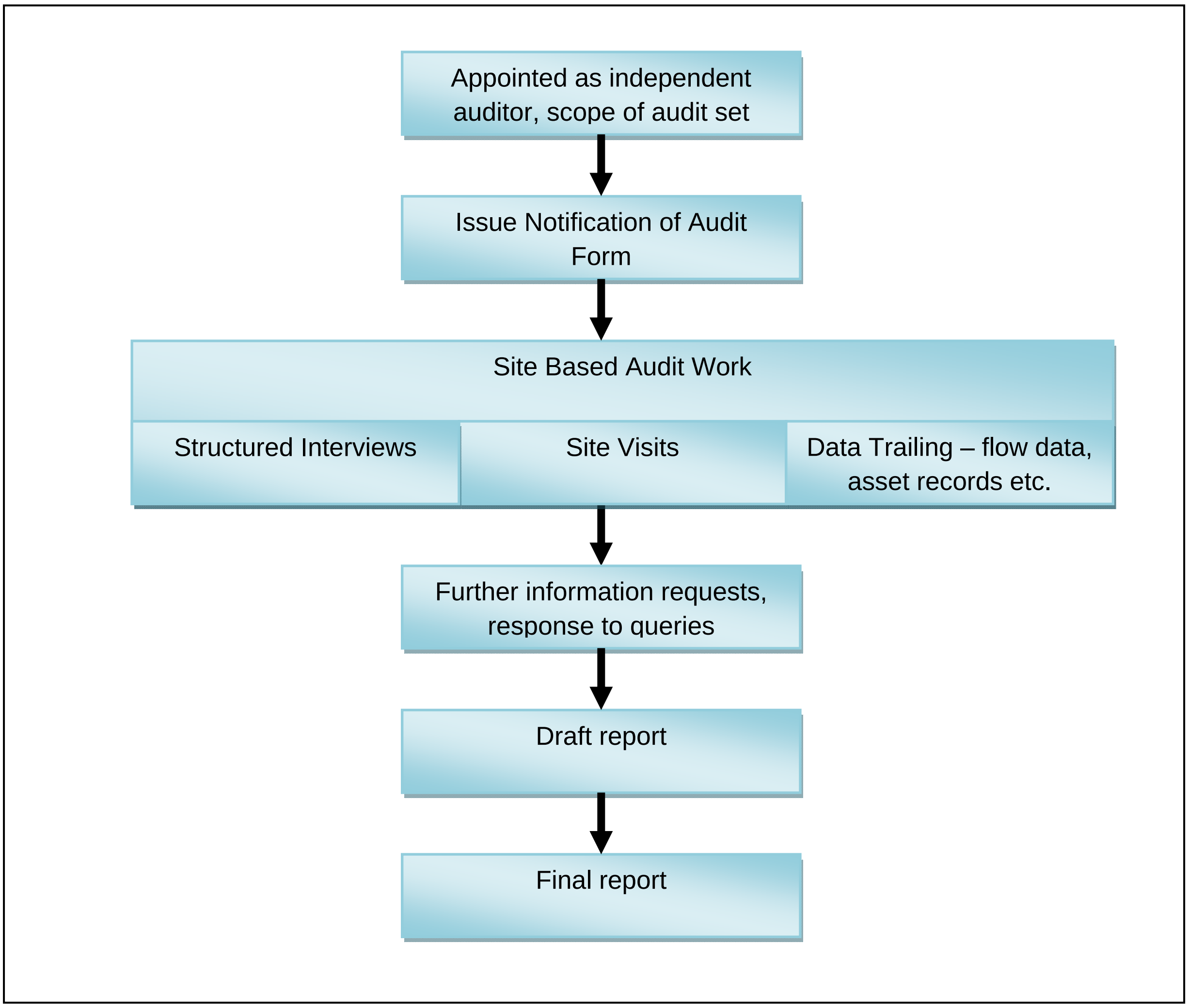

Figure 3-1 Overview of Audit Methodology

3.3 Site Visits

The Audit Protocol states that spot checks of the program of works be undertaken to verify that the works have been implemented. A sample of sites where irrigation modernisation works have been completed was visited on Wednesday 8 September 2010. The sample selected included sites within both the NVIRP and G-MW works areas. Sites had to be selected based on accessibility. The sites visited are listed in Appendix 1.

We found that the sites visited were located as indicated on works maps produced by NVIRP and G-MW. We found the irrigation assets were clearly identified in accordance with the works schedules. On this basis, we gained assurance that works have been implemented as documented in the water saving calculations, as required by the audit protocol.

3.4 Schedule of Audit Meetings

Table 3-1 lists the meetings held to complete the audit work.

Table 3-1 Schedule of Audit Meetings

Date	Audit Work	Auditee	Organisation
Monday 6 September 2010	Start-up Meeting	Murray Smith	NVIRP
		Peter Roberts	NVIRP
		Jeremy Nolan	G-MW
		Fiona Nioa	G-MW
		Betty Lettraz	NVIRP
		Betty Edwards	NVIRP
		Tom Russell	Transfield
		Ross Plunkett	NVIRP
	Audit of NVIRP calculations	Peter Roberts	NVIRP
		Betty Lettraz	NVIRP
Tuesday 7 September 2010	Audit of G-MW calculations	Fiona Nioa	G-MW
		Jeremy Nolan	G-MW
	▪ Outfall volume record keeping	Paul Cox	G-MW
		Fiona Nioa	G-MW
	▪ Audit of determination of season length from IPM	Phil Slender	G-MW
		Fiona Nioa	G-MW
	▪ Audit of pondage data for channel remediation calculation	Mike Schulz	G-MW
Wednesday 8 September 2010	Site Visits	Jeremy Nolan	G-MW
		Fiona Nioa	G-MW
		Peter Roberts	NVIRP
		Betty Lettraz	NVIRP
Thursday 9 September 2010	Review of construction records with Transfield	Bob Adams	Transfield
		Felipe Villafrade	Transfield
		Ian Wright	NVIRP
		Peter Roberts	NVIRP
	Review of construction records with Futureflow	John Davison	Futureflow
		Fiona Nioa	G-MW
	Review of progress achieving past recommendations	Peter Roberts	NVIRP
Friday 10 September 2010	Close-out meeting	Murray Smith	NVIRP
		Ross Plunkett	NVIRP
		Peter Roberts	NVIRP
		Merrill Boyd	NVIRP
		Jeremy Nolan	G-MW
		Fiona Nioa	G-MW
		Mike Schulz	G-MW

3.5 Document Register

A list of the documents received before, during and after the audit from both G-MW and NVIRP is included in Appendix 2.

4 IRRIGATION RENEWAL IN SHEPPARTON AND CENTRAL GOULBURN 1-4

4.1 Introduction

The Goulburn Murray Irrigation District (GMID) covers an area in northern Vitoria bordered by the Murray River in the north and the Great Dividing Range in the south. The GMID is Australia's largest irrigation district. Irrigation assets were first provided in this area in the early 20th century by the State Rivers and Water Supply Commission.

Due to the age and condition of irrigation assets, NVIRP estimates that up to 900GL (Long Term Cap Equivalent) of water in the Goulburn Murray Irrigation District is lost through leaks, evaporation and other inefficiencies. Irrigation renewal in the GMID seeks to improve the efficiency of irrigation water use from its current level at around 70% to 85%.

A program of research and pilot studies commenced in 2002 to examine the cost effectiveness of irrigation modernisation works. The following sections detail these early projects that led to the Shepparton and Central Goulburn 1-4 project and the NVIRP project.

4.2 Prior Works Programs

Figure 4-1 outlines the sequence of modernisation projects that have been completed to date or are still in progress.

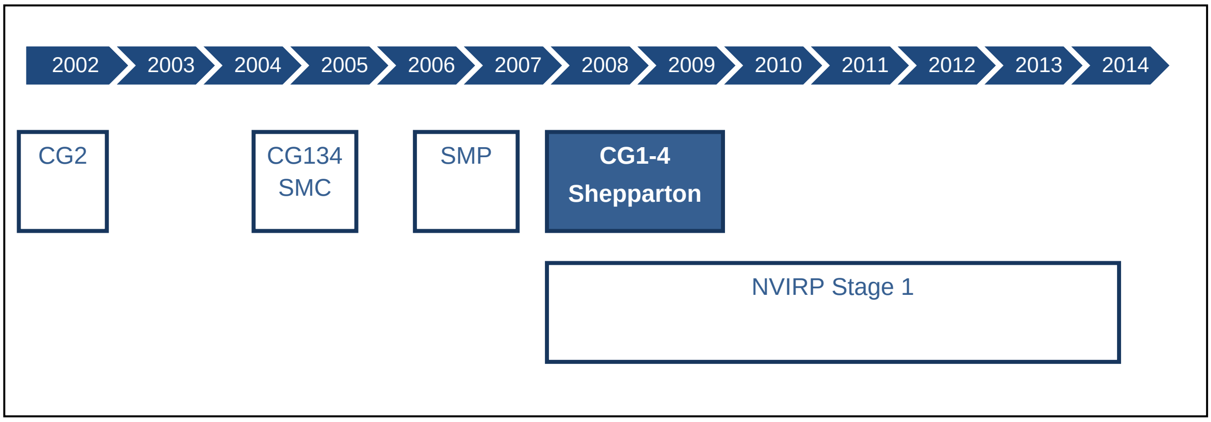

Figure 4-1 Timeline of Irrigation Modernisation Programs

Source: Adapted from G-MW report "Impact of Modernisation – Whole of Life Cost Analysis". Version 10.0.

A brief description of each program is provided following:

- **Central Goulburn Channel 2 System (CG2) Pilot Program**

  G-MW commenced channel automation works in 2002. This pilot project installed 27 regulators and 142 meters on the Central Goulburn No. 2 Channel. The works included remote monitoring of these assets.

- **Central Goulburn Channel 1, 3 and 4 (CG134) and the Stuart Murray Canal (SMC) Project**

  From mid 2004 - mid 2005, 255 automatic gates were installed throughout the Central Goulburn Channels 1, 3 and 4. A further 16 gates were installed on the Stuart Murray Canal.

- **Strategic Measurement Project (SMP)**

  The Strategic Measurement Project targeted the automation of important offtakes, inline regulators and outfalls. 374 gates were installed at 305 sites during the 2006/07 financial year.

4.3 Shepparton and Central Goulburn 1-4 Project

The Central Goulburn 1-4 and Shepparton project commenced in early 2008. The works were outlined in two separate business cases developed by G-MW and involved a more extensive implementation of modernisation works based on the earlier programs completed. The works were undertaken by the Futureflow alliance and were largely completed in late 2009.

The Central Goulburn project had three stages:

- Channel automation on the 1, 2, 3 and 4 channels;
- Leakage and seepage remediation of identified areas; and
- Meter replacement or rationalisation of all farm outlets.

The works included replacement of approximately 900 meters and rationalisation of several hundred more, as well as channel remediation works.

The Shepparton modernisation project includes the following upgrade works:

- Automation of around 960 channel regulators;
- Replacement or rationalisation of approximately 1800 service points;
- 39km of channel rationalisation; and
- Replacement of two channels with 27km of gravity pipeline.

4.4 Northern Victorian Irrigation Renewal Project

The Northern Victoria Irrigation Renewal Project (NVIRP) was established following completion of the initial projects described above and acceptance by the State Government of a business case for Stage 1 of modernisation works across the wider Goulburn Murray Irrigation District. The NVIRP Stage 1 works expand on the initial modernisation works and occur in five of the six irrigation areas.

The Stage 1 works area covers approximately 85% percent of the GMID and a total of around 6,000 km of channels. Stage 2 works are planned to occur following completion of the Stage 1 works pending acceptance of the related business case.

We discuss NVIRP and the water savings achieved by this project for the 2009/10 irrigation season in a separate report released concurrently with this report.

5 AUDIT FINDINGS – SYSTEMS AND PROCESSES

This section of the audit report is largely similar to that in the 2009/10 NVIRP water savings audit report due to the common systems and processes used by both for data management.

5.1 Introduction

Our audit approach is to consider the systems and processes in use by G-MW that support the calculation of water savings 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 savings estimates – asset commissioning and handover, flow measurement and recording, the Irrigation Planning Module system for managing customer deliveries, and pondage testing investigations.

Because of the importance of demonstrating that the water savings 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 data trailing undertaken is a combination of random and targeted sampling. The targeted sampling has been applied in particular to the outfall flow volumes where we have focused on the outfalls that contribute the most to the irrigation savings claimed.

5.2 Asset Planning, Design, Construction and Handover

The Shepparton and Central Goulburn 1-4 early works were installed by G-MW with the Futureflow alliance completing the balance of the works. The alliance ceased construction works in late 2009 but still operates to finalise asset handover. G-MW was a member of this alliance along with construction contractors and designers. The alliance undertook planning, design, construction and commissioning functions.

When regulator gates and service points are commissioned, an Inspection Test Procedure (ITP) certificate is produced which records relevant commissioning details. These ITP certificates are stored by Futureflow in hardcopy files along with other relevant construction documents. Because these irrigation works have largely been complete for at least one irrigation season, the commissioning date becomes less critical to the water savings calculations. However, it is still important to ensure that the assets claimed are actually installed.

While handover of assets to G-MW 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 savings are typically achieved from the time that an asset is commissioned.

We also note that when regulator gates and online service points are wet commissioned, the assets appear in G-MW's SCADA and field data begins being received from this site. Therefore, when data begins being captured from the new site it can reasonably be assumed that the gate has been successfully commissioned. This provides an additional level of assurance in addition to the presence of ITP certificates that works have been installed and commissioned.

To complement our review of the systems used to manage asset delivery and commissioning, we selected a sample of assets (service points and channels) that Futureflow has delivered and requested that evidence of commissioning be provided to us. This in part fulfils the requirement of the Audit Protocol to confirm the extent of works installed for the irrigation season in question. The results of this data trailing are detailed in the following sub-sections.

5.2.1 Trailing of Commissioning Certificates for Service Point Works

We requested G-MW to provide to us commissioning certificates (ITP certificates) for 22 sites in the Shepparton Irrigation Area and 8 sites in the Central Goulburn 1-4 Channels where service points had been replaced or rationalised to confirm that the works have been completed and on the date claimed in the water savings calculations. This sample of sites was selected randomly.

We received all of the commissioning certificates we requested. Our review found the following:

- 24 out of 30 sites checked have ITP certificates agreeing with the date claimed.
- Four sites have ITP certificates that disagree with the date claimed. In all cases the date on the ITP certificate precedes the date claimed in the calculations (i.e. conservative in terms of water savings estimates). G-MW was not certain as to why the dates used in the calculations differed from those on the certificates in these instances. However, it noted that it was likely that the date used in the calculations was the date the record was entered into its asset database. That the ITP date is systemically before the date claimed supports this suggestion. These small differences do not materially affect the water savings estimates.
- For one service point rationalisation site, there were no records supporting the date claimed.
- In one case, a service point was re-commissioned after the date used in the water savings calculations. While the leakage through and around the meter will be unaffected, the meter error volume would not be reliable. G-MW noted that it did not have a procedure for correcting estimates when meters are re-commissioned. We note that this is likely to be a rare occurrence.

We conclude from this review that all except one of the service points included in the water savings calculations have evidence supporting the fact that they have been installed and commissioned. We found some minor discrepancies between the date used in the calculations and that on the commissioning certificated. These discrepancies are minor in terms of their impact upon the water savings claimed and their impact will diminish in coming years as the assets will in future contribute a full year of water savings. One site was re-commissioned which may impact the meter error component of water savings.

5.2.2 Trailing of Commissioning Certificates for Channel Rationalisation

We requested G-MW to provide to us evidence for a sample of ten sites where channel have been rationalised to confirm that the works have been completed and on the date claimed.

Our review of the project hardcopy records for each of the ten sites found that while all sites had material substantiating the scope of the works, the agreement with the affected landholders and associated compensation, in only one instance was there direct evidence that the works had been completed on the date used in the water savings calculations.

Following this review of hardcopy details, G-MW provided to us a spreadsheet used as the primary information source for tracking the details of channel rationalisation works. This spreadsheet includes a column for recording de-commissioning dates. While we accept that the spreadsheet provides indirect evidence of the channel rationalisation dates, we believe that construction records would be a more robust means of demonstrating this information. However, we note that the channel rationalisation dates do not materially impact upon the water savings estimates as channel rationalisation only accounts for a small fraction of the savings claimed and as most works were completed before 2009/10, they have a lessening impact on the calculations as time progresses.

5.3 Information Systems Overview

To manage its irrigation network, Goulburn Murray Water 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;
- GIS – records location of channels and control gates. Channel length and width is measured from here; and
- Irrigation Planning Module – takes customer orders, checks system capacity to deliver orders.

When an order is placed by a customer who is located on an automated channel, the Irrigation Planning Module directs the order to the customer's outlet. The IPM specifies the times to open and close the customer outlet and the ordered flow rate. The automation system uses a combination of feedback control on water level with feed-forward on flow to control to the channel.

The SCADA system monitors the status of control gates along automated channels in the field. Data from the control gates (channel water levels, flow rates, accumulated flows, gate open position etc.) can be monitored in SCADA. It is also stored in the data warehouse and can be retrieved from here.

5.4 Outfall Flow Data

The volumes of flows through outfalls are an important data input into the water savings calculations as savings from outfalls comprise the largest component of all water savings achieved. G-MW as the system operator is responsible for recording all outfall flow volumes.

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 G-MW SCADA. A number of unmetered outfalls where flows are estimated by operators remain in operation. However, these account for only a small proportion of the water savings achieved.

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.

5.4.1 Trailing of Outfall Volumes Data

We requested G-MW demonstrate to us the outfall volumes recorded in the current year for a targeted sample of sites across the Central Goulburn 1-4 and Shepparton works areas. Our sample focused on the outfalls with the largest savings to provide an appropriate level of assurance, as well as a selection of smaller sites to ensure that there were no systemic errors in the reported data. The coverage of our sample is summarised in Table 5-1.

Table 5-1 Coverage of Outfall Volumes Sample

Area	No. Outfalls in Sample	Coverage of all Outfall Savings (approx.)
Shepparton	16	71%
Central Goulburn 1-4	2	60%

To trail the outfall volumes, we reconciled the volumes used in the calculations for each outfall site with those recorded on the G-MW SCADA. The SCADA data is based on a snapshot of the records taken at the end of the 2009/10 season. To interrogate SCADA, we reviewed outfall data on a site by site basis for a date range corresponding to the irrigation season. Our review of outfall volumes found:

- The majority of outfall flow volumes used in the calculations from operator logsheets could be reconciled to the flows recorded in SCADA;
- We did not need to make any adjustments or corrections to the outfall volumes presented by G-MW;
- Although many sites (e.g. just under 90% of 2009/10 outfall flows in the Shepparton Irrigation Area) are monitored online through SCADA, operator logsheets are used as the source of outfall data for the calculations. This is because the operator logsheets are the primary data source where adjustments for meter errors etc are made and are the basis for internal reporting;
- A number of outfall gates are recorded incorrectly in SCADA in terms of their name, location or type (automated or DMO);
- Some minor flows (e.g. <0.5ML in a day) are not included in operator logsheets in some Areas; and
- Rainfall rejections are removed from outfall volumes in some irrigation areas as operational practice is for channel volumes to be reduced to create headspace for irrigators to dewater excess rainfall volumes from their properties into;

We conclude from this review that the majority of outfall volumes used in the water savings calculations can be readily reconciled to the flows recorded online in SCADA.

We found that despite the potential that SCADA offers for recording, storing and reporting flow measurements, outfall volumes are still reported from operator logsheets. We understand that this is in part due to the ability of operators to identify any incorrect flow measurements that have occurred, for example, in the past when channel levels have become low. We are also aware that G-MW intends to increase its use of SCADA for reporting of outfall volumes. We believe that if used with appropriate filters and alarms to identify potentially erroneous readings, utilising SCADA as the primary source of flow data offers significant advantages over manually completed logsheets.

We found that some irrigation areas have a number of differing practices in the treatment of outfall volumes, e.g. recording of minor flows, treatment of rainfall rejections and rounding of flow measurements. While these differing practices do not materially affect the water savings estimates, they highlight how using SCADA could lead to uniform recording of outfall volumes.

5.5 Irrigation Planning Module

Irrigation Planning Module (IPM) is the business system used by G-MW 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 supply is in excess of entitlement.

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

The following describes the results of our trailing of a selected sample of data sourced from IPM.

5.5.1 Trailing of Customer Deliveries Volumes

We reviewed the 2009/10 usage through 41 customer service points that have been replaced by modernisation works. We compared the usage recorded for each service point in IPM with that used in the calculations. The review identified two service points where the usage for 2009/10 did not agree with that used in the calculations – one in the NVIRP project area and one in the Central Goulburn1-4 and Shepparton project area.

For the first site (RN484), the usage was adjusted on 15 June 2010 which was after the data for reporting was extracted. In the second case (TN13009), the reporting query did not correctly identify that the meter had been replaced. The net error due to these two discrepancies is 9 ML out of a total usage volume through all service points in the sample of 1207ML, i.e. 0.7%. Given that the accuracy of a newly installed and calibrated magflow meter is +/-5%, we do not consider these discrepancies to be material and they have an insignificant impact on the water savings calculations.

5.5.2 Trailing of Season Lengths

We selected two irrigation districts – Central Goulburn and Torrumbarry - and compared the dates recorded in IPM for the last deliveries in each for the 2009/10 season with the dates used for the end of the season in the water savings calculations. We found that in both cases the dates agreed.

5.6 Pondage Testing

Goulburn Murray Water has a staff member dedicated to undertaking pondage testing for both the NVIRP and its own areas. The results of pondage tests are used to determine the most cost effective channels to remediate and in water savings estimates. Goulburn Murray Water has prepared a procedure (#2708378) that sets out how pondage field tests are undertaken. The tests undertaken are static tests. A second procedure (#2708405) outlines how the results of field tests should be evaluated and leakage and seepage rates determined. We reviewed these procedures and had their use demonstrated to us by Goulburn Murray Water. We believe that these procedures are sufficiently complete and reflect the analysis we saw undertaken by G-MW.

During field tests, logsheets are kept that detail the site conditions, any rainfall etc. If rainfall occurs, the measurements taken during and after that period are excluded. A test takes a minimum of four days to complete so that sufficient data is collected. The data used in the analysis is the change in water level in the channel over time and the volume of any flows into the channel. Both of these variables are measured on-line and recorded in SCADA.

We reviewed the calculation of pre and post works loss estimates for channels RN227-228 and RN321-322 and did not identify any errors.

The length of channel remediated is first determined using GIS. However, the actual length remediated is also measured in the field following completion of the remediation works. Because channel lining typically stops short of in-line structures (e.g. bridges) and regulator gates, the actual length remediated is usually slightly less than the initial length estimated.

5.7 Conclusions

Our review of the systems and processes used by G-MW has found that they are generally sufficiently robust to generate data and inputs are that are accurate as could reasonably be expected for the purpose of calculating water savings.

We found the great majority of the assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. The exception was a single service point site and nine channel rationalisation sites. While there were some minor discrepancies over commissioning dates, these do not impact upon the water savings claimed.

We conclude from our review of outfall volume data that the majority of outfall volumes used in the water savings calculations can be readily reconciled to the flows recorded online in SCADA.

We found that G-MW sources outfall volumes from operator logsheets but intends to move increasingly to using SCADA as the primary source of flow measurement data. We found that some irrigation areas treat outfall flow volumes differently but that these practices do not have a material impact on the water savings estimates.

We believe that G-MW should make every effort to utilise SCADA as the primary source of outfall flow volumes in future years. Operator logsheets should only be relied upon for unmetered outfalls.

For deliveries through customer meters, we found 2 small discrepancies out of the 41 records we reviewed. These errors do not have any significant effect on the water savings estimates.

For the season length data sourced from IPM, we identified no discrepancies in our samples for data trailing. We also found that the procedures in place for extracting data from this system for the purpose of water savings are sufficient.

5.8 Recommendations

- SCADA should 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 the water level drops below the sensor range.
- Outfalls names used in the business should be reconciled with the outfall names used in SCADA. We identified several outfalls that could not be readily identified on SCADA or were incorrectly labelled.
- As more outfall flow data is recorded online into the SCADA data warehouse, reporting from here should be streamlined and made robust for water savings audit purposes. For example, a report that allows users to enter the start and end dates for the irrigation season in each irrigation district and then have returned the totalised outfall flows in that period on an outfall by outfall basis would be very useful.
- While operator logsheets continue to be used, operational practice should be standardised across regions, e.g. rounding of flows, treatment of rainfall rejection.
- Minor flow volumes should not be discounted from outfall volumes unless a valid reason is identified by the operator.

6 AUDIT FINDINGS – WATER SAVINGS CALCULATIONS

6.1 Application of the *Technical Manual* formulae and determination of long-term savings

The purpose of the *Technical Manual for the Quantification of Water Savings* is to apply a transparent and consistent approach to determining the water savings achieved through irrigation modernisation projects at all project phases, but most importantly, the long term savings in the system following project completion. The *Technical Manual* defines four separate phases at which water savings calculations are applied to projects:

- *Phase 1*: The initial 'Business Case' long term estimates of water savings for the planned program of works;
- *Phase 2*: The annual pre-works estimates of interim water savings to be set aside within the water savings account;
- *Phase 3*: The annual post-works measurement or verification of interim water savings able to be allocated from the water savings account; and
- *Phase 4*: The assessment of the overall long term water savings achieved through the modernisation program.

The purpose of this audit report is to review the Phase 3 water savings achieved in the Shepparton Irrigation Area and Central Goulburn Channels 1-4 for the 2009/10 season. That is, the actual water savings realised in the 2009/10 irrigation season (Phase 3). There is no onus on G-MW to determine the water savings that would have occurred over a comparable long term average year (Phase 4).

However, there are a number of instances where G-MW has not applied the preferred Phase 3 methodologies specified in the *Technical Manual* to estimate water savings. In these instances , G-MW has applied alternative approaches described in the *Technical Manual, as* detailed in Table 6-1 below.

Table 6-1 Departures from the *Technical Manual* in G-MW Water Savings Calculations

Instance of departure from preferred *Technical Manual* equations	Reason for departure from preferred *Technical Manual* equations	% of savings affected
Bank leakage water savings due to automation – Modified Phase 2 calculations used in place of Phase 3.	Using the Baseline Year leakage figure in Phase 3 calculations results in negative leakage losses. This is most likely due to the large difference between the Baseline Year deliveries and the current year deliveries (43% of Baseline Year)	0.7%
Service point rationalisation – Savings due to meter error. Not included	Meter error component not included as assumed that all flows from rationalised service points now go through metered service points. Conservative.	-
Channel remediation – Phase 2 calculation used to determine pre-works losses	Pre works pondage test data not available and no audited Baseline Year estimates available for losses	0.7%

We believe that G-MW has taken a reasonable approach in each of these instances of departure from the preferred *Technical Manual* calculations. We also note that these departures apply to an insignificant fraction of the water savings estimates.

The following sections detail the application of the water savings calculations by intervention type – channel rationalisation, channel automation, service point replacement and rationalisation and channel remediation.

6.2 Savings from Channel Rationalisation

6.2.1 Scope of Irrigation 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 is water savings due to reduced evaporation, bank seepage and bank leakage. Channel rationalisation accounts for approximately 5% of the Phase 3 savings claimed by G-MW for the 2009/10 irrigation season.

6.2.2 Overview

The Phase 3 water savings from channel rationalisation is the sum of the savings from reduced leakage, seepage and evaporation:

$$\mathbf{WS_{Year\ X} = WS_{bank\ leakage} + WS_{seepage} + WS_{evaporation}}$$

6.2.3 Water Savings Calculations

Phase 3

$$\mathbf{WS_{leakage} = [(L_{base} \times FL) + (L_{Base} + V_L \times (D_{Year\ X}/D_{base})] \times CL \times t \times EF}$$

$$\mathbf{WS_{seepage} = S_{Base} \times CL \times t \times EF}$$

$$\mathbf{WS_{Evaporation} = E_{Base} \times CL \times t \times EF}$$

6.2.4 Input Data

The inputs required to calculate Phase 3 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. 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
L_{Base}	Leakage in the Baseline Year	Baseline Year water balance
V_L	Proportion of bank leakage recognised as variable	*Technical Manual*
FL	Proportion of bank leakage recognised as fixed	*Technical Manual*
D_{base}	Effectiveness Factor for reducing measurement error	Baseline Year water balance
EF	Effectiveness Factor for channel rationalisation	*Technical Manual*
S_{base}	Seepage in the Baseline Year	Baseline Year water balance
E_{base}	Evaporation in the Baseline Year	Baseline Year water balance

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

Parameter	Description	Source
$D_{Year\ X}$	Customer deliveries in the year in question to the irrigation system	IPM reports
CL	Ratio of length of spur channel length rationalised to total spur channel length in system	GIS and direct measurement
t	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

We have reviewed the input data and confirm that the fixed parameters sourced from the Technical Manual are correct. We reviewed the parameters sourced from the Baseline Year water balance and identified that there were some minor discrepancies between the baseline Year seepage, leakage and evaporation used in G-MW's calculations and those detailed in the Arup Baseline Year audit report. G-MW explained that the difference was due to a change in the number of significant figures used for an evaporation factor. We are satisfied with this change to the Baseline Year data and note that it does not significantly impact upon the water savings estimates.

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

Customer Deliveries in the Current Year ($D_{Year\ X}$)

Customer deliveries through the meters replaced in each irrigation district are determined through IPM. These delivery volumes are used for customer billing and as noted previously, we therefore believe they will be reliable due to the scrutiny they are subject to by G-MW and customers. We outline the results of our data trailing of customer delivery volumes in Section 5.5.1. We did not identify any errors or have need to make adjustments to the customer delivery volumes used by G-MW.

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

This ratio is intended to be calculated with the total length of spur channels only (i.e. the backbone omitted). However, as G-MW does not have the Baseline Year seepage, leakage and evaporation loss components separated into spur and backbone volumes, it has determined this ratio using the entire length of channels as the denominator. This situation has arisen because all of the channels in these systems have been nominated as backbone channels.

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

This variable depends on the channel de-commissioning date being correctly recorded. While we noted in Section 5.2.2 that these dates are not recorded well by Futureflow, as most works have been completed in previous years, their exact date of de-commissioning has no bearing on the savings for the 2009/10 irrigation season. This factor has been calculated from the input data.

6.2.5 Results

We found that G-MW has correctly applied the water savings formulae to the input data. Correcting for the discrepancies noted, the audited water savings due to channel rationalisation are summarised in Table 6-16.

Table 6-4 Phase 3 Water Savings due to Chanel Rationalisation

	Shepparton	Central Goulburn 1-4
Seepage (ML)	625	22
Bank leakage (ML)	221	19
Evaporation (ML)	409	8
Total (ML)	**1255**	**49**

6.3 Savings from Channel Automation

6.3.1 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 within a pool in a relatively restricted band.

Both the Shepparton and Central Goulburn 1-4 districts have largely automated backbone channel networks. Spur channels will not be automated as these will most likely be rationalised in future years. Table 6-5 details the extent of automation in each irrigation area.

Table 6-5 Extent of Automation by Irrigation Area at end of 2008/09 Season

System	Length of Backbone (km)	Length Automated (km)	% Automated
Shepparton	625	569	91%
Central Goulburn 1-4	264	258	98%

While the confirmation that automation works have been complete is ultimately evidenced by the reduction in outfall volumes from automated systems, we undertook the following additional checking to confirm that the regulator sites claimed have been constructed and commissioned as indicated:

- Site visit to a selection of sites that have been automated. We discussed this in Section 3.3 ; and
- Witnessing of commissioning certificates for a sample of randomly selected automated regulator sites. For this exercise, we focused on gates commissioned in 2010. This is discussed further in Section 5.2.2.

6.3.2 Overview

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

Phase 3: $WS_{Year\ X} = WS_{outfalls} + WS_{bank\ leakage}$

Water savings from outfalls account for the majority of water savings due to automation, and the majority of water savings overall. Therefore, we have subjected this element of the water savings calculations to particular scrutiny. As noted previously, G-MW has applied the Phase 2 calculations for determining bank leakage in place of the Phase 3 calculations.

6.3.3 Water Savings Calculations

Phase3 Calculations

Phase 3 water savings have been calculated by G-MW using the Phase 3 outfalls formula and the Phase 2 bank leakage formula:

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

$$WS_{Bank\ Leakage} = L_{Base} \times EF \times A \times t \times (D_{Year\ X} / D_{Base})$$

6.3.4 Input Data

The inputs required to calculate Phase 3 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
EF	Effectiveness Factor Channel automation (bank leakage)	*Technical Manual*

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

Parameter	Description	Source
O_{Yearx}	Outfalls in Current Year	SCADA and operator logsheets
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	ITP certificates for commissioning dates
A	Ratio of the length of channel to be or actually automated to the total length of channel in the defined system (%)	Determined from G-MW GIS
D_{yearx}	Customer Deliveries in the Current Year in 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 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 2009/10 calculations. We comment on the inputs from the current operating year following:

Outfalls in Current Year (O_{yearx})

The largest outfalls responsible for the greatest water savings are generally measured on-line with feedback to Goulburn Murray Water's SCADA. Operators review SCADA and enter daily volumes into logsheets. These logsheets are used as the source of the outfall flow volumes for the water savings calculations.

Given the importance of the outfall volumes to the water savings estimates, we reviewed these in detail. Our findings regarding systems for handling this data are included in Section 5.4 and the results of our data trailing are included in Section 5.4.1.

Ratio of Length of Channel Automated (A)

The ratio of length of channel automated is determined from the G-MW GIS. The calculation is limited to the length of backbone channel automated only as the spur channels will eventually be abandoned through the connections program. We consider that the automated length ratios used in the calculation of bank leakage are justified.

Customer Deliveries in the Current Year ($D_{Year\ X}$)

Customer deliveries in each irrigation district are determined through IPM. These delivery volumes are used for customer billing. Therefore, we believe that they will be reliable due to the scrutiny they are subject to by G-MW and customers. We outline the results of our data trailing of customer delivery volumes in Section 5.5.1. We have made adjustment for one delivery volume in the CG1-4 area identified as being incorrect.

Length of Time Channel Automated ($OP_{Year\ X}$)

G-MW calculate this factor as a simple ratio of the length of the 2009/10 irrigation season over the Baseline Year season length as the automation has been in place for the entire season.

6.3.5 Results

The audited water savings due to channel automation are summarised in Table 6-8.

Table 6-8 Phase 3 Water Savings due to Chanel Automation

	Shepparton	Central Goulburn 1-4
Inputs		
O_{base} (ML)	19,888	485
O_{yearx} (ML)	895	20
D_{base} (ML)	191,844	78,951
D_{yearx} (ML)	121,206	39,197
OP_{yearx} (ML)	1.01	0.99
$L_{base\ (backbone)}$ (ML)	5,746	8,912
$A_{backbone}$	0.91	0.98
t_a	1.00	1.00
Phase 3 Water Savings		
Outfalls (ML)	11,765	218
Bank Leakage (ML)	66	87

Note that outfall SP497 had outfall flows during 2009/10 greater than the baseline year volumes adjusted for LTCE, meaning that there are small 'negative' savings from this site. These 'negative' savings are included in the calculated water savings totals in accordance with s10.3.1 of the *Technical Manual* as all outfalls in the Shepparton area are treated as a single group.

We believe that the theoretical basis for zeroing outfalls is not made sufficiently clear by the *Technical Manual*. We recommend that the justification for this adjustment be included in the *Technical Manual*.

6.4 Savings from Service Point Replacement and Rationalisation

6.4.1 Scope of Service Point Replacement and Rationalisation Works

Water savings are achieved when existing customer service points, usually Detheridge Wheels, are replaced with modern outlets. The modern designs are typically pipes with magflow meters or flume gates. 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. Savings may also be achieved when existing service points are removed and not replaced (i.e. rationalised).

In the Shepparton and Central Goulburn 1-4 areas, the program of service point replacement and rationalisation works has been completed in previous years. Therefore all service pints have been in place for all of the 2009/10 irrigation season. Table 6-9 details the meter replacement and rationalisation works in place for the 2009/10 irrigation season.

Table 6-9 Extent of Meter Replacement and Rationalisation by Irrigation Area at end of 2008/09 Season

	Shepparton	CG1-4
Number of Manual Meters Replaced (No.)	566	244
Number of Automatic Meters Replaced (No.)	1,064	307
Total Meters Replaced (No.)	1,630	551
Number of Meters Rationalised (No.)	302	59

6.4.2 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 equation applies to both replacements and rationalisations although the individual components are determined differently.. G-MW has not included water savings due to meter error from rationalisations as it assumes that all flows through rationalised meters will now pass through new meters and the savings will be counted under service point replacement. This is a reasonable assumption. The high level equation is:

Phase 3:

$$WS_{Year\ X} = WS_{meter\ error} + WS_{leakage\ through} + WS_{leakage\ around} + WS_{unauthorised}$$

Service point replacements are the next most significant source of water savings after channel automation, accounting for around 35% of all savings estimated for the 2009/10 year. Service point rationalisation only accounts for a small fraction of savings estimated to date due to the small scope of works completed.

6.4.3 Water Savings Calculations

Phase 3 Calculations – Service Point Replacement

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

$$WS_{meter\ error} = \sum D_{MYear\ X} \times (1/MCF) \times (MCF - 1) \times EF_{error}$$

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

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

$$WS_{unauthorised} = N_{replaced} \times U_{Base} \times EF_{unauthorised} \times (D_{Year\ X}/D_{base}) \times t_m$$

Phase 3 Calculations – Service Point Rationalisation

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

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

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

$$WS_{unauthorised} = N_{rationalised} \times U_{Base} \times EF_{unauthorised} \times (D_{Year\ X}/D_{base}) \times t_m$$

6.4.4 Input Data

The inputs required to calculate Phase 3 water savings due to service point replacement and rationalisation are summarised in Table 6-10 and Table 6-11. 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 6-10 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_{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*

Parameter	Description	Source
U_{Base}	Unauthorised use loss in the Baseline Year	*Technical Manual*
D_{Base}	Customer Deliveries in the Baseline Year	Baseline Year water balance
D_{Mbase}	Customer deliveries through the Rationalised meters in the Baseline Year	Baseline Year water balance

Table 6-11 Current Year Parameters for Service Point Replacement and Rationalisation Water Savings Calculation

Parameter	Description	Source
$D_{MYear\ X}$	Customer deliveries through the replaced meters for the year in question	IPM reports
$D_{Year\ X}$	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
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	Construction records – date commissioned

We have reviewed the input data and confirm that the fixed parameters sourced from the *Technical Manual* are correct. G-MW 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. We comment on the inputs from the current operating year following:

Customer Deliveries through Replaced Service Points ($D_{MYear\ X}$) and in the Irrigation System ($D_{Year\ X}$)

We have commented on this variable before and the results of our data trailing of customer delivery volumes are outlined in Section 5.5.1. We made one adjustment for service point RN484, reducing its volume from 10.7ML to 0ML as noted in Section 5.5.1.

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

The number of meters replaced and rationalised is determined from construction records. We reviewed the commissioning certificates for a sample of service points as outlined in Section 5.2.2. While we found a number of minor errors, we are confident that the figures used in the calculations are generally reliable.

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

This factor is calculated by G-MW based on the commissioning (or de-commissioning in the case of rationalisation) dates for each service point. Our review of commissioning certificates for a sample of service points is outlined in Section 5.2.2. We found that the t_m factor had been calculated and applied correctly by G-MW for service point replacements and rationalisations. However, after further discussions with G-MW and NVIRP, we accepted that the denominator for the calculation for the factor t_m for service point rationalisations should be the length of a standard irrigation season, not the length of the irrigation season in the Baseline Year as detailed in the *Technical Manual*. We made this adjustment to G-MW's calculations which led to an 18ML decrease in the savings achieved, This represents a 2% decrease for service point rationalisation but only a 0.1% decrease on all savings.

6.4.5 Results

The audited water savings due to service point replacements are summarised in Table 6-12 and the savings due to service point rationalisation are summarised in Table 6-13.

Table 6-12 Phase 3 Water Savings due to Service Point Replacement

	Shepparton	CG 1-4
Inputs		
$D_{MYear\ X}$ (ML)	41,955	20,646
$D_{Year\ X}$ (ML)	121,206	39,197
$N_{replaced}$ (Manual) (No.)	566	244
$N_{replaced}$ (Automatic) (No.)	1,064	307
t_m	0.80	0.94
Phase 3 Water Savings		
Meter error (ML)	3,322	1,636
Leakage through service points (ML)	2,394	941
Leakage around service points (ML)	522	207
Unauthorised Use (ML)	594	185
Total (ML)	6,833	2,969

Table 6-13 Phase 3 Water Savings due to Service Point Rationalisation

	Shepparton	CG 1-4
Inputs		
$N_{rationalised}$ (No.)	302	59
t_m	0.84	0.93
D_{yearx} (ML)	121,206	39,197
Phase 3 Water Savings		
Leakage through service points (ML)	468	105
Leakage around service points (ML)	99	22
Unauthorised Use (ML)	140	25
Total (ML)	707	152

6.5 Savings from Channel Remediation

6.5.1 Scope of Irrigation Channel Remediation Works

Channel remediation involves lining earthen channels, installing pipelines and bank remodelling. These works can generate irrigation water savings through reduced evaporation, reduced bank seepage and reduced bank leakage. Channel remediation is further progressed in Shepparton and Central Goulburn 1-4 compared to the NVIRP areas. Channel remediation accounts for around 14% of the Phase 3 savings claimed by G-MW.

6.5.2 Overview

The *Technical Manual* outlines a 'theoretical' method and a 'direct' method for determining savings due to channel remediation. The direct method is to be used where pre-works and post-works pondage testing data is available and is preferred. The theoretical method is used in the absence of pondage testing data. Both direct and theoretical equations have the same high level form:

$$\mathbf{WS_{Year\ X} = WS_{bank\ leakage} + WS_{seepage} + WS_{evaporation}}$$

For the more recent remediation works completed in Central Goulburn 1-4, pre and post works pondage testing data is available so the direct method has been applied. For the earlier works completed in Central Goulburn 1-4 and Shepparton, no pre and post works pondage testing data is available and so the theoretical equations must be used. However, to apply the Phase 3 theoretical calculations for channel remediation savings, Baseline Year estimates of leakage and seepage losses are required. G-MW does not have these for the year the works commenced and also notes that as leakage is used to close the water balance, it may be subject to error when the remediation effects only a small fraction of the overall channel length.

G-MW has included water savings due to reduced evaporation resulting from installation of pielines. This is calculated using the theoretical equation.

6.5.3 Water Savings Calculations

Phase 3 Calculations– No pre-works pondage test data available

As noted, where no pre or post works pondage test data is available, the theoretical equation has been used which incorporates the Baseline Year leakage:

$$\mathbf{WS_{leakage} = \{[(L_{base} \times V_L \times (D_{Year\ X}/D_{base})) - (VL \times L_{Year\ X})] + [(FL \times L_{Base}) - (FL \times L_{Year\ X})]\} \times RL}$$

$$\mathbf{WS_{seepage} = (S_{Base} - S_{Year\ X}) \times RL}$$

$$\mathbf{WS_{Evaporation} = (E_{Base} - E_{Year\ X}) \times RL}$$

Where pre works pondage data is available but not post works data, the Phase 3 equation is used which incorporates an effectiveness factor:

$$\mathbf{WS_{leakage} = [(L_{pre\ works} \times V_L \times (D_{Year\ X}/D_{base})) + (L_{pre\ works} \times FL)] \times RL \times EF \times F(PA)}$$

$$\mathbf{WS_{seepage} = S_{Pre\ works} \times EF \times F(PA)}$$

Phase 3 Calculations– Pre and post works pondage test data is available

The *Technical Manual* calculations have been used without alteration for Phase 3 estimates where pre and post works pondage test data is available:

$$WS_{leakage} = (L^{pre\ works} - L^{Post\ works}) \times F(PA) \times t$$

$$WS_{seepage} = = (S^{pre\ works} - S^{Post\ works}) \times F(PA) \times t$$

6.5.4 Input Data

The inputs required to calculate Phase 3 water savings due to channel remediation are summarised in Table 6-14 and

Table 6-15.

. 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 6-14 Fixed Parameters and Baseline Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
V_L	Proportion of bank leakage recognised as variable	*Technical Manual*
FL	Proportion of bank leakage recognised as fixed	*Technical Manual*
D_{base}	Effectiveness Factor for reducing measurement error	Baseline Year water balance
EF	Effectiveness Factor for channel remediation	*Technical Manual*
L_{Base}	Leakage in the Baseline Year	Baseline Year water balance
S_{base}	Seepage in the Baseline Year	Baseline Year water balance

Table 6-15 Current Year Parameters for Channel Remediation Water Savings Calculation

Parameter	Description	Source
$L_{Pre\ works}$	Pre works bank leakage	Pondage testing or theoretical estimate
$L_{Post\ works}$	Post works bank leakage	Pondage testing
$D_{Year\ X}$	Customer deliveries in the year in question to the irrigation system	IPM reports
RL	Ratio of length of channel length remediated to total channel length in system	GIS and direct measurement
F(PA)	Pondage Testing Adjustment Factor to account for dynamic losses in addition to static losses	Technical Manual and soil type
$S_{pre\ works}$	Pre works seepage	Pondage testing or theoretical estimate
$S_{post\ works}$	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 is the deliveries in the Baseline Year sourced from the Baseline Year Water Balance.

The Leakage in the Baseline Year is calculated by G-MW as the residual of the water balance, i.e., bulk water losses less all other loss components (outfalls, leakage around outfalls, meter inaccuracy, leakage through and around meters, seepage, evaporation, unauthorised use and unmetered stock and domestic use). Because this component is back calculated from nine other loss components, each with its own inaccuracies, these inaccuracies are conveyed into the estimate of Baseline Year leakage. Therefore, while Goulburn Murray Water has determined this component in accordance with the *Technical Manual*, we are not confident that it represents a robust estimate. However, as there is no clear alternative, we accept the use of this estimation method. We note that this assumption applies to around 1.8GL of Phase 3 water savings (i.e. the savings for the Shepparton area) estimated by G-MW which is around 6% of the total. We comment following on the current year parameters.

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 discuss these tests in Section 5.6. We believe that the pre and post works pondage estimates determined through site testing are sound.

Customer Deliveries in the Current Year ($D_{Year\ X}$)

We have commented on this variable before and the results of our data trailing of customer delivery volumes are outlined in Section5.5.1.

Ratio of Channel Length remediated to Total Channel Length (RL)

As discussed in Section 5.6, channel remediation lengths are determined using GIS and through direct measurement on site. We are satisfied that these measurements are sufficiently accurate.

6.5.5 Results

The audited water savings due to channel remediation are summarised in Table 6-16.

Table 6-16 Phase 3 Water Savings due to Channel Remediation

	Shepparton	Central Goulburn 1-4
Pre and post works pondage data not available		
Bank leakage (ML)	1,806	
Seepage (ML)	16	
Evaporation (ML)	4	
Pre and post works pondage data available		
Bank leakage (ML)	-	1,942
Seepage (ML)	-	258
Combined		
Bank leakage (ML)	1,806	1,942
Seepage (ML)	16	258
Evaporation (ML)	4	
Total (ML)	**1,825**	**2,199**

7 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. The recommendations made in the audit of water savings for the 2008/09 season have been discussed by NVIRP, G-MW and DSE at a number of meetings over the last year.

We have outlined the progress against these recommendations in the 2009/10 NVIRP water savings audit report so do not repeat them here.

8 RECOMMENDATIONS ON TECHNICAL MANUAL AND WATER SAVINGS APPROACH

The Department of Sustainability and Environment request that comment be made following audit work regarding:

- Potential improvements to estimate the water savings in the areas of :
  - data collection,
  - data analysis,
  - assumptions and
  - methods.

- Recommended changes to the Technical Manual for the Quantification of Water Savings.

We make the following recommendations in these areas. These recommendations have been included within the body of this report or in the water savings report for the areas that G-MW is responsible for. We have repeated this recommendations section in each report for completeness:

Data Collection, Data Analysis, Assumptions and Methods

- SCADA should 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.
- Outfalls names used in the Areas should be reconciled with the outfall names used in SCADA. We identified several outfalls that could not be readily identified on SCADA or were incorrectly labelled.
- As more outfall flow data is recorded online into the SCADA data warehouse, reporting from here should be streamlined and made robust for water savings audit purposes. For example, a report that allows users to enter the start and end dates for the irrigation season in each irrigation district and then have returned the totalised outfall flows in that period on an outfall by outfall basis would be very useful.
- While operator logsheets continue to be used, operational practice should be standardised across regions, e.g. rounding of flows, treatment of rainfall rejection.
- Minor flow volumes should not be discounted from outfall volumes unless a valid reason is identified by the operator.
- As we found it difficult to find evidence to support the date on which channel rationalisation occurred in the Futureflow works area, we believe that NVIRP should ensure that its systems and procedures are sufficient to capture this information. This will become increasingly important as the Connections program progresses and applies also to the rationalisation of service points.
- We agree with the recommendation from the 2008/09 audit report that the water savings estimates should be reported accompanied by compliance grading for the accuracy and reliability of the information. We have repeated this recommendation as we believe that this is an important means for communicating the robustness of the water savings estimates.
- We identified a number of minor formatting and typographical errors in the Technical Manual. Where NVIRP and G-MW use Baseline Year audit data to calculate current year water savings, these values should be locked so that they are not accidentally changed.

Technical Manual

- We believe that the theoretical basis for zeroing these outfalls in the calculation of water savings from channel automation is not made sufficiently clear in the Technical Manual. We recommend that the justification for this adjustment be included in future revisions of the Technical Manual.
- For the calculation of water savings from service point rationalisation, the Baseline Year length is used in the denominator for the factor t. It may be more appropriate to use the length of a standard irrigation season.
- We will submit separately to the Department of Sustainability and Environment a schedule of errata we have identified in the Technical Manual.

Appendix 1

Schedule of Sites Visited

Site	Description
RN2307	Customer Service Point
TN1100	Regulator gate
TN1119	Regulator gate
TN13060A	Customer Service Point
TN1102	Regulator gate
TN587	Regulator gate
Near TN587	Channel lining
TN3561	Customer Service Point
TN500	Outfall
TN467A	Outfall
TN3822	Customer Service Point
RO297	Outfall
RO311	Outfall
RO359	Regulator gate
RO5654	Customer Service Point
RO5655	Customer Service Point
RO405A	Outfall
RO539	Regulator gate or Outfall?
RO617A	Customer Service Point
RO537	Regulator gate
RO555	Regulator gate
Near RO555	Channel lining
RO173	Offtake from Waranaga Main Channel
RO174	Regulator Gate

Appendix 2

Schedule of Documents Received

Document	Type	From
TATDOC-#2880511-v4- 2009_2010_ PHASE_3_WATER_ SAVINGS_ ESTIMATOR_-_17_JUNE_2010	Excel	Fiona Nioa
*TA0233~1	Excel	Fiona Nioa
*TABAFE~1	Excel	Fiona Nioa
TATDOC-#1991385-v1-PYRAMID-BOORT_EFFICIENCY_-_WWC_ AUTOMATION _AND_TANDARRA_PONDAGE_AUGMENTATION_PROPOSAL	Excel	Fiona Nioa
TATDOC-#2029252-v3-CG_3_CHANNEL_WIDTHS_-_MEASURED	Excel	Fiona Nioa
TATDOC-#2656547-v2-START_&_END_OF_SEASON_BY_ORDERS	Excel	Fiona Nioa
TATDOC-#2749699-v1-NOTE__PONDAGE_TEST_SUMMARY_2007_-_CG1-4_2006_07_TOP_LOSS_POOL_REASSESSMENT_NOVEMBER_2009	Excel	Fiona Nioa
TATDOC-#2764311-v1-2_DECEMBER_2009_-_PRELIMINARY_NVIRP_BACKBONE_LENGTHS	Excel	Fiona Nioa
TATDOC-#2867697-v4-LIST_OF_ALL_GMID_ CHANNELS_WITH_BACKBONE_ STATUS_-_CONFIRMED_BY_NVIRP_AND_G-MW_-_29_JUNE_2010	Excel	Fiona Nioa
TATDOC-#2880858-v1-2009_10_TCC_ACTIVATION_DATES_BY_IPM_REGULATOR_AND_IRRIGATION AREA_-_ 15_JUNE_2010	Excel	Fiona Nioa
TATDOC-#2882820-v1-GOULBURN-MURRAY_WATER_ANNUAL_REPORT_09-10_IRRIGATION_DELIVERIES	Excel	Fiona Nioa
TATDOC-#2886906-v1-CG1234_DIVERSIONS_FOR_2009_10_-_USED _IN_ PHASE _3_WATER_SAVINGS_CALCULATIONS	Excel	Fiona Nioa
TATDOC-#2886917-v1-2009-10_SYSTEM_FILL_CALCULATION_FOR_PHASE_3_WATER_SAVINGS_ ESTIMATOR	Excel	Fiona Nioa
TATDOC-#2886920-v2-RATIONALISED_ AND_REPLACED_METERS_IN_FF_ AND _NVIRP_AREA_FOR_2009_10_WATER_SAVINGS_ESTIMATOR	Excel	Fiona Nioa
TATDOC-#2889491-v1-WEATHER_-_WATER_BALANCE_RAIN_AND_EVAPORATION_-_KERANG__KYABRAM__SHEPPARTON_-_2009-10	Excel	Fiona Nioa
TATDOC-#2893980-v3-SERVICE_ POINT_SUMMARY_USED_ FOR _WATER_ SAVINGS_-_DATA_ UPDATED_FROM_V_DRIVE _ SPREADSHEETS	Excel	Fiona Nioa
TATDOC-#2903925-v1-2009_10_LEAKAGE_DATA_BY_AREA	Excel	Fiona Nioa
TATDOC-#2922335-v1-RAW_RATIONALISATION_DATA_FROM_FUTURE_FLOW	Excel	Fiona Nioa
TATDOC-#2926883-v1-AUTOMATED _CHANNEL_LENGTHS_FOR_NVIRP _AREA_FOR_PHASE_3_WATER_SAVINGS_ESTIMATION_2010	Excel	Fiona Nioa
*TATDOC~3	Excel	Fiona Nioa
*TATDOC~4	Excel	Fiona Nioa
*TA6CE6~1	Word	Fiona Nioa
*TA956C~1	Word	Fiona Nioa
*TA3664~1	Word	Fiona Nioa
*TA7866~1	Word	Fiona Nioa
*TABE6E~1	Word	Fiona Nioa
*TAC537~1	Word	Fiona Nioa
*TAF78A~1	Word	Fiona Nioa

Document	Type	From
TATDOC-#1488754-v4-STANDARD_ IRRIGATION_AREA_METER_ READING_ PROCEDURE	Word	Fiona Nioa
TATDOC-#2656973-v3-PROCEDURE_FOR_ESTIMATION_OF_SYSTEM_FILL_-_14_MAY_2009	Word	Fiona Nioa
TATDOC-#2705533-v1-FLOW_ CHART_PROCEDURE_FOR_COLLECTING _OUTFALL_DATA	Word	Fiona Nioa
TATDOC-#2705583-v3-PROCEDURE_FOR_COLLECTING_OUTFALL_DATA	Word	Fiona Nioa
TATDOC-#2706495-v3-PROCEDURE_FOR_DETERMINING_ OUTFALL_ SAVINGS_ F OR_DYEARX	Word	Fiona Nioa
TATDOC-#2706497-v1-PROCEDURE_DESCRIPTION_OF_G-MW _BUSINESS _SYSTEMS_	Word	Fiona Nioa
TATDOC-#2707346-v2-PROCEDURE_FOR_DETERMINING_AVERAGE_ DAILY_ WEATHER_VALUES_FOR_IRRIGATION_SEASONS	Word	Fiona Nioa
TATDOC-#2708378-v2-PROCEDURE_FOR_PONDAGE_TESTS_-__FIELD_ COMPONENT	Word	Fiona Nioa
TATDOC-#2708405-v2-PROCEDURE_FOR_PONDAGE_TESTS_-_DATA _ANALYSIS	Word	Fiona Nioa
TATDOC-#2709098-v1-FLOW_ CHART_PROCEDURE_FOR_COLLECTING _SERVICE_POINT_DATA	Word	Fiona Nioa
TATDOC-#2710073-v3-FILE_NOTE_-_PROCEDURE_-_DETERMINATION_ OF_ LEAKAGE _FOR_MODERNISATION_PROJECTS	Word	Fiona Nioa
TATDOC-#2713483-v2-PROCEDURE _FOR_CALCULATING_SEEPAGE_ RATES_ FOR_GMID_CHANNE L_SECTIONS_BASED_ON_SOIL_TYPE	Word	Fiona Nioa
TATDOC-#2723389-v2-PROCEDURE_-_ASSET_RATIONALISATION_FUTURE _FLOW_SHEPPARTON_IRRIGATION_AREA	Word	Fiona Nioa
TATDOC-#2745875-v2-PROCEDURE_SYSTEM_LOSS_NATURAL_CARRIERS_-_TORRUMBARRY_-_2_NOVEMBER_2009	Word	Fiona Nioa
TATDOC-#2806037-v1-PROCEDURE_-_MEASUREMENT_OF_CHANNEL_ WIDTH_-_17_FEBRUARY_2010	Word	Fiona Nioa
TATDOC-#2806687-v1-PROCEDURE_FOR_ESTIMATION_OF_F(PA)_-_ FEBRUAR Y_ 2010	Word	Fiona Nioa
TATDOC-#2926582-v1-PROCEDURE_FOR_DETERMINING_THE_ DELIVERIES _T HROUGH_NEW_SERVICE_POINTS	Word	Fiona Nioa
TATDOC-#2244076-v1-CAMPASPE_EAST_AND_WEST_CHANNEL_FLOW _MEASUREMENT	Word	Fiona Nioa
TATDOC-#2606839-v1-SPO_BENCKMARK_REPORT_2004-05_SEASON	Word	Fiona Nioa
TATDOC-#2659828-v3-FILE_NOTE_-_SUMMARY_OF_REPORTS_ ON_LEAKAGE_ THROUGH_OUTLETS_-_20_MAY_2009	Word	Fiona Nioa
TATDOC-#2684885-v1-REPORT_-_PONDAGE_TESTS_2008_09_-_GMID_ POST_IRRIGATION_SEASON	Word	Fiona Nioa
TATDOC-#2684998-v1-A_MANAGER_PLANNING_-_VERIFICATION_OF_ BULK_DIVERSIONS	Word	Fiona Nioa
TATDOC-#2753137-v2-IMSVSID_PROJECT_FINAL_REPORT	Word	Fiona Nioa
TATDOC-#2813750-v3-REVIEW_OF_ FLOW_DATA_FOR_EAST_GOULBURN_ MAIN_CHANNEL_-_2004_05	Word	Fiona Nioa
TATDOC-#2813791-v3-ADJUSTMENT_OF_DATA_FOR_CAMPASPE _IRRIGATION _DISTRICT_-_2003_04	Word	Fiona Nioa

Document	Type	From
TATDOC-#2865274-v3-MEMORANDUM_-_COMMENTS_ON_FINAL_STATE METERING_IMPLEMENTATION_PLAN	Word	Fiona Nioa

Note that documents indicated with an asterisk have inadvertently had their document name truncated and the names listed here will not correspond with those in G-MW's document management system. G-MW will supply complete document numbers in due course.