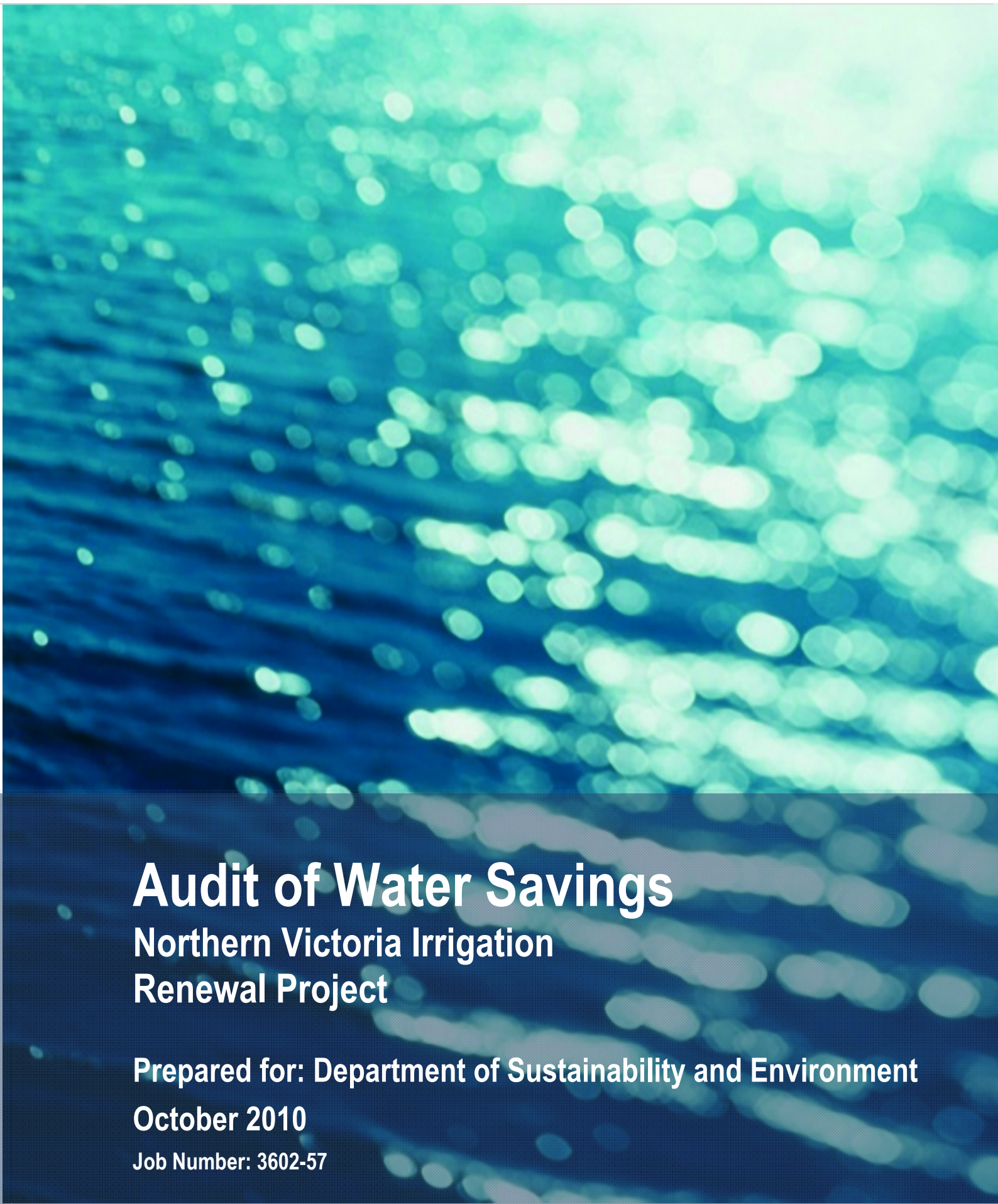

Audit of Water Savings

Northern Victoria Irrigation Renewal Project

Prepared for: Department of Sustainability and Environment

October 2010

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Document Control

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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 Northern Victoria Irrigation Renewal Project (NVIRP) for the 2009/10 irrigation season. The water savings estimates were prepared by NVIRP. The irrigation renewal works relate to the Central Goulburn (Channels 5-9), Murray Valley, Pyramid Boort, Rochester and Torrumbarry irrigation areas. A separate audit report has been prepared for the water savings achieved in the Shepparton and Central Goulburn (Channels 1-4) irrigation areas. Goulburn-Murray Water (G-MW) is the proponent for these water savings.

Audited Water Savings Estimates

The audited Phase 3 and Phase 4 water saving estimates are summarised in the following tables.

Audited Phase 3 Water Savings Estimates

Water Savings Intervention	CG 5-9	RO	PB	MV	TO[1]	TOTAL
Channel Automation						
Outfalls (ML)	10,165	2,872	516	577	483	14,613
Bank Leakage (ML)	63	37	7	24	29	160
Total - Channel Automation (ML)	***10,228***	***2909***	***523***	***601***	***512***	***14,773***
Service Point Replacement						
Meter error (ML)	3,333	473	133		46	3,985
Leakage through service points (ML)	2,067	223	38		8	2,336
Leakage around service points (ML)	450	48	8		2	508
Unauthorised Use (ML)	354	49	7		1	411
Total - Service Point Replacement (ML)	***6,204***	***792***	***185***		***58***	***7,239***
Service Point Rationalisation						
Leakage through service points (ML)	283	35			0	328
Leakage around service points (ML)	60	7			0	67
Unauthorised Use (ML)	59	9			0	68
Total - Service Point Rationalisation(ML)	***402***	***52***			***0***	***454***
Channel Remediation						
Theoretical method (ML)	223					223
Direct method (ML)	1,573					1,573
Total - Channel Remediation (ML)	***1,796***					***1,796***
TOTAL - All sources (ML)	**18,630**	**3,753**	**708**	**601**	**570**	**24,262**

Note

Torrumbarry has small volumes of water savings due to service point rationalisation that appear as zero due to rounding.

Audited Phase 4 Water Savings Estimates

Water Savings Intervention	CG 5-9	RO	PB	MV	TO[1]	TOTAL
Channel Automation						
Outfalls (ML)	28,211	6,053	1,419	1,507	1,392	38,582
Bank Leakage (ML)	188	86	19	68	85	446
Total - Channel Automation (ML)	***28,399***	***6,139***	***1,438***	***1,575***	***1,477***	***39,028***
Service Point Replacement						
Meter error (ML)	9,535	1352	379.25		132	11,398
Leakage through service points (ML)	1,653	178	30.05		7	1,868
Leakage around service points (ML)	428	46	7.54		2	484
Unauthorised Use (ML)	1,054	113	18.57		4	1,190
Total - Service Point Replacement (ML)	***12,670***	***1,689***	***435***		***145***	***14,939***
Service Point Rationalisation						
Leakage through service points (ML)	283	35			0	319
Leakage around service points (ML)	60	7			0	67
Unauthorised Use (ML)	174	22			0	196
Total - Service Point Rationalisation (ML)	***518***	***65***			***0***	***582***
Channel Remediation						
Theoretical method (ML)	391					391
Direct method (ML)	1,646					1,646
Total - Channel Remediation (ML)	***2,037***					***2,037***
TOTAL - All sources (ML)	**43,624**	**7,893**	**1,873**	**1,575**	**1,622**	**56,586**

Note

Torrumbarry has small volumes of water savings due to service point rationalisation that appear as zero due to rounding.

Systems and Processes

The water savings estimates for the NVIRP area rely on data sourced from systems and processes, some of which are the responsibility of NVIRP and some of which are the responsibility of G-MW. Our review of the systems and processes used by G-MW and NVIRP 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 that all the assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. 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 outflow 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 make SCADA the primary source of outfall flow volumes for use in the water savings calculations 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 customer deliveries volumes and season length data sourced from the 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 (DSE'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 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 NVIRP had determined water savings generally in accordance with the *Technical Manual*. For a number of instances (e.g. bank leakage from channel remediation) NVIRP 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 and NVIRP 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 sued 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. We detail our findings in Section 7 of this report.

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Figures

Tables

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 Shepparton, Central Goulburn, Rochester-Campaspe, Pyramid-Boort, Murray Valley and Torrumbarry Irrigation Areas in northern Victoria. Goulburn-Murray Water (G-MW) is responsible for the operation of all these irrigation areas.

The water savings referred to in this report have been achieved through the Northern Victoria Irrigation Renewal Project (NVIRP). NVIRP is a state owned entity responsible for installing works in the Central Goulburn (Channels 5-9), Murray Valley, Pyramid Boort, Rochester and Torrumbarry irrigation areas. A separate audit report has been prepared for the water savings achieved in the Central Goulburn (Channels 1-4) and Shepparton irrigation areas. Goulburn-Murray Water (G-MW) is the proponent for these water savings. More detail on the Northern Victoria Irrigation Renewal Project 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:

- 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.
- Checking that the data collection and inputs are as accurate as could reasonably be expected for the purpose of calculating water savings.
- Spot checks that the program of works has been implemented as documented in the water saving calculations.
- 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.
- Providing a corrected estimate of the water savings 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 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.
- 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.

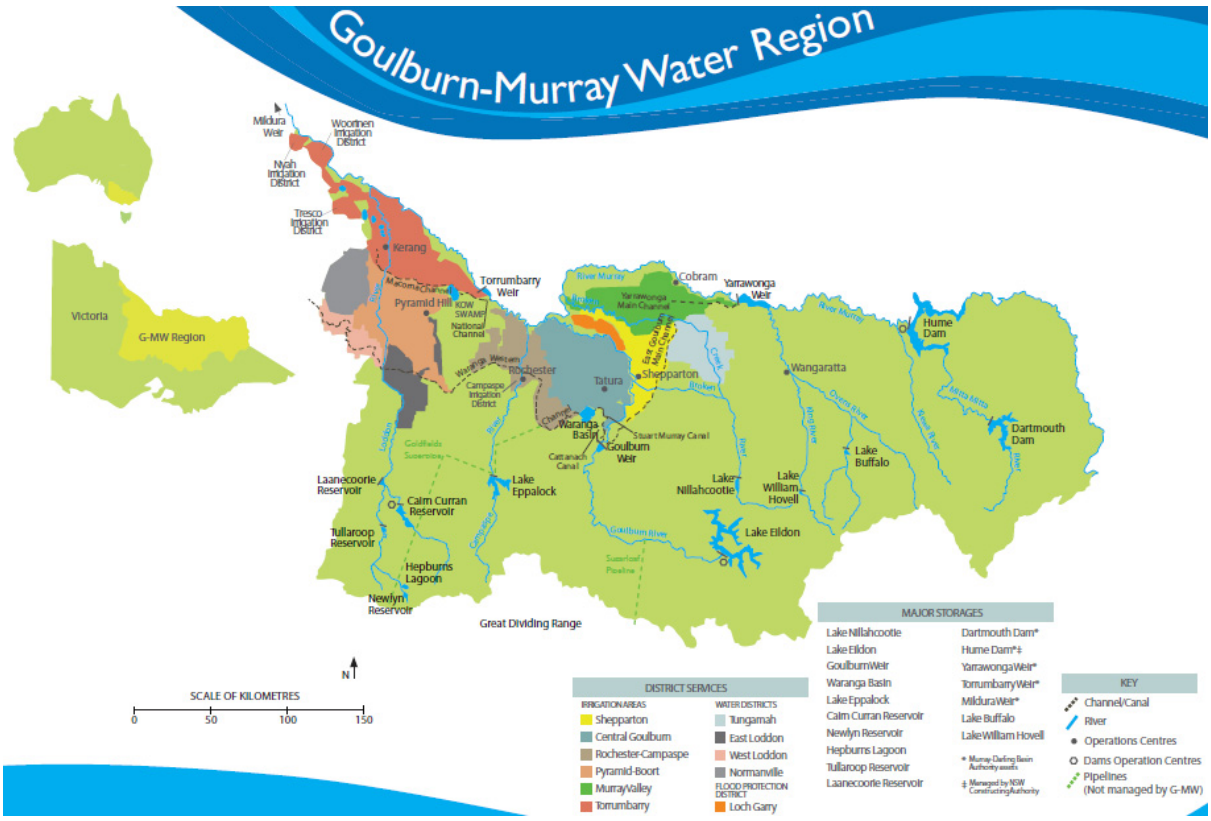

Figure 2-1 Goulburn Murray Irrigation District

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. 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. 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 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 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 7 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 0

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 structure 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.

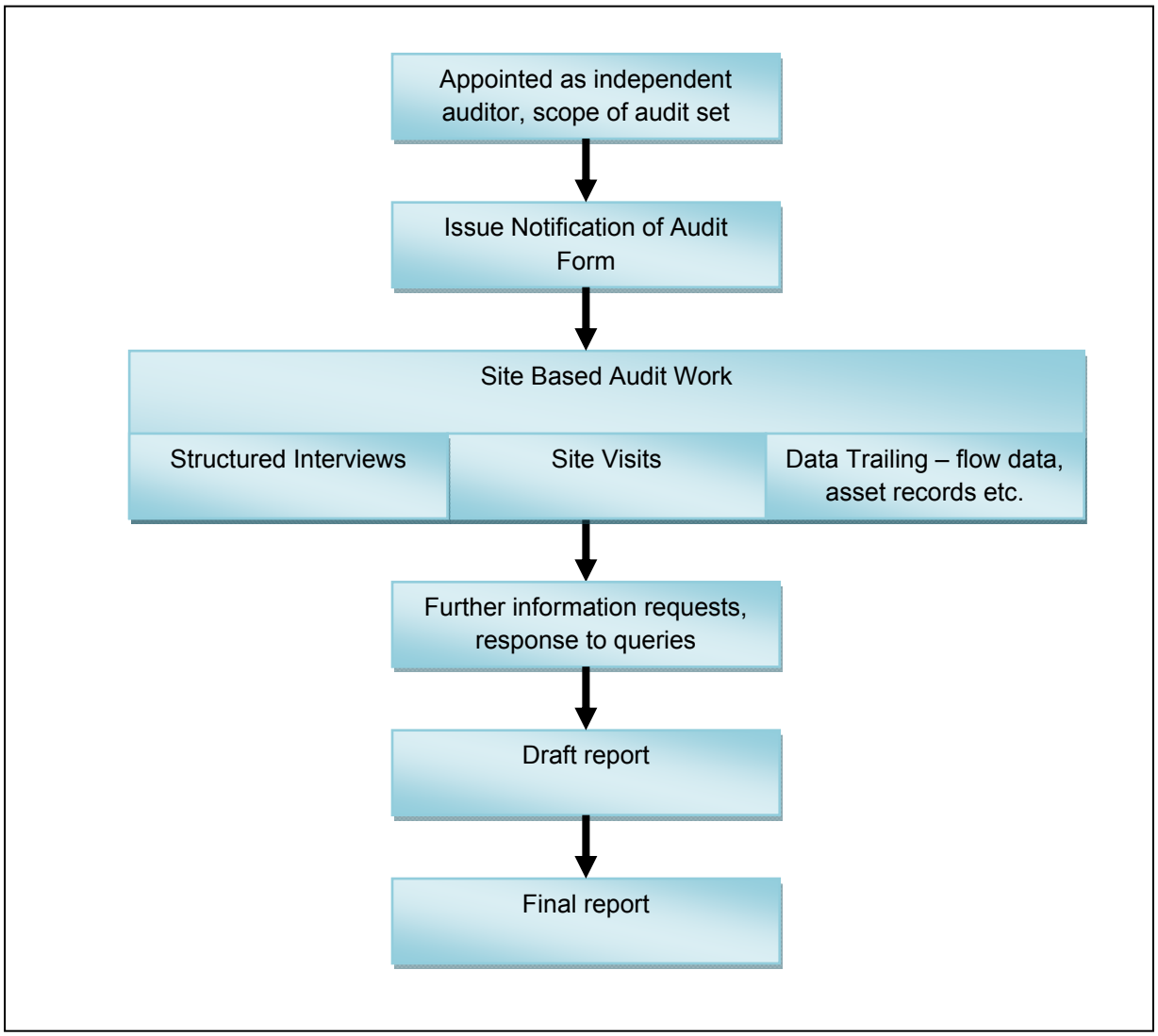

Figure 3-1 Overview of Audit Methodology

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 are included in Appendix 2.

4 NORTHERN VICTORIA IRRIGATION RENEWAL PROJECT

4.1 Project Background

The Northern Victoria Irrigation Renewal Project (NVIRP) is a scheme to deliver irrigation modernisation works in the Goulburn Murray Irrigation District, including automation of regulators, replacement of customer service points and remediation and decommissioning of channels. NVIRP is also the name of the State Owned Entity responsible for delivering the works.

NVIRP was established following acceptance by the State Government of a business case for Stage 1 of the modernisation works. The Stage 1 works only occur in five of the six irrigation areas as the Shepparton and Central Goulburn 1-4 areas have been previously upgraded as part of the Futureflow water savings project.

The Stage 1 NVIRP works area is shown in Figure 4-1. This 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.

Of the 6000km irrigation channels in the NVIRP work area, approximately 2,300km are large delivery or 'trunk' channels. This trunk network is referred to as the 'backbone' of system. The remainder of the delivery channels are termed connections or spurs. The network also includes natural watercourses (termed natural carriers) that are used to transport water within irrigation areas. These occur particularly within the Torrumbarry and Pyramid Boort areas.

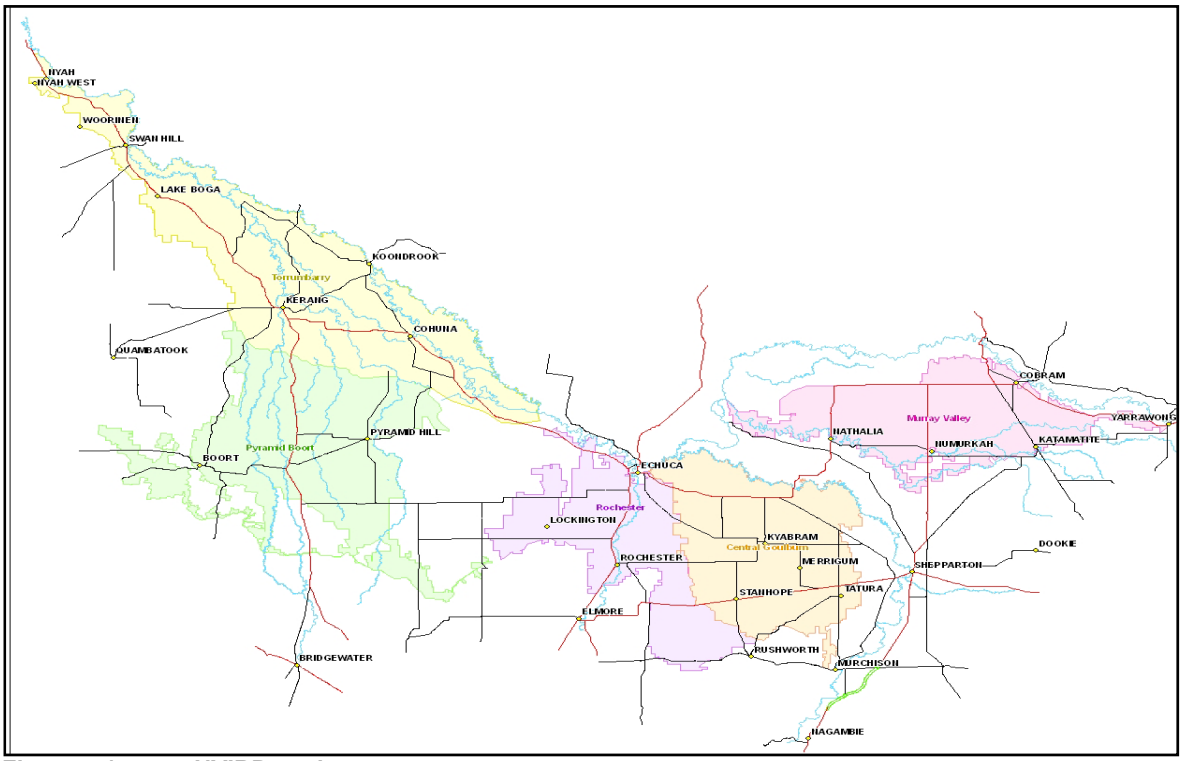

Figure 4-1 NVIRP works area

Source: NVIRP

4.2 Summary of Irrigation Modernisation Works

NVIRP Stage 1 works are targeted at fully automating the backbone channel network throughout the GMID. Additionally, a 'Connections Program' will streamline the way that farmers draw water from channels by moving connections from side channels (spurs) to the backbone, removing unnecessary connections and removing unnecessary side channels. Around 30% of this connections program will occur in Stage 1 with the balance to be delivered in Stage 2.

The modernised assets to be delivered through Stage 1 of the project are summarised in Table 4-1.

Table 4-1 Summary of Assets to be Delivered in NVIRP Stage 1

	Murray Valley	Central Goulburn	Rochester	Torrum-barry	Pyramid Boort	TOTAL
Channel Lining (km)	120	70	59	73	58	**380**
Regulator Gates (No.)	669	936	453	546	564	**3168**
Meters Installed (No.)	1237	1788	1080	1211	977	**6293**

Source: Connections Program – Information for Farmers. NVIRP.

NVIRP and G-MW provided us with the following further detailed information that details to the scope of works completed that we referred to in completing this audit report:

Plans

- Central Goulburn – Outfalls and NVIRP Works Program Update
- Murray Valley – Outfalls and NVIRP Works Program Update
- Pyramid Boort – Outfalls and NVIRP Works Program Update
- Rochester – Outfalls and NVIRP Works Program Update
- Torrumbarry – Outfalls and NVIRP Works Program Update
- Central Goulburn – Outfalls and PODs
- Murray Valley – Outfalls and PODs
- Pyramid Boort – Outfalls and PODs
- Rochester – Outfalls and PODs
- Torrumbarry – Outfalls and PODs
- Central Goulburn – Channel Works Statistics
- Murray Valley – Channel Works Statistics
- Pyramid Boort – Channel Works Statistics
- Rochester – Channel Works Statistics
- Torrumbarry – Channel Works Statistics

Reports and Presentations

- 2009/10 Water Savings Overview Report
- Water Savings Presentation to MCC

5 AUDIT FINDINGS – SYSTEMS AND PROCESSES

The water savings estimates for the NVIRP area rely on data sourced from systems and processes, some of which are the responsibility of NVIRP and some of which are the responsibility of G-MW. This section of the audit report is largely similar to that in the 2009/10 Shepparton and Central Goulburn 1-4 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 NVIRP and 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 (IPM) 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. We discuss the data trailing undertaken in the following sections.

5.2 Asset Planning, Design, Construction and Handover

NVIRP is responsible for installing irrigation modernisation assets in the Goulburn Murray Irrigation District on behalf of the asset operator, Goulburn Murray Water. NVIRP undertakes the planning function, as well as customer and community consultation. This consultation includes management of parallel works programs to deliver on-farm efficiency initiatives.

Transfield Service Australia (TSA) has been engaged from mid 2009 by NVIRP as the Managing Contractor for the delivery of construction works. TSA 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.

Prior to TSA starting work, early works in the areas that NVIRP is responsible for delivering irrigation modernisation works to were carried out by the Futureflow alliance. Futureflow also completed the works Shepparton and Central Goulburn 1-4 irrigation areas. The water savings in these areas are the subject of a separate audit report released concurrently with this report.

Delivery of the modernisation assets generally follows the following sequence:

1. NVIRP planning determine the schedule of works to be undertaken;
2. TSA project manage 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. Commission asset; and
4. Handover asset to G-MW.

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 TSA on a document management system (Aconex) along with other documents relevant to the construction and commissioning of each site.

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. Asset commissioning dates are recorded by TSA on schedules and forwarded to NVIRP. NVIRP then use these dates in its water savings calculations.

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.

We believe that NVIRP's and TSA's systems for asset delivery and commissioning are sufficiently robust to completely and correctly record the details of irrigation modernisation asset installation and commissioning. TSA's document management system provides the reference database for the storage and retrieval of all construction and commissioning records.

To complement our review of the systems used to manage asset delivery and commissioning, we selected a sample of assets (regulator gates, service points and channels) that NVIRP 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 NVIRP to provide to us commissioning certificates (ITP certificates) for a sample of sites 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 both Futureflow and TSA managed sites was selected randomly.

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

- All 27 sites selected randomly had commissioning certificates confirming that the works included in the calculations have been installed;
- Four sites had discrepancies of 1-3 days between the date used in the calculations and the date recorded on the commissioning certificate; and
- 1 site from the early works program had a discrepancy of around 2 months between the date used in the calculations and the date recorded on the commissioning certificate.

We conclude from this review that all 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 very 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. For one site, there was a discrepancy of 2 months which could not be explained. While this is a significant variation, it is an isolated instance based on our sample and we do not believe that there is any systemic error.

Trailing of Commissioning Certificates for Regulator Gate Works

We requested NVIRP to provide to us commissioning certificates for a sample of sites where automatic regulator gates have been installed to confirm that the works have been completed and on the date claimed.

We received all of the commissioning certificates we requested. Our review found that the dates that automation commenced used in calculations were later than the dates that the corresponding regulator gates were commissioned. NVIRP explained that this is because Total Channel Control (i.e. automation) is not implemented until all gates on a channel are commissioned, which may be some months after individual regulator gates installed.

We are satisfied that the automation dates used in the water savings calculations are sound.

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;
- IPM – takes customer orders, checks system capacity to deliver orders.

When an order is placed by a customer who is located on an automated channel, IPM 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. These volumes are provided to NVIRP for input into the water savings calculations.

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 as the system operator demonstrate to us the outfall volumes recorded in the current year for a targeted sample of sites across the NVIRP 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

	No. Outfalls in Sample	Coverage of all Outfall Savings (approx.)
Central Goulburn 5-9	11	75%
Rochester	7	54%
Pyramid-Boort	2	80%
Murray Valley	2	69%
Torrumbarry	2	91%

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 and used in the calculations by NVIRP;
- 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;
- 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; 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 (from both Futureflow and TSA works) 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.

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. NVIRP uses the actual length remediated in its calculations.

5.7 Conclusions

Our review of the systems and processes used by G-MW and NVIRP 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 that all the assets included in our samples for data trailing had sufficient evidence to support the fact that they have been constructed and commissioned. 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 outflow 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 make SCADA the primary source of outfall flow volumes for use in the water savings calculations 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 customer deliveries volumes and 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 a sensor is out of the flow.
- 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 (SP1204, TN583, RO524, PH436, TO663).
- 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, 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 and Phase 4 water savings achieved by NVIRP for the 2009/10 season. That is, the actual water savings realised in the 2009/10 irrigation season (Phase 3), as well as an estimate of the water savings that would have occurred over a comparable long term average year (Phase 4).

However, there are a number of instances where NVIRP has not applied the preferred Phase 3 or Phase 4 methodologies specified in the *Technical Manual* to estimate water savings. In these instances, NVIRP 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 NVIRP 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 1 and 2 calculations used in place of Phase 3 and Phase 4.	Using the Baseline Year leakage figure in Phase 3 and 4 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 used in Phase 3 and 4 calculations	Pre works pondage test data not available and no audited Baseline Year estimates available for losses	0.7%

We believe that NVIRP 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 automation, service point replacement and rationalisation and channel remediation.

6.2 Savings from Channel Automation

6.2.1 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.

In the NVIRP works areas, automation of the backbone channels is most progressed in Central Goulburn, followed by Rochester. The remaining three areas all had less than 40% of their backbone systems automated by the close of the 2009/10 season. Spur channels will not be automated as these will most likely be rationalised in future years. Table 6-2 details the extent of automation in each irrigation area in which NVIRP is active.

Table 6-2 Extent of Automation by Irrigation Area at end of 2008/09 Season

System	Length of Backbone (km)	Length Automated (km)	% Automated
Central Goulburn 5-9	561	499	89%
Rochester	277	180	65%
Pyramid-Boort	565	214	38%
Murray Valley	388	128	33%
Torrumbarry	441	166	38%

NVIRP provided to us a spreadsheet “230710_2008, 2009, 2010 sites.xls” that details the sites where automatic regulator gates have been installed. The progress of gate installation in each irrigation area by year is summarised in Table 6-3.

Table 6-3 Progress of Regulator Gate Installation at end of 2008/09 Season

Irrigation Area	2008 (No.)	2009 (No.)	Total (No.)
Central Goulburn	390	146	536
Murray Valley	51	66	117
Pyramid-Boort	4	190	194
Rochester	7	213	220
Torrumbarry	34	65	99
Total	**486**	**680**	**1166**

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 0.

6.2.2 Overview

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

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

Phase 4: $WS_{Year\ X(LTCE)} = WS_{outfalls(LTCE)} + WS_{bank\ leakage(LTCE)}$

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, NVIRP has applied the Phase 2 calculations for determining bank leakage in place of the Phase 3 and Phase 4 calculations.

6.2.3 Water Savings Calculations

Phase 3 Calculations

Phase 3 water savings have been calculated by NVIRP using the Phase 3 outfalls formula from the *Technical Manual*. Bank leakage was calculated using a modified Phase 2 bank leakage formula (as per Note 2 of Section 10.3.4 of the *Technical Manual*):

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

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

Phase 4 Calculations

Phase 4 water savings due to reduction in outfalls are estimated by the following equations from the *Technical Manual*, the bank leakage calculation being a modification of the Phase 1 calculation (as per Note 2 of Section 10.3.5 of the *Technical Manual*):

$$WS_{outfalls} = \sum [(O_{base} \times F(LTCE_{base})) - (O_{YearX} \times F(LTCE_{YearX}) \times (1/OP_x))] \times DF$$

$$WS_{Bank\ Leakage} = L_{Base} \times EF \times DF \times A \times F(LTCE_{base})$$

6.2.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to outfall automation are summarised in Table 6-4 and Table 6-5. 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 6-4 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*
EF	Effectiveness Factor Channel automation (bank leakage)	*Technical Manual*
$F(LTCE_{Base})$	Long Term Cap Equivalent Factor to convert Baseline Year volumes to Long Term Cap Equivalent volume	Department of Sustainability and Environment

Table 6-5 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
$F(LTCE_{Year\ X})$	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. 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. NVIRP limits its calculation to the length of backbone channel automated only as the spur channels will eventually be rationalised 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 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 CG5-9 area identified as being incorrect.

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

NVIRP has calculated this factor by taking an average of the fraction of the 2009/10 irrigation season that sections of channel have been automated for. This calculation relies on the channel TCC commissioning date being correct which is sourced from Rubicon. We are satisfied that these dates are sound. However, changes to commissioning dates are unlikely to materially affect the water savings estimates.

We note that as the NVIRP calculation is a simple average it weights each section of channel evenly. We believe that an approach that better reflects the potential savings realised from reduced bank leakage would be to weight the average by channel length. However, the additional accuracy gained is unlikely to make a material difference to the result, especially as the works progress and more gates become automated for an entire season.

Long Term Cap Equivalent Factor F($LTCE_{Year\ X}$)

This factor has been calculated by NVIRP in accordance with the formula in the *Technical Manual* using a factor of 1.3 for $LTCE_{Base}$ as advised by the Department of Sustainability and Environment. The ratio of deliveries volumes has been applied for all of the NVIRP operating areas, i.e. the GMID less Shepparton and Central Goulburn 1-4. We are satisfied with this approach.

6.2.5 Results

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

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

	CG 5-9	Rochester	Pyramid-Boort	Murray Valley	Torrumbarry
Inputs					
O_{base} (ML)	24,892	6,140	1,410	1,347	1,465
O_{yearx} (ML)	990	586	115	185	53
D_{base} (ML)	312,082	199,271	221,668	293,026	405,049
D_{yearx} (ML)	136,288	112,255	102,593	132,730	176,663
OP_{yearx} (ML)	1.02	0.99	0.97	1.04	0.99
$L_{base\ (backbone)}$ (ML)	10,892	7,175	3,344	9,041	18,959
$A_{backbone}$	0.89	0.65	0.38	0.33	0.38
t_a	0.74	0.71	0.58	0.88	0.46
Phase 3 Water Savings					
Outfalls (ML)	10,165	2,872	516	577	483
Bank Leakage (ML)	63	37	7	24	29
Phase 4 Water Savings					
Outfalls (ML)	28,211	6,053	1,419	1,507	1,392
Bank Leakage (ML)	188	86	19	68	85

Note that the following sites have outfall flows during 2009/10 greater than the baseline year volumes adjusted for LTCE, meaning that there are small 'negative' savings from these sites:

- RO5629
- R26 / RO No. 26
- RO No. 29
- TN1130
- MV42 and
- MV426

These sites have been excluded from the calculated water savings totals in accordance with s10.3.1 of the Technical Manual. These exclusions will lead to small discrepancies between the savings calculated on an outfall by outfall basis and the savings calculated across an entire irrigation district.

We believe that the theoretical basis for zeroing these outfalls 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*.

6.3 Savings from Service Point Replacement and Rationalisation

6.3.1 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. 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.

In the NVIRP works areas, meter replacement and rationalisation is well advanced in the Central Goulburn Area. Significant numbers of meters have also been replaced in Rochester, Pyramid Boort and Torrumbarry. However, rationalisation has only occurred in Rochester to a significant extent outside of the Central Goulburn Area. NVIRP's Connections program will seek to rationalise a large number of meters in the coming years. Table 6-7 details the meter replacement and rationalisation works completed to the end of the 2009/10 irrigation season.

Table 6-7 Extent of Meter Replacement and Rationalisation by Irrigation Area at end of 2008/09 Season

	CG 5-9 (No.)	Rochester (No.)	Pyramid-Boort (No.)	Torrumbarry (No.)	Total (No.)
Number of Manual Meters Replaced	430	73	6	19	528
Number of Automatic Meters Replaced	835	208	141	58	1242
Total Meters Replaced	1265	281	147	77	1770
Number of Meters Rationalised	167	55	-	1	223

6.3.2 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. NVIRP has not included water savings due to meter error from rationalisations of meters on the backbone as it assumes that all flows through rationalised meters will now pass through new meters on the backbone and the savings will be counted under service point replacement. This is a reasonable assumption but may slightly underestimate the savings achieved. The high level equations are the same for both Phase 3 and Phase 4 savings:

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

Service point replacements are the next most significant source of water savings after channel automation, accounting for approximately 30% of all savings estimated for the 2009/10 year. Service point rationalisation only account for a small fraction of savings estimated to date due to the small scope of works completed.

6.3.3 Water Savings Calculations

Phase 3 Calculations – Service Point Replacement

Phase 3 water savings have been calculated by NVIRP 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 NVIRP using the formula in the *Technical Manual*, however the unmetered component has been omitted as discussed:

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

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

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

Phase 4 Calculations – Service Point Replacement

Phase 4 water savings have been calculated by NVIRP using the formula in the *Technical Manual*:

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

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

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

$$WS_{unauthorised} = N_{replaced} \times U_{Base} \times EF_{unauthorised} \times t_m \times DF_{unauthorised} \times F(LTCE_{base})$$

Phase 4 Calculations – Service Point Rationalisation

Phase 4 water savings due to service point rationalisation have been calculated by NVIRP using the formula in the *Technical Manual*, however the unmetered component has been omitted as discussed:

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

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

$$WS_{unauthorised} = N_{rationalised} \times U_{Base} \times EF_{unauthorised} \times DF_{unauthorised} \times F(LTCE_{Base}) \times t_m$$

6.3.4 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 6-8 and Table 6-9. 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 6-8 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*
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
V_d	Deemed customer deliveries through individual unmetered service points 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 Sustainability and Environment*

Table 6-9 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
$F(LTCE_{Year\ X})$	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. NVIRP 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 ($D_{Year\ X}$)

Customer deliveries through the meters replaced and 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 made the following minor changes to the flows through customer meters in NVIRP's calculations:

- We removed two service points (TN4969 and PH2440) that were completed just outside of the 2009/10 season;

- We included flows totalling 2.9ML through five meters (PH2450, PH2463, PH2483, PH777A and PH862) that had been excluded by NVIRP; and
- We made a minor (1.7ML) adjustment to the volume of deliveries in the Central Goulburn 5-9 area to align with the figure reported by NVIRP.

None of these changes materially impacted on the savings estimated by NVIRP.

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 0. 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 NVIRP 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 0. We found that the t_m factor has been calculated and applied correctly by NVIRP for service point replacements.

For service point rationalisation, we found that NVIRP had used the length of a standard irrigation season (i.e. 15 August – 15 May) as the denominator in the calculation of t_m. However, the *Technical Manual* calls for the denominator to be the length of the irrigation season in the Baseline Year. We discussed this issue with NVIRP who reasoned that as the variables LTT, LTA and U were determined for a standard irrigation season, then this standard season length should be used as the denominator for this variable, not the Baseline Year season length. We agree with NVIRP's position and so have not changed the water savings calculations. If the Baseline Year season length was used, the Phase 3 savings would increase by around 12ML, or 3% for all savings due to service point rationalisation. However, this only represents around 0.05% of all savings so is insignificant. We believe that this aspect of the *Technical Manual* should be reviewed.

Long Term Cap Equivalent Factor F($LTCE_{Year\ X}$)

This factor has been calculated by NVIRP in accordance with the formula in the *Technical Manual* using a factor of 1.3 for $LTCE_{Base}$ as advised by the Department of Sustainability and Environment. The ratio of deliveries volumes has been applied for all of the NVIRP operating areas, i.e. the GMID less Shepparton and Central Goulburn 1-4. We are satisfied with this approach.

6.3.5 Results

The audited water savings due to service point replacements are summarised in Table 6-10 and the savings due to service point rationalisation are summarised in Table 6-11 .

Table 6-10 Phase 3 and Phase 4 Water Savings due to Service Point Replacement

	CG 5-9	Rochester	Pyramid-Boort	Torrum-barry	Total
Inputs					
$D_{MYear\ X}$ (ML)	42,094	5,970	1,674	585	
$D_{Year\ X}$ (ML)	136,286	112,255	102,593	176,663	

	CG 5-9	Rochester	Pyramid-Boort	Torrum-barry	Total
$N_{replaced}$ (Manual) (No.)	430	73	6	19	
$N_{replaced}$ (Automatic) (No.)	835	208	141	58	
t_m	0.89	0.43	0.13	0.06	
$F(LTCE_{Year\ X})$	2.86	2.86	2.86	2.86	
Phase 3 Water Savings					
Meter error (ML)	3,333	473	133	46	
Leakage through service points (ML)	2,067	223	38	8	
Leakage around service points (ML)	450	48	8	2	
Unauthorised Use (ML)	354	49	7	1	
Total (ML)	*6,204*	*792*	*185*	*58*	*7,240*
Phase 4 Water Savings					
Meter error (ML)	9,535	1352	379	132	
Leakage through service points (ML)	1,653	178	30	7	
Leakage around service points (ML)	428	46	8	2	
Unauthorised Use (ML)	1,054	113	19	4	
Total (ML)	*12,670*	*1,689*	*435*	*145*	*14,939*

Table 6-11 Phase 3 and Phase 4 Water Savings due to Service Point Rationalisation

	CG 5-9	Rochester	Torrumbarry[1]	Total
Inputs				
$N_{rationalised}$ (No.)	167	55	1	
t_m	0.92	0.34	0.04	
D_{yearx} (ML)	136,286	112,255	176,663	
Phase 3 Water Savings				
Leakage through service points (ML)	283	35	0	
Leakage around service points (ML)	60	7	0	
Unauthorised Use (ML)	59	9	0	
Total (ML)	402	52	0	454
Phase 4 Water Savings				
Leakage through service points (ML)	283	35	0	
Leakage around service points (ML)	60	7	0	
Unauthorised Use (ML)	174	22	0	
Total (ML)	518	65	0	582

Note

1. Torrumbarry has small positive savings that appear as zero as they are below the level of significance.

6.4 Savings from Channel Remediation

6.4.1 Scope of Irrigation Channel Remediation Works

Channel remediation involves lining earthen channels, lining pipelines and bank remodelling. These works can generate irrigation water savings through reduced evaporation, reduced bank seepage and reduced bank leakage. Only a small amount of remediation works consisting of channel lining has been completed by NVIRP to date, totalling around 20km.

Channel remediation accounts for around 7% of the Phase 3 savings claimed by NVIRP and less than 4% of the Phase 4 savings. Channel remediation is likely to become an increasingly important component of the water savings achieved as more works are completed.

6.4.2 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:

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

For the remediation works completed in 2009, NVIRP generally has pre and post works pondage testing data or pre works data only available. NVIRP was able to apply the direct method with pre and post data or modified direct method using pre works data and a conservative expected efficiency of remediation works. Savings estimates made only using pre works data will need validation and any adjustment to savings claimed made in subsequent years when post works pondage testing data is available.

For the works completed in 2008 however, no pondage testing data is available and so the theoretical equations must be used. However, to apply the Phase 3 and Phase 4 theoretical calculations for channel remediation savings, Baseline Year estimates of leakage and seepage losses are required. NVIRP does not have these estimates 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.

Therefore, NVIRP has used Phase 2 calculations to determine the pre works leakage and seepage losses for the 2008 works. We believe that this is a sound approach given the unavailability of pre-works pondage data. We note that this approach generates estimates of water savings that accounts for less than 1% of all water savings in the NVIRP area.

6.4.3 Water Savings Calculations

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

As noted, where no pre-works pondage test data is available, a modified Phase 2 calculation has been used:

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

$$WS_{seepage} = S_{Base} \times EF \times RL \times F(PA)$$

Phase 3 Calculations– Measured pre-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. If no post pondage test data is available, the pool post works losses are estimated based on the observed remediation effectiveness in other pools and the individual measured pre pondage pool data:

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

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

Phase 4 Calculations – No pre-works pondage test data available

As for Phase 3 water savings, a modified Phase 2 formula has been used to determine Phase 4 water savings due to channel remediation where no pre works pondage data is available:

$$WS_{leakage} = [(L_{pre\ works} \times V_L \times LTCE) + (L_{pre\ works} \times FL)] \times DF \times EF \times F(PA)$$

$$WS_{seepage} = S_{pre\ works} \times EF \times RL \times F(PA)$$

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

Phase 4 water savings have been calculated by NVIRP using the formula in the Technical Manual where pre-works pondage test data is available. If no post pondage test data is available, the pool post works losses are estimated based on the observed remediation effectiveness in other pools and the individual measured pre pondage pool data:

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

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

6.4.4 Input Data

The inputs required to calculate Phase 3 and Phase 4 water savings due to channel remediation are summarised in Table 6-12 and Table 6-13. 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 6-12 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*

Table 6-13 Current Year Parameters for Service Point Replacement and Rationalisation 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. We comment following on the current year parameters used in the calculations.

Pre Works and Post Works bank Leakage and Seepage ($L_{pre\ works}$, $L_{Post\ works}$, $S_{pre\ works}$, $S_{Post\ works}$)

Where no pondage testing data is available, pre-works bank leakage and seepage have been determined theoretically based on soil type and the SHLP, LHLP equations in Appendix 5 of the *Technical Manual*. We have reviewed these estimates and believe that they have been calculated transparently and in accordance with the stated approach.

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. 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 subsequent years.

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 Section 5.5.1.

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.

6.4.5 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 audited water savings due to channel remediation are summarised in Table 6-14.

Table 6-14 Phase 3 and Phase 4 Water Savings due to Chanel Remediation

	Phase 3	Phase 4
Theoretical method (ML)	223	391
Direct method (ML)	1,573	1,646
Total (ML)	**1,796**	**2,037**

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.

These discussions have produced a schedule that details the party responsible for actioning each recommendation and the progress to date in achieving that action. We reviewed this schedule with NVIRP and sought evidence to support the progress in achieving the recommendation. We found that significant work has been undertaken through various working groups to act on these recommendations.

The schedule, along with the finding from our review of the actions, is included at Appendix 3.

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 and 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.
- 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 identified a number of minor formatting and typographical errors in the *Technical Manual*. 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
3561	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 Waranga Main Channel
RO174	Regulator Gate

Appendix 2

Schedule of Documents Received

Document	Type	From
2009 10 water savings overview report	Word	Peter Roberts
Business case for Stage 1 3 February 10 Final	PDF	Peter Roberts
Conversion factor from 0405 to long average v3a	Word	Peter Roberts
Letter from G-MW to NVIRP regarding pondage testing dated 10/05/10	PDF	Peter Roberts
Water Savings Presentation to MCC Nov 2009	Powerpoint	Peter Roberts
Water savings from lining remodelling CG2-4	Word	Peter Roberts
TATDOC-_2662325-v3-FILE_NOTE_-_ UMMARY_OF_FIXED_AND_VARIABLE_ COMPONENTS _BANK_LEAKAGE-_MAY_2009	Word	Peter Roberts
TATDOC-_2684885-v1-REPORT_-_PONDAGE_T ESTS_2008_09_-_GMID_POST_IRRIGATION_SEASON	Word	Peter Roberts
TATDOC-_2937043-v1-summary_of_2009_10_outfall_volumes_by_ measurement_type_for_auditor	Excel	Peter Roberts
2009 2010 NVIRP Water Savings Estimation Procedures	Word	Peter Roberts
WSP10a Estimation of Water Savings Channel Automation Outfalls v2	Word	Peter Roberts
WSP10b Estimation of Water Savings - Channel Automation - Upper Bank Leakage- Use of Lbase and L yearx NOT RECOMMEND	Word	Peter Roberts
WSP10c Estimation of Water Savings Channel Automation Upper Bank Leakage where L yrx not available ver2	Word	Peter Roberts
WSP11a Estimation of Water Savings - Reduction in Leakage Around Replaced Outlets v2	Word	Peter Roberts
WSP11b Estimation of Water Savings - Reduction in Leakage Thruough Replaced Outlets v2	Word	Peter Roberts
WSP11c Estimation of Water Savings - Reduction in Unauthorised Use Replaced Outlets	Word	Peter Roberts
WSP11d Estimation of Water Savings - Reduction in Metering Error Replacment of Outlets	Word	Peter Roberts
WSP12a Estimation of Water Savings - Reduction in Leakage Around Rationalised Outlets v2	Word	Peter Roberts
WSP12b Estimation of Water Savings - Reduction in Leakage Through Rationalised Outlets v2	Word	Peter Roberts
WSP12c Estimation of Water Savings - Reduction in Leakage Around Rationalised Meters, open outlets v2	Word	Peter Roberts
WSP12c Estimation of Water Savings - Reduction in Unauthorised Use Rationalised Outlets	Word	Peter Roberts
WSP12d Estimation of Water Savings - Reduction in Unauthorised Use via Rationalisation v2	Word	Peter Roberts
WSP13a Estimation of Water Savings -Channel remediation - Direct Method	Word	Peter Roberts
WSP13b Estimation of Water Savings -Channel remediation - Measured L pre works data only	Word	Peter Roberts
WSP13c Estimation of Water Savings -Channel remediation Theortetical Method both Lbase L yrx good	Word	Peter Roberts
WSP13d Estimation of Water Savings -Channel remediation - Estimate L pre works	Word	Peter Roberts

Document	Type	From
Central Goulburn – Outfalls and NVIRP Works Program Update	PDF	Peter Roberts
Pyramid Boort – Outfalls and NVIRP Works Program Update	PDF	Peter Roberts
Rochester – Outfalls and NVIRP Works Program Update	PDF	Peter Roberts
Torrumbarry – Outfalls and NVIRP Works Program Update	PDF	Peter Roberts
Central Goulburn – Outfalls and PODs	PDF	Peter Roberts
Murray Valley – Outfalls and PODs	PDF	Peter Roberts
Pyramid Boort – Outfalls and PODs	PDF	Peter Roberts
Rochester – Outfalls and PODs	PDF	Peter Roberts
Torrumbarry – Outfalls and PODs	PDF	Peter Roberts
Central Goulburn – Channel Works Statistics	PDF	Peter Roberts
Murray Valley – Channel Works Statistics	PDF	Peter Roberts
Pyramid Boort – Channel Works Statistics	PDF	Peter Roberts
Rochester – Channel Works Statistics	PDF	Peter Roberts
Torrumbarry – Channel Works Statistics	PDF	Peter Roberts
sent to Auditor Automation Water Savings for season 2009 2010	Excel	Peter Roberts
Sent to Auditor Service Point Outlet Water Savings 2009 2010	Excel	Peter Roberts
V2 2009 10 water savings worked examples	Excel	Peter Roberts
Water Savings Summary Tablev3	Excel	Peter Roberts
Pete_Roberts_reconiled_with_FN_outfall_spreadsheet	Excel	Peter Roberts
peter_roberts_Tcc_dates	Excel	Peter Roberts
230710_2008,2009,2010 sites	Excel	Peter Roberts
2009 Channel remediation water savings estimation from 2009 works in 2009 2010 season	Excel	Peter Roberts
2008 Channel remediation water saving from 2008	Excel	Peter Roberts

Appendix 3

Schedule of Progress against Previous Recommendations

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
1	That a definition for start and finish dates of the irrigation season be discussed and agreed by the Water Saving Protocol Implementation Review committee and included in the Technical Manual.	GMW Report # 2656547	Procedures written: #2792065 (generic process) #2656547 (Area annual dates)	NVIRP/ GMW/DSE	complete	Complete
2	That a script be developed to run a report at the end of each season identifying the start and finish date for the irrigation season in each irrigation district. This will eliminate the current Technical Manual process and reduce the risk of error.	GMW Report # 2656547	#2792065	GMW	complete	Season lengths verified at audit
3	That a copy of the report run to calculate the 'start' and 'end of season' dates be kept on file for audit purpose and if electronic, locked to prevent amendment, except by approved staff.	GMW REPORT # 2656547	#2792065	GMW	complete	Complete – not reviewed
4	That G-MW prepare and implement asset acceptance procedures including verification process	Document ?	Procedure being drafted	GMW	in progress	Asset commissioning is more important than acceptance from a water savings point of view. From this perspective, ITP certificates serve the purpose of identifying when an asset begins contributing to savings

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
5	That where matters relating to definitions, data validation, inputs etc are discussed and agreed between the Project Proponent (NVIRP) and System Operator (G-MW) the agreement should be documented and signed off by both parties.	Agreed	Any matters of import dealt with outside WSG will be by letter or email	GMW-NVIRP	complete	We have seen that this occurs through the WSG, WSPIRG and documented in emails
6	That the Technical Manual be reviewed and where necessary amended to ensure consistency of definitions.	Agreed	TM Version 3	WSPIRC	complete	Complete – not reviewed
6b	Change formula: WSYear X = Σ DYearX x (1/MCF) X (MCF-1) x EF x DF x LTCEYearX to read WSunmetered = Σ DYearX x (1/MCF) X (MCF-1) x EF x DF x LTCEYearX	Agreed	TM Version 3	WSPIRC	complete	Complete – not reviewed
7	That the requirement to estimate Water Saving Outfalls on a "outfall by outfall" be reviewed by the WSPIRC prior to preparation of next year's water savings estimates and that an explanation for the adopted approach be included in the next revision of the Technical Manual.	WIP	TM Version 3 Mitigation Flows need to be identified and treated separately, ongoing issue. Draft Procedure #2706495v3 written to address 'channel system' definitions.	GMW/DSE	in progress	We comment on this under the recommendations section of this report

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
8	That the daily outfall volume reporting sheets be retained on file after the figures have been transferred to the area summary spreadsheet.	Agreed	Electronic storing of such documents has commenced	GMW	complete	Agreed, however SCADA should be used in preference to operator logsheets where possible
9	That a consistent format be adopted for recording outfall volume across all areas.	Agreed	GMW progressing/improving through Loss Management Program	GMW	in progress	Ongoing - discussed in Section 5 of this report
10	That detail of any adjustments made by Supervisors/Loss Management Officers be documented and retained along with a corresponding comment on the reasons for the adjustment	Agreed	Area procedures improved	GMW	complete	No procedures seen at audit
11	That a single LTCEyearx figure be used for the entire NVIRP area in future years when calculating water savings.	Agreed in interim but separate LTCE values for Murray Valley and Goulburn Systems may have to be developed	DSE	DSE	complete	This has been done for this year's calculations
12	That the water balance for 2008/2009 be reviewed and agreed between NVIRP & G-MW.	Agreed.	2009/10 is now the focus, process was established and agreed last year for step process from May 15 through to completion of audit	GMW-NVIRP	complete	The annual water balance for 2009/10 has been agreed but not audited. There is unlikely to be time to audit the water balance within the DSE's timeframe.

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
13	That the water saving estimates for bank leakage – channel automation in 2008/2009 not be calculated in accordance with the Phase 3 and Phase 4 equations.	Agreed	Requires annual consideration after water balance conducted	GMW NVIRP DSE	complete	Technical Manual now updated
14	That Phase 2 and Phase 1 be adopted as theoretical calculations in lieu of Phase 3 & Phase 4 for 2008/2009.	Agreed see above	As above	GMW / NVIRP/ DSE	complete	Technical Manual now updated
15	That alternative methodologies for calculating bank leakage water saving be investigated and evaluated by the Water Saving Protocol Implementation Review Committee.	Agreed	As above	GMW/ NVIRP/DSE	complete	As above
16	That pre and post works pondage tests should be carried out for all channel remediation works in future years.	Agreed	Area assistance and field resourcing both optimised to achieve maximum outcomes	GMW/ NVIRP/DSE	complete	We have seen that for all 2009 works pre works pondage testing has been completed
17	That consideration should be given to ensuring flexibility in the programming of out of season maintenance/construction works so pondage test can be completed.	Agreed	Areas formally consulted at start and end of each out of season period	NVIRP	complete	As above, pre-works tests have been completed
18	That the more conservative Water Saving Figures calculated using the G-MW methodology be adopted for Phase 3 Water Saving Estimate Channel Remediation for 2008/09.	Accepted	As per (13)	Auditor	complete	Not relevant to this audit

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
19	That G-MW review its procedures to ensure that in future years the delivery data report for input into the water saving calculations is only run after the end of the irrigation season, all meters read and the IPM database updated.	Agreed	Data quarantined by GMW at completion of all meter reads.	GMW	complete	GMW quarantines delivery volumes at 30 June. We saw an instance where a delivery volume was changed after this date. A later quarantine date is not likely to be workable as the data is needed for the calculations. We accept that this is likely to be an isolated incident.
20	That data recalculations agreed between G-MW and NVIRP should be formally documented.	Agreed	As per (5)	GMW & NVIRP	complete	We witnessed formal documentation of agreement at our audits
21	That the various definitions of DyearX and Dbase be reviewed and clarified.	Agreed	TM Version 3 Need to clarify when considering all deliveries, and when only considering deliveries through inaccurate meters.	WSPIRC	in progress	In progress
22	That the definition for Dbase in 12.3.3 be reviewed and clarified.	Agreed	As above	WSPIRC	in progress	In progress

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
	Recommendations					
23	That both G-MW and NVIRP should continue to develop and refine document procedures covering all aspects of data collection, cleansing, validation, alteration, storage, reporting and calculation of water saving estimates.	Agreed	Ongoing approach	NVIRP-GMW	complete	We have seen evidence of improvements in procedures used by GMW and NVIRP.
24	That all 'input data' prepared and issued for inclusion in water savings estimate calculations be given a 'closed' status at the time of issue and only amended by approved staff members and all amendments documented. A central copy of each report should be returned of each issued report.	Agreed	Data quarantined by GMW prior to audit	NVIRP-GMW	complete	We saw that this was being practiced at audit
25	That a compliance grading system be agreed by the DSE and included in the Technical Manual to be used in future year's audits of the water saving estimates.	Agreed	DSE	DSE	in progress	We agree that this compliance grading system or similar be adopted to provide context to the accuracy and reliability of the estimates

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
26	That the Technical Manual be updated to include a definition on the level of accuracy required for reporting of water saving estimates Phase 3 & Phase 4.	Agreed	DSE	DSE	in progress	We did not see evidence of this
27	That G-MW prepare documented procedures addressing the requirement for validation and reverification of all measurement devices in the irrigation system. The procedure should also address the recording and storage of validation and reverification certificates.	Agreed	Procedure #2865274 (meters)	GMW	complete	Complete
28	That a standardised Water Savings Estimate Calculation Spreadsheet template be developed incorporating the water savings formulae embedded in a spreadsheet as password protected macros. This template should then form part of the Water Savings Protocol.	Agreed.	Generic calculator being developed through DSE. Presents challenges due to unique delivery system arrangements from Authority to Authority.	WSPIRC	in progress	We believe that a standard calculation spreadsheet will restrict the ability of the different organisations who make water savings estimates to efficiently perform the calculations. This is because each organisation has different data sources and different approaches to completing the estimates.
29	That a plain English review of the Technical Manual be undertaken.	Agreed	TM Version 3	WSPIRC	complete	Now complete and Technical Manual revised

	Auditor's Comment	Outcome WSPIRG	Action	By	Status	2009/10 Audit Note
30	Many of the findings of the Sharp Coefficient Pty Ltd audit are relevant to the Cardno audit. As there has been insufficient time since the audit for G-MW to action all the recommendations of that audit, it was agreed with the DSE that this work should be the subject of a separate brief later in the operating year.	Agreed	Key recent undertaking was audit of baseline water balances	GMW	complete	Separate audit of baseline year now complete