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DEVELOPMENT AND IMPLEMENTATION OF IRRIGATION WATER MANAGEMENT PLANS TO IMPROVE WATER USE EFFICIENCY IN THE AGRICULTURAL SECTOR

HEREFORD IRRIGATION BOARD WATER MANAGEMENT PLAN

FINAL REPORT

MARCH 2013

Prepared by

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Contract Title: Development and Implementation of Water Management Plans to improve water use efficiency in the agricultural sector

Report Title: Hereford Irrigation Board - Water Management Plan

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WMP accepted by Hereford IB

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Chief Executive:

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EXECUTIVE SUMMARY

The first farms in the Olifants River Valley were demarcated in 1886 and the farmers cultivated wheat under dry-land conditions. Around 1925, after the successes of the small irrigation schemes, the Hereford Irrigation Board was founded to supply irrigation water to an area of about 2 140 ha which was situated a few kilometres downstream of the present Loskop Dam. The early success of this scheme gave rise to a petition which resulted in studies of the Hereford Scheme, as well as in a soil survey and a topographical survey of the dam basin. This paved the way for the commencement of the construction of the Loskop dam in 1934 as well as the establishment of the Loskop Irrigation Scheme.

The Hereford Irrigation Scheme was proclaimed in 1926 and lies on the left bank of the Olifants River, approximately 16 km downstream of the Loskop Dam. The scheme was established by private landowners after a small weir (known as the Miessner weir) and canal was built by Messer Miessner and Beukes on the Kameeldoorn Farm (71JS). The board acquired the weir on the Kameeldoorn farm and in return supplies irrigation water free of charge to this farm and the original Beukes farm (Kalkfontein 49JS).

Since the irrigation district was proclaimed under the Irrigation and Conservation of Water Act No. 12 of 1912, there has been no change to boundaries of the area. When the Board was established, the Water Court ruled that the total water allocation would be 29.9 percent of the normal flow of the Olifants River at De Wagendrift. In 1935, the Loskop Dam was built, which led to a need to modify the water entitlements. The Hereford IB was then allocated 26.68 million m^3/a free of charge from the Loskop Dam.

Initially, very little land was cultivated under irrigation, with approximately 430 ha in 1930. However, by 1935 this had more than doubled to 1 540 ha. Currently, the scheme has a total of 3 374 scheduled hectares which is approximately half of the total area that falls under the scheme.

The Hereford Irrigation Scheme consists of one irrigation canal 44 km in length on the left bank of the Olifants River. The canal distribution system delivers water to the irrigators at their farm turnouts through 53 sluice gates. The canal is supplied from the Miessner weir with water released from the right bank outlet works of the Loskop Dam. When the canal is flowing at full capacity, the flow at the Miessner weir into the canal is 1.15 m^3/s or 36.3 million m^3/year.

Until 2003, the Hereford canal was an earthen canal, which led to structural water scarcity problems. The situation became so desperate that farmers had their water quota reduced. The Hereford IB, which owns the canal, arranged funding to initiate the reconstruction project and contracted Group Five to undertake the construction work. Work commenced on

September 1, 2003. Hyson cells, which eliminate the need for joints and reinforcing, were used to hold the concrete lining. The total cost of the project was R 29.318 million and the upgrade was privately financed with no assistance from government.

The major crops grown along the Hereford Scheme are similar to the Loskop Scheme. However, table grapes are more widely cultivated and citrus is a more prominent crop. Before the 1960's, most of the irrigation along the scheme was by flood irrigation. This has now changed to sprinklers, centre pivots and drip irrigation and no flood irrigation is currently practiced along the scheme.

Water balance assessment

Prior to November 2012 the inflow into the canal at the Miessner Weir was not measured. Although a measuring structure was in place at the Miessner weir, the high water levels caused the parshall to be fully submerged with the associated inaccuracies. In November 2012 the Board had the parshall at the Miessner Weir recalibrated and have been keeping daily inflow records since then. No long-term inflow records are however available to conduct a proper water balance assessment. The canal discharges in a balancing dam at the end of the scheme and the return flows are therefore zero. The water flowing into this dam is measured on a continuous basis.

The Hereford Irrigation Board measures the weekly volume of water delivered to the water users using pressure regulating sluice gates.

As the Hereford canal was initially not lined with concrete, the water losses were inevitably higher and some 30 years ago, water losses were as much as 60 percent of the inflow into the scheme. Prior to the lining of the canal, scheme management already improved the way in which the scheme was administered, maintained and monitored and these actions resulted in the losses dropping to around 40%.

Following the lining of the canal, the measurements since November 2012 show that the present losses are in the region of 10%.

Existing water conservation measures

The Hereford IB has been implementing various measures to improve the management of delivery to the irrigators and to minimise losses. These measures inter alia include the total relining of the canal, eliminating canal end return flows and operating the scheme on a 24/7 basis.

Water management issues

Following the site visit and discussions held with the management and other parties who are knowledgeable about the scheme, the main water management issues that were identified include the following;

a) *WAS is only partially implemented on the scheme. Flow measurements etc. are only available in spreadsheet format. The problem is not so much with the current system in operation on the scheme but with continuity. WAS is a standardised program in use on various schemes throughout the country with many trained operators handling the system. This reduces the risk of an in-house developed program and temporary personnel could assist with the upkeep of the system should the regular operator(s) leave of fall ill.*

b) *It is currently difficult to disaggregate the various losses.*

Water saving targets

Given the excellent condition of the canal infrastructure the target for unavoidable losses was set as 5% of the input volume.

A Water Research Commission (WRC) study (Report TT465/10) which was conducted in 2010, has provided guidelines of the desired range of operational losses due to metering errors, canal filling losses after each dry period that have to be included in order to determine the BMP for operational and distribution efficiency (Reinders 2010). This is additional to the unavoidable losses determined in the previous sections. This desired range is expressed as a percentage of inflow into the irrigation scheme. The desired range for operational losses (i.e. metering errors, canal fillings, etc.) is 10% of the inflow into the irrigation scheme.

Therefore on the basis of the WRC study a BMP for operational and distribution efficiency has been taken as 10% of the inflow into the scheme.

As no breakdown in terms of avoidable and unavoidable was undertaken due to the absence of sufficient historical measurements, target water losses for the scheme should be based on the allowable water losses of approximately 15% of the total inflow into the irrigation canal. Accurate measurements of inflow into the scheme have commenced and the IB will be able to compile an accurate water budget within one year following the implementation of the WMP.

Conclusions and recommendations

The Water Management Plan forms the backbone of actions that have to be taken in increasing the efficient use of water within the Hereford Irrigation Board.

The intention of the Water Management Plan not to burden the IB and its officials with administrative tasks, but rather to promote a culture of using water as effectively and efficiently as possible. The plan will allow the WUA to improve on current water management practices and to profit from their efforts.

The Water Management Plan is a living document and close and ongoing co-operation between the WUA and DWA is essential to the ultimate success of the WMP and also the goals and strategic objectives of the DWA Directorate: Water Use Efficiency.

The goals for the WMP have been set and the IB believes that the targets and objectives set in the WMP are achievable through proper oversight by the Manager and support from the DWA.

This WMP must be seen as a first generation plan and has to be reviewed and updated on an annual basis.

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ABBREVIATIONS

AIC	Average Incremental Cost
BMP	Best Management Practice
DWA	Department: Water Affairs
ET	Evapo-Transpiration
EWR	Environmental Water Requirements
GIS	Geographic Information System
GWS	Government Water Scheme
IB	Irrigation Board
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MISD	Matching Irrigation Supply and Demand
O&M	Operation and Maintenance
RAT	Remote Assessment Tool
RTU	Remote Telemetry Unit
SLA	Service Level Agreement
WARMS	Water Allocation Registration Management System
WAS	Water Administration System
WCC	Water Conservation Coordinator
WCD	Water Control Department
WC/WDM	Water Conservation and Water Demand Management
WCO	Water Control Officer
WMA	Water Management Area
WMP	Water Management Plans
WUA	Water Use Association

GLOSSARY OF TERMS

Application efficiency	The ratio of the average depth of irrigation water infiltrated and stored in the root zone to the average depth of irrigation water applied, expressed as a percentage.
Applied water:	Water delivered to a user. Also called delivered water. Applied water may be used for either inside uses or outside watering. It does not include precipitation or distribution losses. It may apply to metered or unmetered deliveries
Conduit:	Any open or closed channel intended for the conveyance of water.
Conservation:	Increasing the efficiency of energy use, water use, production, or distribution.
Consumptive use (evapo-transpiration)	Combined amounts of water needed for transpiration by vegetation and for evaporation from adjacent soil, snow, or intercepted precipitation. Also called: Crop requirement, crop irrigation requirement, and consumptive use requirement.
Conveyance loss:	Loss of water from a channel or pipe during conveyance, including losses due to seepage, leakage, evaporation and transpiration by plants growing in or near the channel.
Conveyance system efficiency:	The ratio of the volume of water delivered to irrigators in proportion to the volume of water introduced into the conveyance system.
Cropping pattern:	The acreage distribution of different crops in any one year in a given farm area such as a county, water agency, or farm. Thus, a change in a cropping pattern from one year to the next can occur by changing the relative acreage of existing crops, and/or by introducing new crops, and/or by cropping existing crops.
Crop water requirement:	Crop consumptive use plus the water required to provide the leaching requirements.
Crop irrigation requirement:	Quantity of water, exclusive of effective precipitation, that is needed for crop production.
Crop root zone:	The soil depth from which a mature crop extracts most of the water needed for evapo-transpiration. The crop root zone is equal to effective rooting depth and is expressed as a depth in mm or m. This soil depth may be considered as the rooting depth of a subsequent crop, when accounting for soil moisture storage in efficiency

calculations.

Deep percolation: The movement of water by gravity downward through the soil profile beyond the root zone; this water is not used by plants.

Demand scheduling: Method of irrigation scheduling whereby water is delivered to users as needed and which may vary in flow rate, frequency, and duration. Considered a flexible form of scheduling.

Distribution efficiency: Measure of the uniformity of irrigation water distribution over a field.

Distribution loss: See conveyance loss.

Distribution system: System of ditches, or conduits and their appurtenances, which conveys irrigation water from the main canal to the farm units.

Diversion (water): Removal of water from its natural channels for human use.

Diversion (structure): Channel constructed across the slope for the purpose of intercepting surface runoff; changing the accustomed course of all or part of a stream.

Drainage: Process of removing surface or subsurface water from a soil or area.

Drainage system: Collection of surface and/or subsurface drains, together with structures and pumps, used to remove surface or groundwater.

Drip (trickle) irrigation: An irrigation method in which water is delivered to, or near, each plant in small-diameter plastic tubing. The water is then discharged at a rate less than the soil infiltration capacity through pores, perforations, or small emitters on the tubing. The tubing may be laid on the soil surface, be shallowly buried, or be supported above the surface (as on grape trellises).

Drought: Climatic condition in which there is insufficient soil moisture available for normal vegetative growth.

Dry Period :- A period during which there will be no water flowing in the canal system.

Evaporation: Water vapour losses from water surfaces, sprinkler irrigation, and other related factors.

Evapo-transpiration: The quantity of water transpired by plants or evaporated from adjacent soil surfaces in a specific time period. Usually expressed in

	depth of water per unit area.
Farm consumptive use:	Water consumptively used by an entire farm, excluding domestic use. See irrigation requirement, consumptive use, evapo-transpiration.
Farm distribution system:	Ditches, pipelines and appurtenant structures which constitute the means of conveying irrigation water from a farm turnout to the fields to be irrigated.
Farm loss (water):	Water delivered to a farm which is not made available to the crop to be irrigated.
Geographic Information System (GIS)	Spatial Information systems involving extensive satellite-guided mapping associated with computer database overlays
Irrigation schedule :	This is the list prepared by the Board showing the sequence the Irrigators will lead and dependent on the scheduled area the time period that the Irrigator is entitled to receive water
On-farm:	Activities (especially growing crops and applying irrigation water) that occur within the legal boundaries of private property.
On-farm irrigation efficiency:	The ratio of the volume of water used for consumptive use and leaching requirements in cropped areas to the volume of water delivered to a farm (applied water).
Operational losses:	Losses at the tail ends, sluices not opened or closed on time or opened to big and spills
Operational waste:	Water that is lost or otherwise discarded from an irrigation system after having been diverted into it as part of normal operations.
Pan evaporation:	Evaporative water losses from a standardized pan. Pan evaporation is sometimes used to estimate crop evapo-transpiration and assist in irrigation scheduling.
Parshall flume:	A calibrated channel-like device, based on the principle of critical flow, used to measure the flow of water in open conduits. Formerly termed the Improved Venturi Flume.
Percolation:	Downward movement of water through the soil profile or other porous media.

Reservoir: Body of water, such as a natural or constructed lake, in which water is collected and stored for use.

Return flow: That portion of the water diverted from a stream which finds its way back to the stream channel, either as surface or underground flow.

Return-flow system: A system of pipelines or ditches to collect and convey surface or subsurface runoff from an irrigated field for reuse. Sometimes called a "reuse system".

Run-off This is the water produced when irrigation water is applied to fields at rates and in amounts greater than can be infiltrated into the soil profile.

Request Form : A form on which an Irrigator requests the quantity of water he requires.

Tail end water This is water at the endpoint of a canal

Telemetry Involving a wireless means of data transfer

Water Note A form issued by the Control Officer informing the Irrigator of the quantity of water he will be receiving.

1 INTRODUCTION

1.1 Background

Irrigation agriculture is the biggest water user in the South Africa using approximately 62% of the current water use nationally. With the increasing competition between existing user sectors, the available water cannot meet the demand under current water use practices and operating conditions in all water use sector. Therefore it has become a major imperative that there is a need to ensure that available water supplies are used efficiently and effectively to avoid supply shortages and intermittent water supplies. This will have a major impact on the socio-economic growth and development of the country the scarce water resources of the catchments.

The savings that can potentially be made from implementing WC/WDM measures will enable delay in the development of additional new water supplies, while ensuring that the natural environment is maintained or is not degraded further. The Department of Water Affairs (DWA) identified that, based on preliminary assessment of water losses in the agricultural sector, there was potential to implement measures to improve water use efficiency in the sector. The overall aim of reducing water losses and improving irrigation water use efficiency levels in the Water User Associations (WUAs)/Irrigation Schemes is that the limited available water can be optimally utilised to ensure a high economic return for the scheme area.

The study was commissioned because of the increasing water scarcity in a number of Water Management Areas (WMAs). One of the approaches in addressing the increasing water scarcity and competition for water is to ensure existing water users utilise their existing water entitlement efficiently. The Department of Water Affairs (DWA) Directorate: Water Use Efficiency which has the mandate to ensure the efficient use of the water resources in the country by all water using sectors identified that since the development of the pilot Water Management Plans (WMPs) for improving water use efficiency in irrigation agriculture, not progress had been made by the irrigation sector develop and implement WMPs for the sector.

In order to ensure the irrigation sector review their current water use efficiency levels and develop strategies to improve their water use efficiency, the DWA has identified a need to assist a number of irrigation schemes in developing their irrigation water management plans in order to primarily reduce their water losses. A secondary outcome can be seen as the enablement of irrigators to increase their on-farm irrigation efficiency.

- Following on the meetings with DWA Directorate: Water Use Efficiency and the DWA Regional Office this report provides an overview of the water allocation and use situation of the Hereford IB and related institutional arrangements.

1.2 Study Objectives

The primary objective of the study is the development and implementation of an Irrigation Water Management Plan for the Hereford IB to improve water use efficiency in the scheme. In order to achieve this objective, the following aspects were considered:

- Compilation of a situation assessment of the current water use and irrigation water use practices in the scheme.
- Determination of the irrigation water budget and establishing a water use baseline for the irrigation scheme.
- Determination of the irrigation water management issues based on the situation assessment and water budget prepared for the scheme.
- Identification of opportunities to improve water use efficiency in the scheme.
- Benchmarking of irrigation water use efficiency and setting irrigation water use efficiency targets for the scheme.
- Preparation of an irrigation water management plan for the irrigation scheme.
- Capacity building of the IB implement the identified opportunities to improve water use efficiency.

The development of a WMP for the Hereford IB will not only provide a plan for reducing water losses and improve system efficiencies but if the management plan is implemented and water losses and water demand is reduced, the benefits to the agricultural sector, customers and the catchments in general will include:

- Improved system efficiencies
- Reduction in irrigation water return flows,
- system operation and maintenance expenses,
- Potential cost savings due to deferral or downsizing of capital works,
- Benefits which are important but difficult to quantify such as reduced environmental impact resulting from delays in or deferment of construction of water sources and the maintenance of higher water levels in rivers and reservoirs.

1.3 Structure of the report

This report has been structured to first provide a perspective of the Hereford IB as well as the potential for irrigated agriculture in the Olifants River catchment. The chapter then provides the overall objective of assessing water conservation and demand management measures in the context of increasing competition between existing water users and the need for water for the environment. This is the focus of **Chapter 1**.

Chapter 2 describes the catchment characteristics of the Olifants River catchment in which the Hereford IB is situated. The chapter describes the history of the Hereford IB, the scheduled quotas and current land-use practices in the catchment.

Chapter 3 provides an overview of water distribution infrastructure found in the Hereford IB. The chapter also describes the measurement of flow into and out of the Scheme.

Chapter 4 provides a condition assessment of the infrastructure of the Hereford IB.

Chapter 5 describes the Scheme operations and operating procedures. In this section the procedures relating to the ordering and delivery of irrigation water are *inter alia* discussed. The trading and transfers of water are handled as well as the present water pricing structure.

Chapter 6 describes the water balance assessment undertaken for the Hereford IB. The various losses identified on the scheme are also handled in detail.

Chapter 7 of this report describes the existing water conservation and demand management measures that have already being implemented by the IB.

Chapter 8 describes the key issues that the Hereford IB is facing and also includes the goals of the IB when WC/WDM is contemplated.

Chapter 9 provides the Water Management Plan for the Hereford IB.

Chapter 10 includes the conclusion and recommendation for the Hereford IB.

2 CHARACTERISTICS OF THE OLIFANTS RIVER CATCHMENT

2.1 Overview

The Hereford Irrigation Scheme is situated in the Greater Groblersdal and Marble Hall Local Municipalities. **Figure 2.1** presents the locality map of the Hereford Irrigation Board. The Olifants River has its headwaters in quaternary catchment B11A near Bethal in the Highveld of Mpumalanga. The major tributaries of the Olifants River are the Wilge, Elands and Ga-Selati Rivers on the left bank and the Steelpoort, Blyde, Klaserie and the Timbavati Rivers on the right bank . The total catchment area is estimated to 54 550 km ^{2}. There are a few major storages in the catchment namely Witbank, Doringpoort, Loskop and Flag Boshielo Dams.

The Olifants River initially flows from gently sloped hills northwards then cuts through the Drakensberg in an easterly direction through the Kruger National Park in the relatively featureless Lowveld region where it joins the Limpopo River in Mozambique and eventually discharges into the Indian Ocean.

2.1.1 Climate and rainfall distribution

Largely attributable to the topography, distinct differences in climate occur. The climate varies from cool in the southern Highveld region of the WMA through temperate in the central parts to sub-tropical east of the escarpment. The rainfall is strongly seasonal occurring mainly in summer. The mean annual rainfall falls in the range 500 mm in the Lowveld region, reaching 1000 mm in the mountains and reducing to 700 mm in the South in the Mpumalanga Highveld region of the WMA. The potential evaporation is well in excess of the rainfall.

2.1.2 Geology and soils of the catchment

The geology consists mainly of hard rock formations, with the occurrence of the Bushveld Igneous Complex as the most prominent feature. The eastern limb of this formation cuts through the northern part of the WMA. Rich coal deposits occur in the Upper Olifants Sub-area in the vicinity of Witbank and Middelburg. A large dolomitic intrusion extends along the Blyde River, curving westwards along the northern extremity of the WMA.

Figure 2-1 Location map of Hereford Irrigation Board

2.2 History of the Hereford Irrigation scheme

The first farms in the Olifants River Valley were demarcated in 1886 and the farmers cultivated wheat under dry-land conditions. Around 1925, after the successes of the small irrigation schemes, the Hereford Irrigation Board was founded to supply irrigation water to an area of about 2 140ha which was situated a few kilometres downstream of the present Loskop Dam. The early success of this scheme gave rise to a petition which resulted in studies of the Hereford Scheme, as well as in a soil survey and a topographical survey of the dam basin. This paved the way for the commencement of the construction of the Loskop dam in 1934 as well as the establishment of the Loskop Irrigation Scheme.

The Hereford Irrigation Scheme was proclaimed in 1926 and lies on the left bank of the Olifants River, approximately 16 km downstream of the Loskop Dam. The scheme was established by private landowners after a small weir (known as the Meissner weir) and canal was built by Messer Miessner and Beukes on the Kameeldoorn Farm (71JS). The board acquired the weir on the Kameeldoorn farm and in return supplies irrigation water free of charge to this farm and the original Beukes farm (Kalkfontein 49JS).

Since the irrigation district was proclaimed under the Irrigation and Conservation of Water Act No. 12 of 1912, there has been no change to boundaries of the area. When the Board was established, the Water Court ruled that the total water allocation would be 29.9 percent of the normal flow of the Olifants River at De Wagendrift. In 1935, the Loskop Dam was built, which led to a need to modify the water entitlements. The Hereford IB was then allocated 26.68 million m^3/a free of charge from the Loskop Dam.

Once the figure of 26.68 million m^3/a (0.85 m^3/s) was decided on, the same quota was used as the one already in place, i.e., 7 700 m^3/ha. The Board was allocated an additional 30% that could be diverted at the Miessner Weir (35.12 million m^3/a in total). The additional 8.3 million m^3/a was allocated from water emanating from the tributaries (mainly Selons River) between the Loskop Dam and the weir.

Initially, very little land was cultivated under irrigation, with approximately 430 ha in 1930. However, by 1935 this had more than doubled to 1 540 ha. Currently, the scheme has a total of 3 426 scheduled hectares which is approximately half of the total area that falls under the scheme.

2.3 Water use permits / licenses and contracts

When National Water Act (Act 36 of 1998) came into effect in 1998, irrigation boards were required to submit applications for the transformation into Water User Associations (WUA). The Hereford Irrigation Board has submitted an application for transformation but has not been transformed yet.

Policy proposals regarding the treatment of scheduled irrigation allocations on Government and Irrigation Board schemes as existing lawful water use in terms of section 33 of the NWA, 1998, were approved by the Minister on 10 May 1999. Under this policy, all lawful scheduling in terms of sections 63 and 88 of the Water Act (1956) on Government and Irrigation Board schemes, which has been annually paid for before 1 January 1999, was declared as existing lawful use in terms of section 33 of the NWA, 1998. The Policy also stated that all unexercised water uses must be exercised within three years after the promulgation of the Act to be considered as existing lawful water use

In Circular 18 of 2001 the Director General stated that *"all lawful scheduling in terms of section 63 and 88 of the WA for which all due water use rates and charges were paid on 30 September 1998, should be treated as existing lawful water uses in terms of section 33 of the WA. As there is no authority for the Minister to attach conditions to a declaration of an existing lawful water use, the three-year period to develop unutilised water allocations as granted in terms of Circular 59 of 1999 is hereby withdrawn. These unutilised rights can be treated as existing lawful water use until compulsory licensing is required."* The entitlement to use water on the scheme is therefore the continuation of existing lawful use. The Board therefore functions under the rules and regulations of the previous Water Act until the Board is transformed and compulsory licensing is required.

2.4 Irrigated areas and types of crops

The major crops grown along the Hereford Scheme are similar to the Loskop Scheme. However, table grapes are more widely cultivated and citrus is a more prominent crop. The typical crop mix across the Loskop Irrigation Scheme is indicated in Table 2.1 below.

Before the 1960s, most of the irrigation along the scheme was by flood irrigation. This has now changed to sprinklers, centre pivots and drip irrigation. No flood irrigation is currently practiced along the scheme.

Table 2-1: Crops under irrigation in the Hereford Scheme

Crops	%
Wheat (winter)	25
Citrus	20
Table Grapes	4
Cotton	18
Tobacco	18
Vegetables	15
TOTAL	***100***

Winter wheat covers the highest number of hectares and is popular because the crop utilises both capital and labour, while all the other crops are primarily summer crops. This improves the cash flow of the farming enterprise.

The seasons during which farmers irrigate the various crops are shown in Table 2-2.

Table 2-2: Irrigation season

Crops	Irrigation Season
Tobacco	October–March
Cotton	October–April
Wheat (winter)	May–early October
Citrus	12 months, peaks in September/October and December to February
Table grapes	12 months

3 INVENTORY OF THE EXISTING INFRASTRUCTURE

3.1 Overview

The Hereford Irrigation Scheme consists of one irrigation canal on the left bank (of the Olifants River), which originates at the Miessner Weir. The canal distribution system delivers water to the irrigators at their farm turnouts through 53 sluice gates.

3.2 Miessner Weir

On 25 September 1926 the Water Court for the district of Middelburg (Transvaal) apportioned the normal flow of a portion of the Olifants and judged that the normal flow during dry months of average years is not likely to often exceed 100 cusecs.

The owners of Kameeldoorn and those of the farm Kalkfontein constructed a weir (Miessner Weir built by Messers Miessner and Beukes) in the Olifants River (and a furrow) in order to use their portion of the normal flow of the Olifants River, as allocated by the Water Court.

On 24 September 1925 some of the owners of the farm Kameeldoorn entered into an agreement with the Hereford Irrigation Board. A memorandum of agreement was drafted by the Irrigation Department of the Union of South Africa on behalf of the Miessner family and the Hereford Irrigation Board during July 1928. In terms of this memorandum of agreement (Clause 1) the agreement provided that:

"the owners declare to make over to and in favour of the said board, who declare to require from them all the right, title and interest of the owners in and to the aforesaid weir and furrow, and in and to the said water, in accordance with the terms and conditions of the aforementioned agreement dated 24 September 1925, upon and subject to the following terms and conditions."

The provision contained in clause 9 of the agreement reads:

"As soon as the irrigation works are completed by the Board the owners shall be entitled to the conveyance in the furrow and deliverance at the outlet sluices of such proportion of the water in the river as was allotted to them in the Water Court judgment dated 25th September 1925, free of charge……The owners agree to abide to any Time Table which the Board may in consultation with themselves draw up, amend or alter from time to time for the proper and economical distribution of the water."

The water was to be delivered "free of charge" because the owners in the agreement "Miessner and Beukes" had already constructed a weir and irrigation canal and would not

derive any additional benefit from the upgrading of the water works by the Hereford Irrigation Board.

Figure 3-1: Miessner Weir

3.3 Hereford irrigation canal

The Hereford canal was constructed in 1926, has a total length of 44 km and lies on the left bank of the Olifants River approximately 16 km downstream of the Loskop Dam. Since its inception, the scheme has been run as a private irrigation scheme. The canal is supplied from the Miessner weir with water released from the right bank outlet works of the Loskop Dam. When the canal is flowing at full capacity, the flow at the Miessner weir into the canal is 1.15 m^3/s or 36.3 million m^3/year.

Figure 3-2: Outlet works at Loskop Dam

Until 2003, the Hereford canal was an earthen canal, which led to structural water scarcity problems. The situation became so desperate that Board had to reduce the water quota (not entitlement) to ensure that all the members receive some water.

The Hereford IB, which owns the canal, arranged funding to initiate the lining project and contracted Group Five to undertake the construction work.

It was stipulated that there must be no irrigation disruption, that the farm roads be kept open and the final water loss in the new canal had to be less than 10%.

The best option was to construct a deviation away from the canal, deposit the material on the roadside, divert the water into the deviation, backfill the old canal, excavate the new canal and backfill the deviation.

Work commenced on September 1, 2003. Hyson cells, which eliminate the need for joints and reinforcing, were used to hold the concrete lining.

Figure 3-3: Use of Hyson cells during construction

Along the length of the canal there were 57 weirs, which were all pre-cast in a yard on site. At the beginning of October 2003 the first 2 km of canal was handed over to the Board and after 10 hours of testing, the water loss was calculated as 0,5%. The total cost of the project was R 29.318 million and the upgrade was privately financed with no assistance from government.

Figure 3-4: Sluice at property

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Figure 3-5: View of lined canal

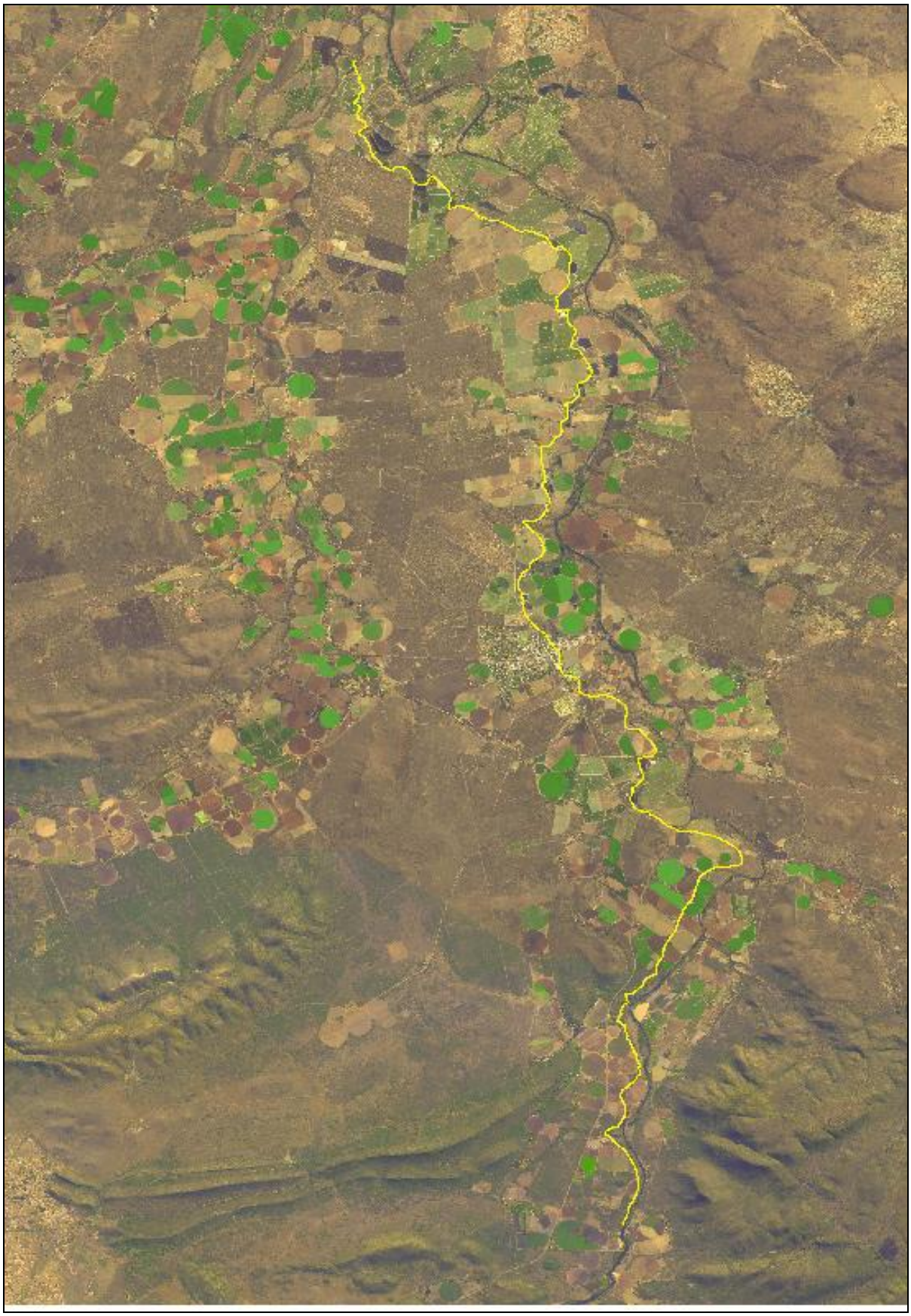


Figure 3-6: Hereford Irrigation Board Infrastructure

3.4 Irrigation storage and regulation system

There are no scheme balancing dams in the Hereford Irrigation scheme, however, almost every farm along the Hereford Scheme has its own storage dam. There are some 52 dams in the irrigation district with an estimated total capacity of 3.3 million m^3 or about 10 percent of the total water allocation of the Board.

3.5 Flow Measurement and telemetry system

3.5.1 Measurement of flow into and out of the Scheme

There is a measuring structure at the Miessner weir at the beginning of the canal. Due to the high water levels the parshall is sometimes fully submerged with associated inaccuracies. During November 2012 the whole measuring structure was professionally re-calibrated and new tables for the parshall was generated and detail inflows recorded. No flow measurements were taken prior to November 2012.

The Hereford Irrigation Board measures the weekly volume of water delivered to the water users using pressure regulating sluice gates.

Figure 3-7: Measuring structure at inlet to the scheme

4 INFRASTRUCTURE CONDITION ASSESSMENT

4.1 Overview

No condition assessment was undertaken as the canal was completely rebuilt during 2003.

5 SCHEME OPERATIONS AND OPERATING PROCEDURES

5.1 General scheme options

The Hereford Irrigation District has, since inception, been run as a private non-profit irrigation scheme. All 42 members of the Hereford Irrigation Scheme are farmers and there are no municipal or industrial water users.

The Board of the Hereford Irrigation Scheme is made up of seven members who are elected by all the members of the scheme. The number of votes that any particular member has depends on the quota of water entitlements that he or she possesses. Each member is entitled to one vote for every 10 hectares or land, or part thereof with a maximum of 10 votes. The Board members of the Hereford Scheme are re-elected every three years.

The Irrigation Board is required to meet with the regional head of DWA at least once a year and report on the functioning and management of the scheme. The Board is also required to meet at least twice a year with the members, where the Board is expected to report back to its members on the management and finances of the scheme and the members are free to raise any issues or problems.

Although the members have the right to request that a particular Board Member be removed if they feel that he or she has not been fulfilling his or her functions satisfactorily, this has never happened.

Apart from the requirements to meet with the Regional Head of the DWA once a year, the Hereford Irrigation Scheme has very few external influences. As a private scheme, it is answerable only to its members and although the DWA can restrict the amount of water that the scheme uses in times of drought and sets the tariffs for raw water charges, it has no influence over the running or management of the scheme.

No other government department such as the Department of Agriculture or nongovernmental organization has ever imposed any regulations or standards on the scheme.

At present there are very few violations of the rules and regulations of the Hereford Scheme. In the past, however, there were several cases where individual farmers were abstracting more than their allocation.

According to the Board however, this problem has been reduced and there is almost complete compliance with the regulations.

Theoretically, the members of the scheme can make formal complaints to the chairman of the Board if they feel that any particular member is not representing their interests adequately or are not performing their functions correctly. To date, however this has not happened and the prospect of it happening in the future did not appear to be realistic according to the Board. At present there are no performance evaluation procedures for the Board and no formal mechanism or body that objectively assesses the function that the Board plays.

Although few members of the scheme contravene its regulations, the Board does have the right to withdraw abstraction rights from members should such contraventions take place. Should irrigation water accounts not be settled, the Board retains the right to charge interest on outstanding amounts and non-paying members can be prohibited from abstracting water. Such cases are very rare and most disputes are discussed and negotiated with the Board and are usually resolved before such actions are deemed necessary.

5.2 Water ordering and delivery procedures

The Hereford Irrigation Board orders water from the Loskop Dam once every 2 weeks and it takes 48 hours for the water to arrive in the Miessner Weir. When the canal is flowing at full capacity, the flow at the Miessner Weir is 1.15 m^3/s or 36.3 million m^3/year.

When there is no restriction in farmers' quotas, the canal flows continuously and each farmer is required to use his water. He cannot postpone taking his share until later because of the limited carrying capacity of the canal. In periods of water restriction, the canal operates only during specific periods. In June 2003, with a 62 percent decrease in water allocation, the canal functioned only for 100 hours every 2 weeks to make sure that farmers at the downstream part of the canal receive at least a limited quantity of water. At such times, every 2 weeks, farmers can decide whether to use their quota or to postpone it to a later period in the season. For instance, farmers growing grapes or citrus prefer to use their quota in September and October.

A WCO is in charge of opening the gates of the farmers. In order to calculate the required height, he uses a specific Excel spreadsheet designed by the DWA and consultant engineers. First, depending on whether each farmer has decided to irrigate or not and his overall allocation, a spreadsheet calculates how many cubic meters he should receive per day for a given 2-week period. Then another spreadsheet calculates the required height of the sluice gate, given the depth of the water at the farmer' sluice, the daily volume calculated

in the previous spreadsheet and the opening of the sluice. The WCO goes from one sluice to another to operate them. He is the only person with the keys to the sluice gates.

The duties of the full time staff are to ensure that sufficient water is released from the Miessner weir, to open the sluice gates for the various farmers, and to monitor the levels of water losses. The amount of water entering the Hereford canal is controlled entirely by the Hereford irrigation scheme staff. However, in times of water shortage, the releases into the river from the Loskop Dam are regulated by DWA. Billing and the collection of fees have been outsourced to a firm of bookkeepers who performs the function.

The individual members of the scheme do not have the authority to request a specific volume of water and are normally required to abstract water while it is available. It is for this reason that there are such a high number of storage dams among the farmers as they have to store water for future use.

5.3 Water trading - Temporary water transfers

The Hereford Irrigation Board allows the trading of water use entitlements along its scheme. Should a particular farmer not require his or her full water allocation at a particular time, he or she is permitted to transfer these rights to another farmer. This transfer has to be approved by the Irrigation Board, which will assess the transfer based on its practicality and any impact that it may have on other water users. No permanent transfers of water use entitlements have been affected and all the trades to date have been temporary transfers, with the water use entitlements reverting to the original property after a fixed period of time

5.4 Water allocation

Once a year, in March, the DWA office in Groblersdal schedules the allocation of water from the Loskop Dam for the coming year. If the dam is not full, the DWA may decrease the annual allocation (which can be increased again in October if there have been sufficient inflows). For example, in March 2003, the dam was only 52 percent full and it was decided that all irrigation quotas would be decreased by 50 percent.

5.5 Water pricing structure

5.5.1 Setting of the irrigation pricing

The Hereford WUA incurs a number of expenses relating to the maintenance of the canal systems and the administration of the scheme. A breakdown of the main cost elements is presented in Table 5-1.

Table 5-1: Water tariffs (2012/13)

Cost element	Amount per hectare
Operation & Maintenance	R 325.70
Loan repayment – Standard Bank	R 1 264.70
Loan repayment – Schoeman Boerdery	R 65.00
Total	**R 1 655.40**

6 HEREFORD IRRIGATION SCHEME WATER BALANCE

6.1 Introduction

The purpose of a water balance is to summarise the inflows, consumption and outflows from the area of operation of an Irrigation Board/Scheme. During the preparation of a water balance the beneficial and non-beneficial consumptive uses are determined which form the basis for the calculation of performance indications which are necessary in identifying water savings opportunities.

Every water use component in a Scheme/Board is represented in a water balance and the various categories for inflows, consumptive use and outflows are described and discussed below.

6.2 Inflows

No inflows were available for the Hereford Irrigation Board

6.3 Consumptive use

Consumptive use can be classified as the use that removes the water from the scheme that renders it unavailable for further use. Consumptive use can be classified into two main categories;

Process consumption

Process consumption or productive use is that volume of water that is used to produce the crops and is therefore considered beneficial use.

Non-process consumption

Non-process consumption or non-productive use occurs when water is consumed (depleted), but not by the irrigation of crops. Non-process consumption can further be subdivided in two types of uses, namely;

- Beneficial use, such as water that is used by indigenous riverine vegetation, and
- Non-beneficial use, such as evaporation or deep percolation that cannot be retrieved for productive use.

The supply to individual water users is measured (or rather administered) through the variable water pressure at different adjustable sluice gates. The irrigation board measures the pressure and a certain pressure is then related to a specific volume of water. The sluices are adjusted by hand in increments.

6.4 Outflows

As the name suggests, outflow is water flowing out of the system or area of operation of the scheme and can be classified as ether committed or non-committed outflow.

Committed outflow is that part of the outflow that is committed to other uses or users. Uncommitted outflow is outflow that is available for other or downstream use. Uncommitted

outflow can occur as a result of a lack of storage or operational measures. No outflows occur on the Hereford Irrigation Scheme due to the fact that the canal ends in a large private balancing dam at the end of the scheme.

6.5 Overall scheme water balance

Measurements of flow into the scheme started in November 2012 and since no historical readings are available, no water balance was undertaken.

6.5.1 Overview

The determination of operational losses (and mechanisms to minimise it) is one of the most important tools for improving irrigation water use efficiency levels. Higher accuracy in determining these losses can underpin the efforts to decrease losses over the extent of the whole canal distribution system. Decreasing “avoidable losses” from irrigation canals is often the only “relatively” inexpensive method available when contemplating water management measures.

Avoidable losses occur as a result of inefficient management in the operation of the canal system and can mainly be attributed to poor canal maintenance (leaks), incorrect headwork and inefficient runtime release determination, inaccurate water measuring structures and other restricting factors such as algae growth, etc.

Unavoidable losses from canal systems can be attributed to seepage and evaporation and is related to the surface area of water in the canal, wetted perimeter area of the canal and to the structural condition of the canal network.

6.5.2 Conveyance losses

Conveyance losses within a canal system can be defined as the difference between the water released at the canal inlets and the water delivered to the farm boundary. Conveyance losses are made up of unavoidable and avoidable losses.

Unavoidable losses

Unavoidable losses takes place on a continual basis and the bulk of unavoidable losses are made up of seepage and evaporation losses.

Avoidable losses

Avoidable losses include items such as leakages and spills and include operational losses and wastages resulting from inter alia, inefficient management of the system and other factors such as algae growth, etc.

A summary of the measurements taken since November 2012 is shown in Table 6-1.

Table 6-1: Hereford Scheme losses

Week	Inflow (m^3)	Delivered to irrigators (m^3)	% Losses
19/11/2012	614 040	573 335	6.63
26/11/2012	613 872	565 817	7.83
03/12/2012	614 040	557 453	9.22
10/12/2012	593 712	534 021	10.05
17/12/2012	603 792	557 453	7.67
24/12/2012	603 792	556 538	7.83
31/12/2012	573 216	548 704	4.28
07/01/2013	511 728	467 555	8.63
14/01/2013	532 224	483 678	9.12
21/01/2013	562 968	526 159	6.54
28/01/2013	314 400	293 625	6.61
04/02/2013	573 216	553 865	3.38
11/02/2013	614 040	540 743	11.94
18/02/2013	614 040	532 186	13.33
25/02/2013	665 280	557 135	16.26
04/03/2013	665 280	647 971	2.60
Total	9 269 640	8 496 238	8.34

7 EXISTING WATER MANAGEMENT MEASURES AND PROGRAMMES

7.1 Overview

The Hereford Irrigation Board has been implementing measures to improve the management of delivery to the irrigators. These existing water management measures are discussed in more detail below.

7.2 Relining of canal

In recent years, there has been a vast improvement in the efficiency of the management and operation of the Hereford Scheme. The Hereford Scheme has a history of very high water losses. About 30 years ago, water losses were as much as 60 percent of the irrigation water. As the Hereford canal was initially not lined with concrete, the water losses were inevitably higher. Prior to the lining of the canal, scheme management has already improved the way in which the scheme is administered, the upkeep of the canal, and the monitoring of water delivery and these actions resulted in the losses dropping to around 40%.

Following the lining of the canal at a cost of R29 million that was privately funded, the present average losses are 8.3%.

7.3 Eliminating canal end return flows

The Hereford Canal empties into a large farm dam situated at the end of the scheme and any canal end return flows are captured in this dam. A measuring device is installed at the inlet to the dam and the inflow is subtracted from the quota of the water user.

7.4 Minimising losses

The Irrigation Board operates the scheme over weekends as well. Although this results in some additional costs in terms of labour, there has been a decrease in operational losses caused by the start-up and shut-down of the system (filling losses).

8 WATER MANAGEMENT ISSUES AND GOALS

8.1 Overview of the management issues

Although no formal water budget was developed for the scheme, analysis of the available information and information gathered during discussions with the management and other people who are knowledgeable about the Hereford Irrigation Scheme, the identification of key issues was still possible. Table 8-1 below provides the key issues identified and these are discussed in more detail in the following sections of this chapter.

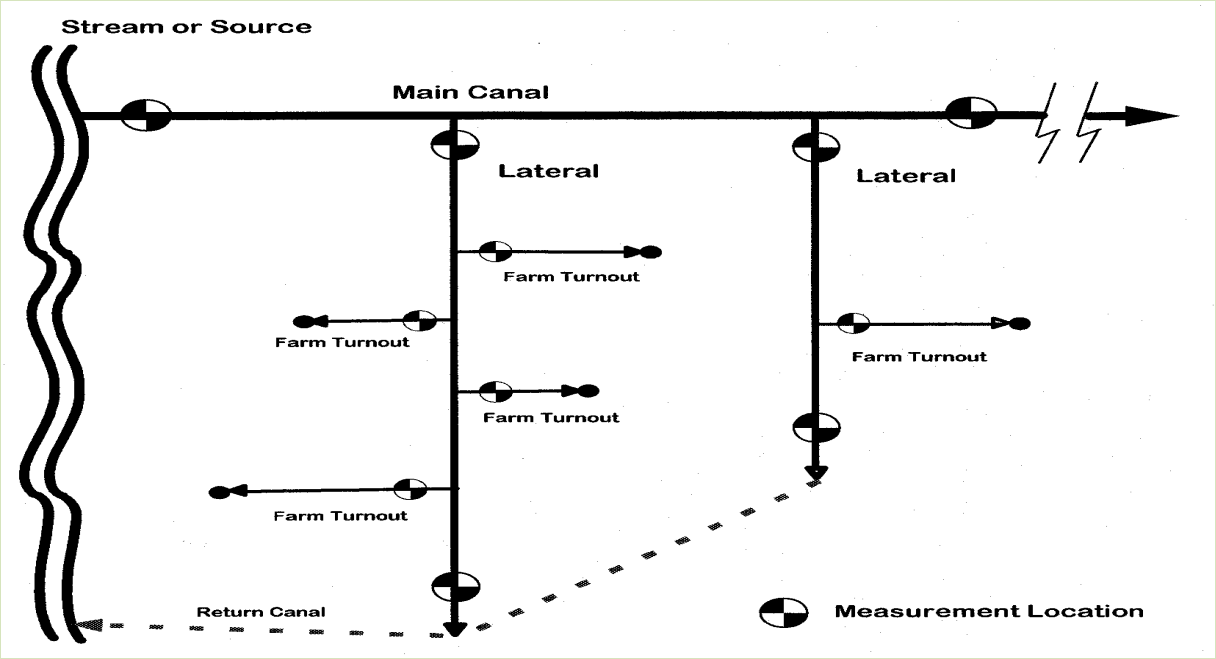
8.2 Flow measurements

8.2.1 Adequacy of flow data

Good information is fundamental to making decisions on managing irrigation water at any irrigation scheme. **Figure 8.1** below, provides the extent of flow measurement that is ideal for conducting an irrigation scheme water budget. The availability of flow measurements helps inform both the water user and the IB about the quantity, timing, and location of water use and therefore enables the IB to conduct a detailed water budget at scheme level.

As illustrated **in Figure 8.1** below, it would be ideal to have flow measurements at the inlet to the primary canals as well as at the tail water ends. This would assist in determining the water losses in each section of the canal system, as well as the operational spills if there are any.

As previously indicated, there used to be a lack of adequate flow measurement data to perform a water budget analysis at scheme level. Presently the IB makes regular measurements of flows into the scheme and water delivered to individual users.



Management Goal 1

The objective to address the above irrigation water management issue is to ensure that the following is achieved by the Hereford IB:

(i) Continuation of regular measurement of flows into individual sluices.
(ii) Measurement of flows into scheme and water at the canal tail-end (farm dam).
(iii) Ensuring that all present measuring devices in the scheme are in good operating condition and regularly calibrated.

(iv) Investigate the possibility of installing telemetry systems at the inlet and end of the canal to monitor deliveries and tail water. The flows and levels are intended to be sent by telemetry system to the offices of the Hereford IB for direct input into the WAS programme.

8.3 Operational water management issues

8.3.1 The installed WAS is currently not being fully utilised

The Water Administration System (WAS) was developed by Dr. Nico Benade (with funding mainly from the WRC and DWA) as a tool to be used by Irrigation Boards/Schemes to optimize their irrigation water management and minimize management-related distribution losses in irrigation canal systems. WAS consists of seven modules integrated into a single program and these modules can be implemented partially or as a whole.

The seven modules are the:

(i) Administration module

(ii) Water order module

(iii) Water accounts module

(iv) Water release module

(v) Measured data module

(vi) Crop water use module, and

(vii) Report module

The Water Release module for example links with the water administration and order modules and can be used to minimize distribution losses on the canal network.

Management Goal 2

The management objective to address the above issue, is to ensure that the usable modules of the WAS programme, particularly the Water Report and Water Release modules, are implemented fully and that weekly and monthly reports from the module are generated. This could be undertaken within 2 years from the completion of this Water Management Plan (WMP).

Furthermore, the measured data module could be linked to a telemetry system to enable direct reading of the measured data into the WAS programme. This can be used to undertake automatic reporting on water losses.

8.4 Irrigation water budget and balance assessment

8.4.1 Disaggregating losses

It is currently not possible to disaggregate the losses. There is no differentiation in the water balance assessment between the losses. Although tail water losses have been eliminated, the remaining avoidable losses such as leakage, spills and over delivery to users have not been disaggregated.

Management Goal 3

The goal to address the above issue is to ensure that all the flow measurements in the Hereford Irrigation Scheme are included in determining water budgets and calculating water losses. This will enable the IB to undertake comprehensive water audits from where priority areas for improving irrigation water management as well as reducing water losses can be identified.

8.5 Institutional Water Management Issues

8.5.1 Updating and implementation of the Water Management Plan

The Manager of the Hereford IB will amongst others be responsible for the annual updating and implementation of the Water Management Plan (WMP) for the scheme. The roles and responsibilities of the Manager for the updating and implementation of the WMP will be the following:

- Take flow measurements and conduct a detailed water balance assessment on a monthly basis at scheme and sub-scheme level
- Compile Water Use Efficiency Accounting Reports and submit it on a monthly basis to the DWA Regional Office
- Develop improved water saving targets
- Do recommendations on observations regarding water conservation issues and report to the Chief Executive: SAAFWUA and DWA on ways to address the identified issues
- Develop activities that build on and complement other WC/WDM initiatives taking place at other water schemes
- Present water conservation information and training to irrigators and inform other scheme managers about success stories undertaken by the scheme
- Maintenance and modernisation of the irrigation infrastructure
- Liaise with DWA and other scheme managers to ensure consistent, efficient and effective deployment of water conservation messages, resources and services throughout the scheme

- Monitor the plan and schedule for implementing water conservation program components
- Report quarterly to DWA on the implementation status of the WMP regarding actions taken to reduce water losses and achievements towards achieving water saving targets, goals and objectives.
- Annually review and update of WMP with a water conservation program for the scheme with goals, objectives, action steps, measures, and timelines taking into consideration the latest measured data and the measures that have already been implemented.

Management Goal 4

Implementation, monitoring, reviewing and updating of the WMP by the Manager and reporting by him/her on the status of water losses, water saving targets, goals and objectives.

Table 8-1: Hereford Irrigation Board: Identified water management issues

Item No.	Issue description	Comments
1	Irrigation water budget cannot be conducted in detail. Data from the monitoring system and other measurements is used for monitoring purposes only and it is impossible to disaggregate the losses.	Break down losses.
2	Data captured manually on the WAS.	Investigate possibility to install telemetry stations at inflow and return point (dam). Import readings directly into the WAS.
3	WAS is not fully implemented on scheme.	Investigate the use and implement the Reporting and Release Modules.

9 HEREFORD WATER MANAGEMENT PLAN

9.1 General

9.1.1 Legal provision for developing and implementing a WMP

The development and implementation of a Business Plan is a legal requirement to be undertaken by a WUA in terms of section 21 of Schedule 4 of the National Water Act (Act 36 of 1998). The constitution of a WUA - referred to schedule 5 for model constitution - outlines the principle functions to be performed by the WUA and will include the following:

Prevent water from any water resource being wasted;

(i) Exercise general supervision over water resources

(ii) Regulate the flow of water course

(iii) Investigate and record quantities of water.

(iv) Supervise and regulate the distribution and use of water from a water resource.

The Business Plan for an Irrigation Board will thus incorporate a Management Plan setting out standards and Best Management Practices. Another key clause in the National Water Act is Section 29(1), which reads as follows:

"A responsible authority may attach conditions to every general authorisation or licence -

(b) relating to water management by:

(i) specifying management practices and general requirements for any water use, including water conservation measures;

(ii) requiring the monitoring and analysis of and reporting on every water use and imposing a duty to measure and record aspect of water use, specifying measuring and recording devices to be used;

(iii) requiring the preparation and approval of and adherence to, a water management plan."

In light of the above legal requirements, the Hereford IB has developed a draft WMP in terms of the provisions of the act to enable it to manage the irrigation water in the scheme effectively and efficiently.

9.1.2 Setting of water savings targets

In order to evaluate the candidate water management measures it was important to first of all determine the water loss target by incorporating not only the unavoidable water losses but also determining the attainable level of water losses based on the Best Management Practices (BMP) that can be achieved in the Hereford IB.

Seepage losses from concrete lined, half lined and earth canals are normally expressed in l/s per 1 000 m^2 and appear to fluctuate between approximately 0.35 l/s per 1 000 m^2 wetted area and 1.9 l/s per 1 000 m^2 (Reid, Davidson and Kotze (1986). For design purposes Butler (1980) suggested a value of 1.9 l/s per 1 000 m^2 wetted perimeter and this could result in an unavoidable loss rate of up to 15%. The depth of the ambient water table also has an effect on seepage losses. In an area where generally high water table levels are found, canal seepage decreases to roughly 5% of the input volume (Streutker, 1981 and Muller, 1984).

Given the excellent condition of the canal infrastructure the target for unavoidable losses was set as 5% of the input volume.

A Water Research Commission (WRC) study (Report TT465/10) which was conducted in 2010, has provided guidelines of the desired range of operational losses due to metering errors, canal filling losses after each dry period that have to be included in order to determine the BMP for operational and distribution efficiency (Reinders 2010). This is additional to the unavoidable losses determined in the previous sections. This desired range is expressed as a percentage of inflow into the irrigation scheme. The desired range for operational losses (i.e. metering errors, canal fillings, etc.) is 10% of the inflow into the irrigation scheme.

Therefore on the basis of the WRC study a BMP for operational and distribution efficiency has been taken as 10% of the inflow into the scheme.

As no breakdown in terms of avoidable and unavoidable was undertaken due to the absence of historical measurements, target water losses for the scheme should be based on the allowable water losses of approximately 15% of the total inflow into the irrigation canal. Accurate measurements of inflow into the scheme and water returned have been taken since November 2012 and the IB will be able to compile an accurate water budget within one year following the implementation of the WMP.

9.2 Action Plan for implementation

9.2.1 Measurement of water

Good information is fundamental to making decisions on managing irrigation water at any irrigation scheme. The availability of flow measurements helps inform both the water user and the WUA about the quantity, timing, and location of water use and therefore enables the WUA to conduct a water budget.

It would be ideal to have flow measurements at the inlet to the primary canal as well as at the end thereof. This will assist in determining the water losses in the canal system, as well as any operational spills.

Since November 2012 there is measurement of water flowing into the dam at the canal end point and water flowing into the scheme.

Measuring the inlet and outlet water through telemetry systems will enable the Hereford IB to conduct real time flow measurements. This will assist the scheme in identifying critical changes to the expected flows, thereby allowing the scheme operators to react to any operational losses or even theft of irrigation water.

Besides the monitoring of flows, the Hereford IB will then be in a position to conduct detailed irrigation water budgets for the scheme. This will enable the scheme operators to determine why losses are occurring.

9.2.2 Full implementation of the WAS programme

The benefits of a measuring system cannot be fully realised without the full implementation of the WAS programme, which needs to be linked with the data and records from the telemetry system. The WAS programme can use the flow records to match the water releases and the water requested in order to minimise operational spills, as well as to reduce flows at the tail ends.

The full implementation of the WAS programme, particularly the Reporting and Release Modules, together with a telemetry system, should substantially improve the operation of the Hereford Irrigation Scheme and reduce operational losses in particular.

Table 9-1: Hereford Irrigation Board: Action Plan

Priority	Goal	Action Plan	Timeline	Responsible Authority
1	Measurement of water inflows and outflows	(i) Calibration of Miessner Weir. (ii) Detail recording of releases into the Miessner weir. (iii) Undertake investigations into the design and costs associated with telemetry stations at the measuring points. (iv) Installation of telemetry equipment. (v) Quantify losses in distribution system through valves, gates and spills though direct monitoring and metering.	Done (Nov 2012) Done (Nov 2012) Nov 2013 Dec 2014 Mar 2015	Hereford IB
2	To fully implement the WAS program	(i) Obtain attributes of canal & distribution system. (ii) Calibrate WAS release module. (iii) Trail runs. (iv) Full implementation (v) Complete mapping of water accounts and tie-in with scheme databases. Use scheme records to determine water budget.	Dec 2013 Mar 2014 Jul 2014 Mar 2015 Apr 2015	Hereford IB

9.3 Funding of the Hereford Irrigation Board WMP

9.3.1 General

All of the Water Conservation and Demand Management measures involve an initial capital investment requirement including the replacement costs over the useful life of the infrastructure. This is followed by ongoing operations and maintenance which is required to ensure the installed infrastructure assets can provide the required performance for its intended use.

It has been proven in the analysis of the identified water use efficiency measures that implementation of these measures provides the most viable option at present to improving irrigation water use efficiency and reduce water losses in the Hereford Irrigation Scheme.

However the financing of the candidate measures should take into account the beneficiaries from water savings made during the implementation of the above identified measures. This is discussed in the following section.

9.3.2 Financing by Hereford IB

The benefits in implementing monitoring the flows to irrigators will directly benefit the Hereford irrigators and ensure that they receive their allocation when required and on time. Therefore based on the fact that the beneficiaries are the irrigators in the Hereford Irrigation Board, the financing of the following aspects should be borne by Hereford;

(i) Providing the full operation of the WAS programme to enable water accounting to be conducted as well as to fulfil the legal requirements in terms of the Act to provide annual reporting to the DWA on the irrigation water management for the scheme.

(ii) Installing measuring device at canal inlet.

9.3.3 Financing by the DWA

It is recommended that the DWA assist in the funding of a telemetry system at the Miessner Weir.

10 CONCLUSIONS AND RECOMMENDATIONS

The Water Management Plan forms the backbone of actions that have to be taken in increasing the efficient use of water within the Hereford Irrigation Board.

The intention of the Water Management Plan not to burden the WUA and its officials with administrative tasks, but rather to promote a culture of using water as effectively and efficiently as possible. The plan will allow the WUA to improve on current water management practices and to profit from their efforts.

The success of WC/WDM through a WMP will depend on the effective participation of all the participants. A well balanced “carrot and stick” plan will be required based on the principal of a “win win “situation where the benefits of the successes of the water management plan will filter through to the users in one or other form such as less water use charges, more water or the possibility of selling any surplus water etc. In terms of WC/WDM the development of a Water Management Plan is in itself a BMP as it force water users and institutions to start thinking and planning. The main aim of a water management plan is to conserve water, to improve water supply services to the water users and to enable irrigators to use their water more efficiently in the sort and long term. The Goals for the WMP have been set and the WUA believes that the targets and objectives set in the WMP are achievable through proper oversight by the CEO and support from the DWA.

This WMP must be seen as a first generation plan and has to be reviewed and updated on an annual basis.

A complete reconstruction of the irrigation canal was undertaken and financed by the Hereford Irrigation Board at a cost of some R29 million. Tests conducted following the upgrade indicate that the present losses are less than 10%.

For the short term which has been taken as 3 years, the plan of the Board is to continue with detailed measurements of water flowing into (since Nov 2012) and from the scheme. These figures will then enable the Board to undertake detailed water budgets and establish meaningful water loss targets.

11 REFERENCE

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