Integrated Water Quality Management: A Mind-Set Change

Using an Integrated Water Quality Management Model (IWQM) to support the implementation of National Water Act Water Use Authorisations

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WATER RESEARCH COMMISSION

by

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EXECUTIVE SUMMARY

BACKGROUND

In 2008 the Water Research Commission initiated a project on Integrated Water Quality Management (IWQM); the aim of the project being to develop a conceptual model for aligning the management of the quality of water resources with that of drinking water quality in order to support the effective management of water use in the interest of all water users (Boyd *et al.,* 2010). The overall premise being that good water quality is in everyone's best interests.

RATIONALE

The IWQM approach that was developed "breaks down" water management into smaller management units while establishing both a horizontal and vertical reporting framework. A further benefit of the model is that responsibility for water quality is based on significantly smaller geographical areas. In this way accountability to the adjoining areas (horizontal accountability) and to the next level of management (vertical accountability) is established with the establishment of a management unit. This allows accountability for water quality to be focussed on smaller management units. In other words, it makes all water users aware of their own responsibility for the protection of South Africa's water resources and accountable for the impacts that they have on the resource.

It is the mutual understanding between water users of the impacts of their own uses and which is aimed at bringing to life the "Everyone is downstream" and "Every water user is a water manager" philosophy.

As part of the implementation testing, hardcopy forms a well as Excel spread sheets were used for recording the requirements of the business process, critical control points (CCP) and Critical Risk Factors (CRF) as well as putting in potential reporting structures and links to performance targets. However, while the implementation process in a management unit – or setting up the model will take at least 6 months, once data collection from the established management units (even those who do not have access to electronic media) is initiated, data collected will need to be stored electronically and used to create reports. Furthermore, most CRFs and CCPs are points, and management units do have spatial boundaries, so it was proposed that the model should ideally be linked to GIS.

The management model was tested and subsequently refined in several management units in the Breede River catchment of the Western Cape Province of South Africa. In addition the model is being implemented as a water quality management tool by the Okavango Basin

Management Committee (OKBMC) in the Kavango, Namibia. Furthermore talks are in the process to use the same tool in Angola and Botswana areas of the Okavango Delta (Boyd *et al*, 2011).

This report describes the IWQM model and the proposed way of rolling out the product to help water users and Department of Water Affairs (DWA) manage the implementation of the water use authorisations and includes a CD containing the system that can be used by water users.

OBJECTIVES AND AIMS

AIM 1

Produce a web-based system that will ultimately link to existing tools such as the DWA Water Management System (WMS) and electronic Water Quality Management System (eWQMS), the stakeholder database and geographical areas, and be available for use by other water users at various levels. Emphasis will be placed on developing a system that is intuitively obvious and efficient to use.

AIM 2

Present the system to show how it can support the implementation of Integrated Water Use Licences (IWUL) and other Water Use Authorisations (WUA) (at both the regulator and user level) and ultimately improve catchment management; and present the system at one relevant conference over the proposed duration of the project.

METHODOLOGY

The methodology that was followed included:

- Developing an electronic system that has included stakeholder and document management, and the ability to spatially reference the management units and their control points. This has included the development of an easy to use training manual that will allow those undergoing the training session to roll-out the system to other potential users;
- Population of the web-based system with data from the phase 2 test cases to test that the system works and refine it as necessary; as well as testing the system with specific data from potential new management units;
- Holding an information/training session to present the system to regulators and relevant water users at one catchment or similar forum which is made up of a number of water users and regulators, all of whom will then be able to take it to broader users or use the system within their own industry; and

- Presenting the final product at a Conference during or at the end of the project.

RESULTS AND DISCUSSION

In developing the web-enabled system the following aspects were considered.

- Ease of use; and
- Links to a map facility.

In light of all the other systems and reporting requirements that officials often need to give input to, the system needed to be user friendly and not data intensive. It needed to produce a simple report that could add value to the officials, environmental officers and managers' report backs to senior management, regulators and to the downstream water users. In other words;

- These are the targets;
- These are the measured values;
- These targets were met (Y);
- Those were not met (N); and
- This is what is going to be done about it, all on one page.

In this way a history of problem areas can easily be built up and dealt with. The maps accompanying the system will make it easy for users to ensure that their CCPs and CRFs are correctly located.

In terms of using the system to help with the implementation of water use authorisations the following National Water Act (Act 36 of 1998)(NWA) sections were considered:

- Section 21 which details both consumptive and non-consumptive water uses;
- Section 41 which requires that all water uses listed in Section 21 of the NWA be authorised; whether it be under General Authorisation (GA), Existing Lawful Use (ELU) or a water use licence (WUL);
- Section 28 of the NWA which sets out the essential requirements of water use authorisations; and
- Section 29 which sets the conditions which need to be met in the authorisations issued. It is these conditions that the IWQM system would help in implementation

All of the authorisations contain conditions relating to quality, quantity and management options related to the water use. The conditions can be related to CCPs and CRFs and are most often associated with standards that need to be met (targets).

CONCLUSIONS

At the start of the project the main objective was to set up a web-based system. The web-based system was developed, tested and refined using existing data as well as including second phase data. However there is still some concern around who should administer such a system. In this respect it was decided that the system would be presented on a CD.

As this project was specifically related to aiding the implementation of water use authorisations, it is proposed that the CMA/ DWA Regional Office be the Administrator for those users that have a water use authorisation or who have applied for a water use authorisation. However, it should be noted that an authorisation is not required to become a MU; CRFs, CCPs and associated targets can still be set up and managed.

RECOMMENDATIONS FOR FUTURE RESEARCH

In developing the system the following aspects for future consideration were highlighted.

- Link to the risk based water quality guidelines;
- Export of results to excel so that trend graphs can be more easily generated; and
- Consider links to the green drop system.

A link to the risk based water quality guidelines would be useful in that where a non-compliant value is recorded then the user would be able to see what impact that particular non-compliance would have on the different users in the catchment, in a way making it more personal.

Currently the system does not allow the export of the results to a spreadsheet format and would require a bit more work. This would be useful in showing the trends for a particular parameter. Potential links to support the green drop system may also be useful.

CAPACITY BUILDING

As part of the capacity building for the project the following were undertaken:

- Mr Oliver Malete, a project team member, registered to complete his BSc (Hons) Applied Science and still has one subject to complete;
- Training sessions were held with the project team members and the system was presented and applied at the DWA Bronkhorstspruit and Gauteng Regional Offices;
- The framework was presented during an Integrated Water Resources Management Course at the Council for Environmental Management at the North West University.
- An abstract was submitted and accepted for a workshop at WISA 2014 in Mpumalanga.

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LIST OF ABBREVIATIONS

BID	Background Information Document
BP	Business Process
CCP	Critical Control Point
CMA	Catchment Management Agency
CMF	Catchment Management Forum
CRF	Critical Risk Factor
DWA	Department of Water Affairs
ELU	Existing Lawful Use
eWQMS	electronic Water Quality Management System
GA	General Authorisation
GIS	Geographical Information System
ISO	International Organization for Standardization
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resources Model
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water and Waste Management Plan
MOMS	Management Oriented Monitoring System
MU	Management Unit
OKBMC	Okavango Basin Management Committee
RWQO	Resource Water Quality Objectives
SANS	South Africa National Standards
WaSP	Water Safety Plan
WHO	World Health Organisation
WMA	Water Management Area
WMS	Water Management System
WRC	Water Research Commission
WSA	Water Services Authority/Water Service Act
WUA	Water User Association

GLOSSARY

Background conditions	Aspects external to water quality which support the implementation of the framework and therefore indirectly impact on water quality
Business process	A process for carrying out a particular activity, in this case, integrated water quality management
Critical Control Point (CCP)	A Critical Control Point (CCP) is defined as a point or process that requires technical target measures or parameter ranges to be met in order to continually assess the hazard potential of the water resource. The CCP is most often defined by regulatory controls. Where, a point includes a discharge point; point in a storm water system; or a point in a water resource[1]; and process may be a procedure or practice such as optimal fertiliser application rate; dam water levels measured or buffer strips in place
Critical Risk Factor (CRF)	A CRF is defined as a point or process at which, if a failure occurs, the CCP performance targets will not be met.
Defining principles	Generalizations that are accepted as true and that can be used as a basis for reasoning or conduct
Hazard potential	Susceptibility of the water resource[1].
ISO 14000	An environmental management system to help organisations to:(a) minimize how their operations negatively affect the environment (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above.

[1] As defined in the NWA a water resource includes a watercourse, surface water, estuary, or aquifer; and ``watercourse'' means -

(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

Management unit A management unit in the context of the IWQM model is a geographical area; not necessarily homogeneous or continuous; that could be managed as a unit owing to common water use characteristics at the “lower” levels and to institutional responsibilities with regard to the management of water quality at the “higher” levels.

1 INTRODUCTION AND OBJECTIVES

1.1 Background to the project

In 2007 the Water Research Commission (WRC) initiated a project on Integrated Water Quality Management (IWQM); aiming to develop a conceptual model for aligning the management of the quality of water resources with that of drinking water quality in order to support the effective management of water use in the interest of all water users (Boyd *et al.,* 2010). The overall premise being that good water quality is in everyone's best interests.

The IWQM approach that was developed "breaks down" water management into smaller management units while establishing both a horizontal and vertical reporting framework. A benefit of the model is that responsibility for water quality is based on significantly smaller geographical areas, and accountability to the adjoining areas (horizontal accountability) and to the next level of management (vertical accountability) is established. This allows accountability for water quality to be focussed on smaller management units, rather than diffused up ever higher levels of management. Thereby ensuring that all water users are aware of their own responsibility in protecting South Africa's water resources and are accountable for their impacts hat they have on the resource. In developing the IWQM model, three main components were identified:

- *Defining principles* which are defined as being generalisations that are accepted as true and that can be used as a basis for reasoning or conduct, such as, water must be properly valued (there is not enough water);
- *Background conditions* which are defined as those conditions external to water quality which support the implementation of this framework and therefore indirectly impact on water quality, such as, management systems and tools; and
- *Management units* which are defined as a geographical area that could be managed as a unit owing to common water use characteristics at the "lower" levels and to institutional responsibilities with regard to the management of water quality at the "higher" levels.

1.2 Aims

The ultimate goal of IWQM is to achieve specific objectives at a particular management unit taking into consideration the defining principles and background conditions relevant to that specific management unit. There are however, specific elements that must be included for each management unit:

- Water use cycle elements' identification;

- Hazard assessment/ risk assessment in which Critical Risk Factors (CRF), Critical Control Points (CCP) and performance targets are set;
- Risk management; and
- Contingency planning.

A CCP is defined as a point or process that requires technical target measures or parameter ranges to be met in order to continually assess the hazard potential of the water resource. The CCP is most often defined by regulatory controls (for example it could be a condition in a Water Use Licence issued in terms of the National Water Act (Act 36 of 1998)). A point includes a discharge point, point in a storm water system, or a point in a water resource; and process may be a procedure or practice such as optimal fertiliser application rate, dam water levels measured or buffer strips in place. A critical risk factor (CRF) is defined as a point or process at which, if a failure occurs, the CCP performance targets will not be met. In other words the CRFs are upstream of the CCPs and would also have performance targets linked to them. However, these are internal targets (targets set by the management unit itself) that if achieved would mean that that the CCP targets would be met. These may be for example, pumping hours met to avoid overflows or process samples collected to ensure adequate chemicals added for phosphate removal.

In view of the above, the business process proposed for the IWQM conceptual model is generic in the sense that its various elements apply at every “level” of management, or to every management unit, and therefore each aspect must be in place at every management unit. However the details of each element will vary according to the management unit in question. It is important to note here that the model allows for linkages with existing tools, such as the DWA Water Management System (WMS) and the Emanti Management's Water Quality Management System (eWQMS) and any other systems that an institution may already have in place.

One benefit of the model is that responsibility for water quality is based on significantly smaller geographical areas, and accountability to the adjoining areas (horizontal accountability) and to the next level of management (vertical accountability) is established with the establishment of a management unit. This allows accountability for water quality to be focussed on smaller management units, rather than diffused up ever higher levels of management. This makes all water users aware of their own responsibility for the protection of South Africa’s water resources and accountable for the impacts that they have on the resource. It is this mutual understanding between water users of the impacts of their own

uses which is aimed at bringing to life the “Everyone is downstream” and “Every water user is a water manager” philosophy.

The management model was tested and subsequently refined in several management units in the Breede River catchment of the Western Cape Province of South Africa (including industries, municipality and catchment levels). In addition the model is currently implemented as the management mechanism by the Okavango Basin Management Committee (OKBMC) in the Kavango, Namibia. There are also intentions to use the same mechanism in Angola and Botswana areas of the Okavango Delta (Boyd *et al.,* 2011).

Management units report to each other on the CCPs on an agreed frequency basis and report internally within the management unit, on the CRFs. If implemented broadly within a catchment, a CCP for one management unit could be a risk factor for another management unit thus reducing reporting. Each management unit must designate a person to be accountable to other management for the targets and to report on whether or not the targets have been met. As mentioned above reporting is both horizontal (between management units on the same level) and vertical (between management units at different levels), with the idea that technical capacity and advice in terms of mitigation and improvement in meeting targets can be shared between management units where capacity is lacking.

As part of the implementation testing, hardcopy forms as well as Excel spread sheets were used for recording the requirements of the business process, CCPs and CRFs as well as putting in potential reporting structures and links to performance targets. However, while the implementation process in a management unit – or setting up the model will take at least 6 months, once data collection from the established management units (even those who do not have access to electronic media) commences, data will need to be stored electronically and also accessed to create reports. Furthermore, most CRFs and CCPs are points, and as management units do not necessarily have spatial boundaries, it is proposed that the model should ideally be linked to a Geographical Information System (GIS).

This report describes the IWQM model and the proposed way of rolling out the product to help water users and Department of Water Affairs (DWA) manage the implementation of the water use authorisations.

1.3 Objectives of the project

The objectives of this project were therefore to:

- Produce a web-based system that will ultimately link to existing tools within the DWA and related user systems such as WMS and eWQMS, stakeholder database and geographical areas, and be available for use by other water users at various levels;
- Emphasis will be placed on developing a system that is intuitively obvious and efficient to use. This task will include inputting data from previous test cases; and training of users (initially project team members and identified individuals within DWA, as well as other individuals who have been involved in the project from its' inception) in the use of the web-based system; and
- Present the system at three work sessions (catchment or similar forums) to show how it can support the implementation of Integrated Water Use Licences (IWUL) and other water use authorisations (at both the regulator and user level) and ultimately improve catchment management; and present the system at one relevant conference over the proposed duration of the project.

1.4 Methodology

The methodology that was followed included:

- Developing an electronic system that has included stakeholder and document management, and the ability to spatially reference the management units and their control points. This has included the development of an easy to use training manual that will allow those undergoing the training session to roll-out the system to other potential users;
- Population of the web-based system with data from the phase 2 test cases to test that the system works (in agreement with relevant stakeholders); as well as testing the system with specific data from potential new management units;
- Holding an information/training session to present the model (including the web-based system) to regulators and relevant water users at one catchment or similar forum which is made up of a number of water users and regulators, all of whom will then be able to take it to broader users or use the system within their own industry; and
- Presenting the final product at a Conference during or at the end of the project.

2 THE INTEGRATED WATER QUALITY MANAGEMENT MODEL

As described in WRC Report TT450/10 (Boyd *et al*., 2010) the model (Figure 1) is comprised of:

- Defining principles;
- Background conditions;
- The management framework; and
- The generic business process. These are described below.

2.1 Defining principles

In the first phase of the project the following principles were prioritised based on the frequency with which they were raised in the consultation process. Principles are defined as being generalisations that are accepted as true and that can be used as a basis for reasoning or conduct. These principles therefore underpin the conceptual model for integrated water quality management in the South African context. The following principles are described:

- Water must be properly valued;
- Institutions responsible for managing water must be accountable for water quality;
- Water quantity and water quality are inextricably linked;
- The Polluter Pays Principle must be applied to the true cost of water pollution;
- Short-term economic gain at the cost of increasingly deteriorating water quality is not acceptable; and
- Everyone should have access to water quality information that may not necessarily be in the form of technical data.

2.1.1 Water must be properly valued

It is not only important to ascribe value to water based on water availability and increasing water scarcity. The concept of value in the context of water should include:

- Downstream costs of pollution;
- Social and economic value of water;
- Value of wastewater;
- Significance of clean water in terms of public health; and
- The price of not having water.

The principle of *'there is not enough' water* should encompass an understanding of the various values of water, and not be limited to the fact that there is not enough water.

2.1.2 Institutions responsible for managing water must be accountable for water quality:

Accountability is 'the obligation to demonstrate and take responsibility for performance in light of commitments and expected outcomes'. In the case of water quality, under our current framework, accountability is not clear because of the complex institutional framework and the current understanding of co-operative governance. Accountability implies that someone is accountable to someone else, for something. It is therefore important to ensure that responsibilities are clearly defined, and that those to whom institutions are accountable, clearly understand the standards at which water must be managed, in order that they can assess whether institutions are fulfilling their obligations with regard to water quality. Finally, commitment to management practises that will ensure good quality water must be evident at all levels both within and across the spectrum of water management institutions.

2.1.3 Water quantity and water quality are inextricably linked

It is important to ensure that the above statement is consistently recognised in all aspects of water management.

Poor quality water will reduce the quantity of water available for use, and the significance of poor water quality is more pronounced where less water is available (concentration).

2.1.4 The Polluter Pays Principle must be applied to the true cost of water pollution

The "Polluter Pays Principle" is a well-known and widely accepted environmental policy principle which is applied internationally through various mechanisms. It does, however, raise the question: "pays what?" In the case of water pollution, there are always "downstream costs" of a pollution incident. The term "downstream costs" must be understood in both its literal and figurative sense. There may be costs to water users physically downstream of a pollution incident, and there may be significant costs over time owing to environmental deterioration (cumulative effect) at the site and physically downstream of an incident. Furthermore, "downstream costs" could refer to indirect costs such as the cost of a community not being able to develop as a result of a lack of availability of clean water. It is important therefore, that the polluter pays principle encompasses the expanded definition of "pays what?"

2.1.5 Short-term economic gain at the cost of increasingly deteriorating water quality is not acceptable

This principle refers mainly to the fees levied on users for discharge of wastewater to the sewer system as the discharge has an impact on the wastewater treatment works and its capacity to operate optimally.

It is not acceptable that the discharger simply pays increasing fees without relative cost of downstream impact being understood when the "downstream" cost of discharging is creating a serious long-term impact on the water resource. The short-term economic gain received by those levying charges must be balanced against the total cost of wastewater entering the resource. This principle is closely related to the appropriate valuing of water.

2.1.6 Everyone should have access to water quality information that may not necessarily be in the form of technical data.

Everyone who uses water has a responsibility for water quality. Because water quality is a largely technical issue, most of the "information" disseminated about it, is technical. While this is necessary at certain levels of responsibility, new and innovative ways to package information about water quality need to be found that will reach all audiences.

It is important that there is some understanding about water quality at all levels, and this will require a "rolling-up" of water quality data into more broadly understood formats.

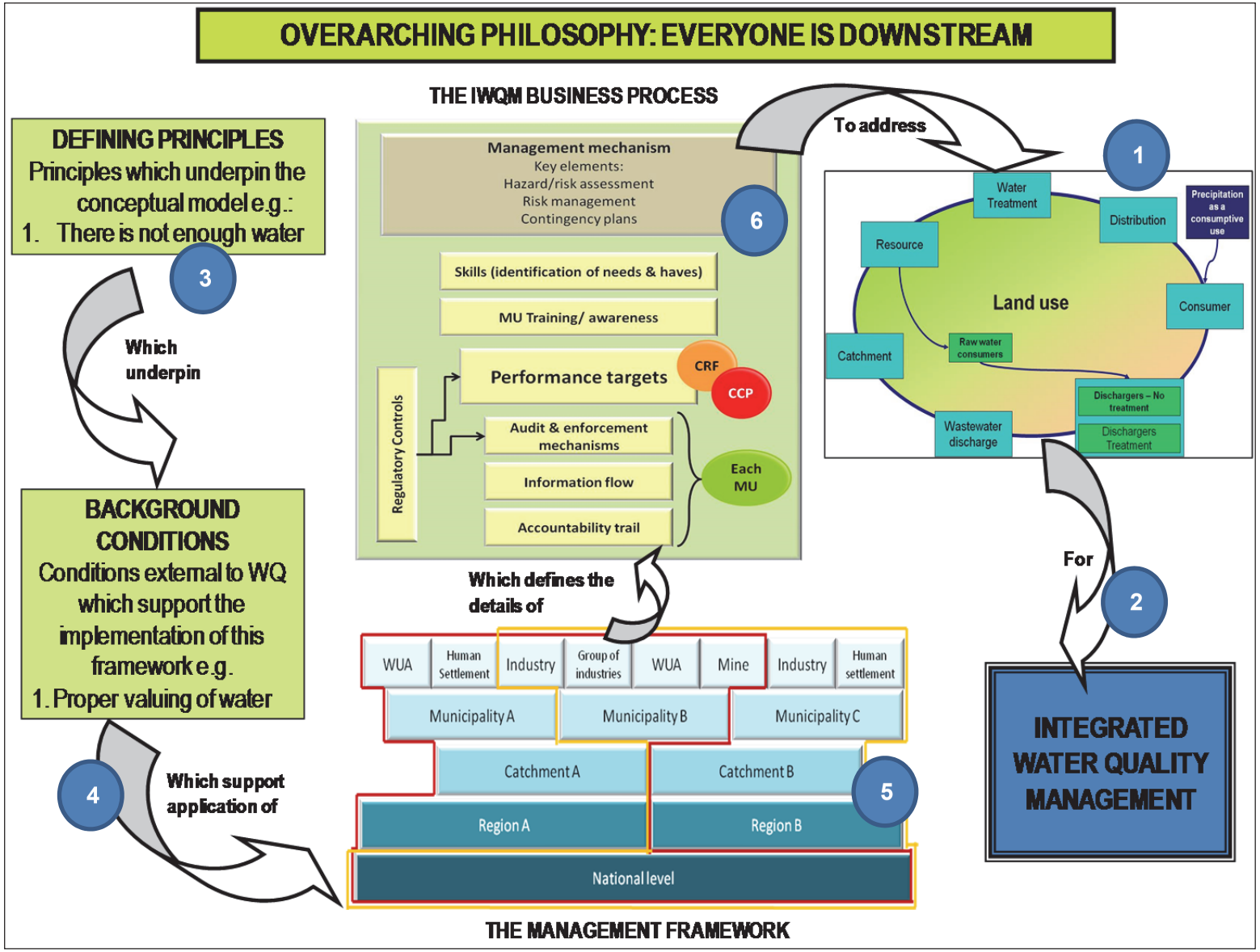


Figure 1: The IWQM Management framework (Boyd *et al.*, 2010)

In order to achieve IWQM (2), an assessment of the catchment, taking into consideration the elements of the water use cycle (1), needs to be undertaken.

In this project defining principles (3) (such as, there is not enough water) that underpin the background conditions (4) (an example being the proper valuing of water) led to the development of the Management Framework.

The Management Framework (5) relates to the identification and registration of MUs at the various levels. It is for each of these MUs that the IWQM BP (6) must then be developed and implemented to achieve IWQM.

2.2 Background conditions

Background conditions are defined as those conditions external to water quality which support the implementation of the framework and therefore indirectly impact on water quality and include:

- The value of water (including wastewater) incorporating issues such as cost-benefit incentives and recycling initiatives;
- Management systems and tools (applicable to the various “levels”) such as River Health Programmes and other existing water management systems or Water Safety Plans;
- Communication between management units as described in the section to follow and also public access to information (which includes thinking about how to package water quality information for public consumption);
- Accountability including aspects such as the implementation of the polluter pays principle, enforcement mechanisms and the implementation of a government watchdog; and
- Improving institutional capacity.
- Education across the board on water issues, using the water use cycle as the basis for education and awareness;
- Effective strategic planning at various levels which is an acknowledged challenge in most developing countries;
- Funding which is seen as an important supporting condition for integrated water quality management.

Two additional conditions that would have an impact on integrated water quality management but do not fit into the eight main categories mentioned above are:

- Understanding the final catchment management structure within the nine Water Management Areas (WMA) in South Africa and how it relates to roles and responsibilities; and
- Research which would include research into alternative and appropriate technologies as well as assessment of certain established parameters such as Resource Quality Objectives (RQOs) which may be different in different parts of the catchment.

2.3 The management framework

A management unit in the context of the IWQM model is a geographical area (not necessarily homogeneous or continuous) that could be managed as a unit owing to common

water use characteristics at the “lower” levels and to institutional responsibilities with regard to the management of water quality at the “higher” levels (described in Section 2.3.1). Many of the management units identified align with existing established institutions such as municipalities, Catchment Management Agencies (CMA) or Water User Associations (WUA). However it is important to note that the establishment of a management unit at whatever scale, is not dependent on whether a legislatively established institution exists at that level.

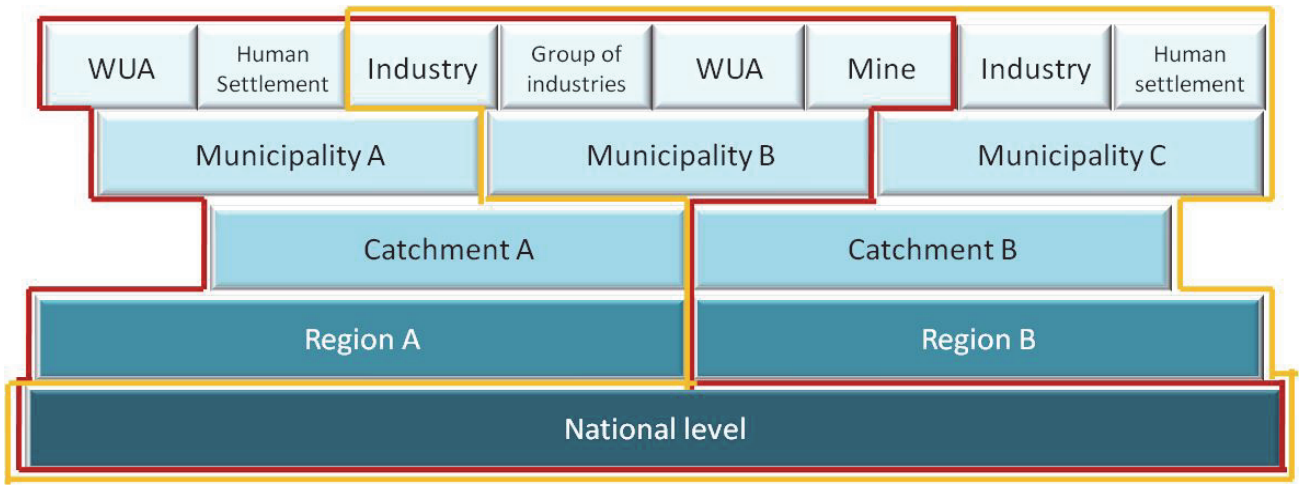


Figure 2: The IWQM Management framework (Boyd *et al.,* 2010)

2.3.1 Management Levels

There are four management “levels”, which would correspond to management unit types indicated in Figure 2. These are described below.

2.3.1.1 Community

Note that the word community is used to refer to a group of people or organisations with common interests regarding the quality and quantity of the water within a specific geographical area. A community-type management could be anything from a single factory to a small settlement (informal or otherwise) to a large group of farmers who participate in an irrigation scheme[1].

[1] A group such as this is referred to as a Water User Association (WUA) and this is a statutory body established under the South African National Water Act (NWA) No. 36 of 1998 and must be established by a proposal to the Minister of Water Affairs. This means that there are specific provisions regarding what a WUA must undertake to put in place when they are established and also what must be reported on. However, the model presented does not require a group of farmers to be organised in an institution such as a WUA.

2.3.1.2 Municipality

Municipalities with a Water Services Authority (WSA) status have the responsibility of ensuring the delivery of water supply to people in their area of jurisdiction and many are also responsible for the treatment and discharge of wastewater.

2.3.1.3 Catchment

South Africa has recently amended the division of Water Management Areas (WMA) from 19 WMAs to 9 WMAs as described in the National Water Resource Strategy (NWRS, 2013). Each WMA comprises several catchments. Under the National Water Act (Act 36 of 1998) (NWA), these areas are administered by Catchment Management Agencies (CMAs) or the DWA if a CMA has not yet been established. The CMA has institutional responsibility for managing water quality in the catchment(s) through the implementation of Resource Quality Objectives (RQOs) which should be identified for all the water resources in their area once classification of the resources has taken place. In the interim while RQOs are still being developed Resource Water Quality Objectives (RWQO) and other measures can be used. A CMA or even a group of water users at catchment level, which becomes a management unit in this model, can therefore begin the process of managing water quality even if the legislative process is incomplete. The management unit area can apply to one catchment or to a group of catchments as delineated by the WMA boundary.

2.3.1.4 Regional/National

This level refers to the regional (or provincial) boundary (which does not always conform to the catchment boundaries) and the national boundary. At this level there is definite institutional responsibility under both the National Water Act (1998) and the Water Services Act (Act 108 of 1997)(WSA) and at this level of the model the background conditions become increasingly important.

The management framework indicated in Figure 2 indicates how the various management units (made up of water users or water user groups) relate to each other. This structure also addresses those instances where management units may occur across municipal or catchment boundaries. Figure 2 further indicates how the water user groups (management units) are represented in an integrated management context and indicates the overlapping management “chains” from the smallest management unit (lower level) to the largest at a national level (higher level). A single full IWQM management chain is highlighted by the red or yellow line.

The basic premise of the management framework is therefore to break down the challenge of IWQM into manageable areas in order to reduce the reporting between management units to a simple “Yes” (quality and quantity parameters are being met) or “No” (they are not). This approach demands effective auditing but is structured in such a way that adjacent management units audit each other. That is, the management unit is responsible for auditing the quality, quantity and management options implemented, as required, of water entering its geographical area and then reporting on that to the next level of management; as well as to the adjacent upstream management unit, from where the water originated.

It’s at this point that the “how” becomes the focus of the model, through a simple generic business process which can be applied at every level of the model.

This framework ensures that each MU is accountable to its constituency, to the next/adjacent MU and to the higher level MU that could be a municipality, CMA or regulator at a national level.

2.4 The generic business process

The ultimate goal of IWQM is to achieve specific objectives at a particular management unit; taking into consideration the defining principles and background conditions relevant to that management unit. How this is done may be through various tools that could include for example, a Water Safety Plan (WaSP) (WRC, 2012) for a municipality or an Integrated Water and Waste Management Plan (IWWMP) for an industry (DWAF, 2010). The IWQM business process (Figure 3) is a generic process with various elements are applicable to every management unit, and therefore each aspect of the business process must be in place in every management unit. However, the detail of each element will vary according to the type of management unit.

Firstly, it is important to establish a management mechanism which must contain the specific elements of:

- Hazard assessment/ risk analysis which includes identification of Critical Control points (CCP) and critical risk factors (CRF);
- Risk management; and
- Contingency planning.

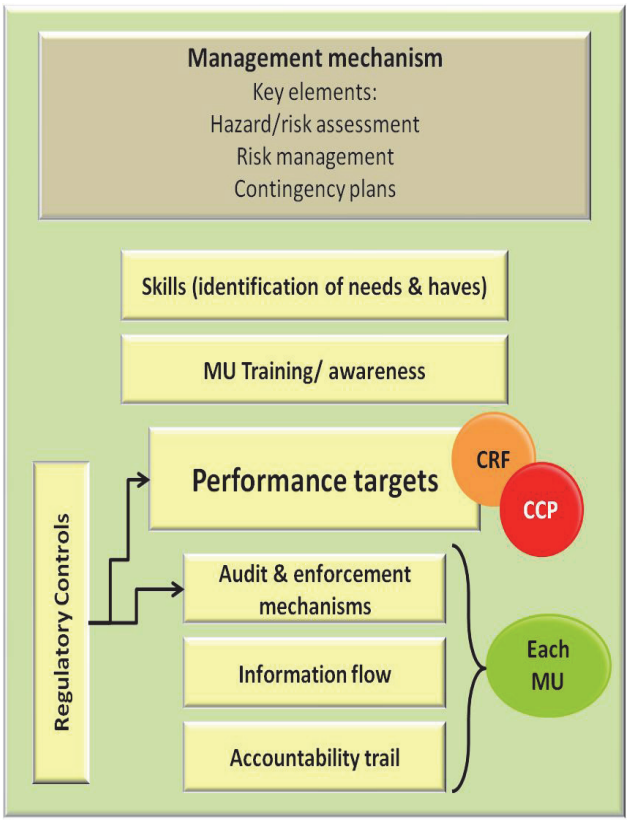


Figure 3: The generic business process (Boyd *et al.*, 2010)

Critical Control Point (CCP)

A Critical Control Point (CCP) is defined as a point or process that requires technical target measures or parameter ranges to be met in order to continually assess the hazard potential of the water resource. The CCP is most often defined by regulatory controls.

Critical Risk Factor (CRF)

A Critical Risk Factor (CRF) is defined as a point or process at which, if a failure occurs, the CCP performance targets will not be met. Where, a ***point*** includes a discharge point; point in a storm water system; or a point in a water resource[2]; and ***process*** may be a procedure or practice such as optimal fertiliser application rate; dam water levels measured or buffer strips

[2] As defined in the NWA a water resource includes a watercourse, surface water, estuary, or aquifer; and ``watercourse'' means -

(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

in place; and ***hazard potential*** is defined as the susceptibility of the water resource. In this respect meeting the targets of a CRF can be mitigation for the CCP.

The implications of implementing the IWQM business process within the various management units would entail the answering of the following five questions (Table 1) in relation to the generic business process described above, and once the risk/ hazard assessment has been undertaken, which would mean that the CCPs and CRFs have been identified.

Table 1: Generic business process questions

Question		**Notes**
1	What do you (the Management Unit) need to know?	• Information/data flow from the adjacent management units, or smaller units within your MU; and • Information/data requirements at each CCP: – performance targets; – management tools; – reporting requirements; – audit requirements; – regulatory requirements; and – contingency plans.
2	Who needs to tell you and what?	• Information flow; • Organisations within the MUs; • Information/data format ; and • Regulatory framework.
3	Who and what do you need do you need to tell?	• Information flow from you (the MU) to the adjacent or internal MUs; • Information content; and • Information format.
4	What do we need to achieve this?	• Management tools (existing/new); • Relevant posts (existing/new); • Skills (existing/new); and • Training/awareness programmes.

3 IMPLEMENTATION FRAMEWORK

As part of the testing of the IWQM framework (Boyd *et al*., 2011) an implementation framework was developed. The framework sets out a step-by-step process for the implementation of the IWQM model. Each step of the process is described; and the requirements for materials, capacity and equipment are identified. The necessary outcomes of each aspect of the process are also identified.

3.1 Establishing the outer boundary

As described in section 2.3, the IWQM model applies at a number of different levels, in a number of different contexts and there are a series of overlapping management chains in the management framework (Figure 2). Although ultimately the model can be applied at a national level, practically, the model should be applied at a smaller boundary such as a catchment or a municipality or even at community level. It is this practical outer boundary that must be initially defined. For example, will the outer boundary be just for one industry or a whole industrial area with several industries all part of the MU?

It is also important to note that management units established do not have to cover the entire area, but obviously, the more area that is covered by a management unit accountable for their water use, the more effective implementation and positive impact on water quality will be.

3.2 Identifying potential management units

Once the outer boundary of the area is defined, potential water user groups, organisations or institutions which can form management units should be identified. It is important to note that the authority or management mandates for the outer boundary area generally exist at the level of the catchment or the municipality.

As described above there are a number of “levels” of the management framework, the first level being the “community” level. Once again it is important to note that in the context of this framework, community is meant in the sense of a community of water users and not necessarily a community of people.

The outcome of this process should be a list of potential management units and contact details for a person who represents or is responsible for the activities undertaken within the ambit of the management unit.

3.3 "Signing up" management units

The IWQM model is based on individuals and organisations or institutions using water being accountable for how they are using that water. Therefore, once potential management units are identified and contact people are identified, each must be approached to 'sign up' to be a management unit.

At this point, appointments should be made with the various representatives that have been elected for the management unit to present the model and to begin identifying activities which could be a risk to water quality and quantity. It is very important to note that the CRFs and CCPs, and the performance targets which will be applied in the model, must be established by the management unit themselves. This will give support in the ownership of the model by the water users.

The approach need to be tailored to the audience. For example, there is no need to create a presentation to give to a rural community on the IWQM model. Instead, the approach should be based around water use. This is something everyone can identify with, rather than complicating the approach with talk of generic business processes and overarching philosophies.

WHAT IS MEANT BY "ACCOUNTABILITY"?

It must be noted that, in the context of implementation of the IWQM model, the term 'accountability' means:

- taking responsibility to manage for those targets;
- mitigate against risks; and most importantly
- report to other management units in the framework when targets are not going to be met because a risk factor has been triggered and the CCP is not likely to meet its requirements.

Thus the "accountability" discussed in the context of this model is not legislative accountability where an institution has a mandate to meet certain requirements established by legislation and is therefore subject to the provision in the legislation if requirements are not met. It is however, voluntary accountability to meet the self-imposed requirements of the performance targets stated in the Business Process (BP) form discussed below, and signed off on by an authorised representative of the Management Unit (MU). This is the critical aspect of the model, in that it confers management responsibility for water use on smaller groups who agree to be accountable for their actions with regard to the use of water.

IN THIS WAY, EVERY WATER USER IS A WATER MANAGER

This outcome of this process would be that management units are signed up as committed to the principles of IWQM and take accountability for achieving the targets set for each CRF or CCP and for reporting on these targets.

A spin-off benefit could be that these actions would support the establishment of the CMA as all stakeholders would be ideally represented.

3.4 The Business Process

The business process has been translated into two forms (Tables 2 and 3 below). The first form relates to the following information that is required:

- Management unit (MU) name;
- Management unit (MU) type;
- Management mechanism;
- Critical control points (CCP) and / Critical risk factors (CRF);
- Existing management tools;
- Regulatory Controls;
- Available skills;
- Training requirements;
- Reporting framework;
- Audit or Enforcement mechanisms; and
- Accountable person for the management unit.

The second form relates to the identification of CCPs and CRFs.

Table 2: Business process form

MU Name					
MU Type	e.g. Community, Water Service Authority, Industrial area, Catchment Management Agency				
Management mechanism	***If there is an existing management mechanism (e.g. WaSP, EMS or CMS), please indicate:***				
	Management Mechanism/(s)				
CCPs / CRFs	*See Table 2 for details*				
Existing management tools	***Indicate whether any tools are currently being used to manage water quality, and if yes, what tools:***				
	Management Tool/(s)				
Regulatory Controls	***Indicate whether any tools are currently being used to manage water quality, and if yes, what tools:***				
	Regulatory Control/(s)				
Available skills:	***Give details of the people involved currently in management of water quality (of factors which may impact water quality)***				
	Personnel Name	***Position***	***Skill***	***Responsible for***	
Training requirements:	***Identify where training is necessary to improve achievement of management objectives***				
	Training Type	***Objective of training***			
Reporting framework	***Give details of other organizations you report to and on what basis:***				
	Report name				
	Date of last report				
	Period (e.g. monthly)				
	Who is the report for				
	What is reported on				
Audit or Enforcement mechanisms	***Indicate whether your area is audited through any process (e.g. ISO 14001 audits, DWA drinking water quality audit, Blue Drop assessment):***				
	Description		***Frequency***		
Accountable person for the MU	***Name***	***Organisation***	***Contact Details***		
			Email		
			Tel		
	Signature:				

3.5 Identifying Critical Risk Factors (CRFs) and Critical Control Points (CCPs)

The CRFs and CCPs depend largely on the various ways in which water is used in the context of the water use cycle (Figure 4) which forms the basic context for which the business process (the "meat" of the IWQM model) has been developed.

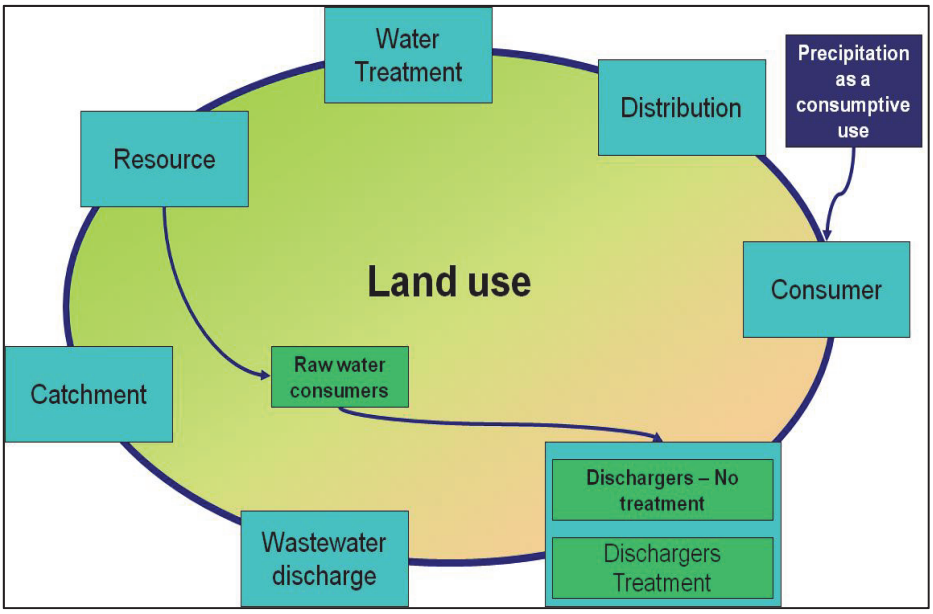


Figure 4: Water use cycle (Boyd *et al.*, 2011)

For example, if the use of water is "Dischargers – Treatment", the CRFs and CCPs are based around the risks to water quality, and quantity in certain catchments, that this particular use of water will generate.

CRFs and CCPs can therefore not be established without an examination of the uses of water in each management unit. Of course, once the CCPs and CRFs have been determined, it is important to set targets for them, so that it is clear as to how the risks should be managed.

In many cases, the performance targets are set by national or local legislation such as municipal bylaws. For example, in the case of a management unit abstracting water to be treated, distributed and provided to consumers, there are likely to be drinking water quality standards required by national legislation, or aligned with international standards under national policy. Often, the performance targets will already be there in the form of conditions set in a water use authorisation – for example, standards for treated wastewater discharge. In these cases, performance targets do not need to be established. However, where there are no regulatory controls, or quality standards, performance targets must be set.

Table 3 shows the form that would be completed when identifying CRFs and CCPs, their relevant performance targets and details regarding how risks will be managed and mitigated and Table 4 shows four examples of CRFs and associated CCPs at different levels.

Table 3: Description of CCPs and CRFs

	Defining Critical Risk Factors and Critical Control Points	**Critical risk factor/(s)**	**Critical control point/(s)**
1	Description: What is it?		
2	Why is it a CRF/CCP? (e.g. a discharge point, or where fertilizer is being used		
3	Where is it? (Coordinate or location description - CCPs MUST have coordinates)		
4	What are its targets?		
5	Is mitigation in place? • If yes, what? • If no. what is being done to improve the situation?		

Table 4: Example CRFs and CCPs at four management unit levels (Boyd *et al.*, 2011)

	Critical Risk Factors (CRF)				Critical Control Points (CCP)			
	CRF1	**CRF2**	**CRF3**	**CRF4**	**CCP1**	**CCP2**	**CCP3**	**CCP4**
Management Unit	**Chicken farms**	**WUA (irrigation scheme)**	**Municipal area: Sewage works**	**CMA**	**Chicken farms**	**WUA (irrigation scheme)**	**Municipal area: Sewage works**	**CMA**
Description: What is it?	Chicken houses	Addition of fertilizer	Maturation ponds	River down-stream of the irrigation farms	Ground-water (borehole)	River down-stream of the irrigation farms	Up and down-stream of the sewage works	Surface water point in the River
Why is it a CRF/ CCP?	Potential ground-water pollution from wash-down water	Diffuse pollution from run-off from areas where excess fertilizer is added	Overflow from the maturation ponds will contribute to pollution load in the River	Surface water from the River is abstracted for other down-stream uses	Groundwater is used by other domestic water users in the area	Surface water from the River is abstracted for other down-stream uses	Surface water from the River is abstracted for other down-stream uses	Surface water from the River is abstracted for other down-stream uses
Where is it?	Chicken houses: 33°37'36"S 19°29'34"E	All farms in the WUA area	Maturation ponds: 33°28'39.21"S 19°39'03.12"E	*Upstream 1:* 33°24'45"S 19°45'33"E *Downstream 1:* 33°32'48"S 19°31'42"E	Borehole at: 33°37'34"S 19°29'34"E	*Upstream 1:* 33°24'45"S 19°45'33"E *Downstream:* 33°32'48"S 19°31'42"E	*Upstream:* 33°28'31"S 19°39'09"E *Downstream:* 33°28'38"S 19°38'55"E	Downstream in the River at the border of the two adjacent catchments
What are its targets?	Dry sweeping for removal of solids before wash down	Optimal volume of fertilizer added per hectare	No overflow of ponds	RWQO for the River	SANS 241 standards for drinking water	Resource Water Quality Objectives for the River	Resource Water Quality Objectives for the River	Resource Water Quality Objectives for the River
What mitigation is in place?	None; plan to install collection sump to collect polluted water for disposal/ treatment	None; Fertilizer use will be measured and added at optimal concentrations	Ponds design; evaporation; and irrigation	Monthly monitoring	Quarterly monitoring	Monthly monitoring	Monthly monitoring	Monthly monitoring

3.6 Reporting in the IWQM model

It is essential that each management unit is very clear on the reporting requirements they are responsible for if they sign up as a management unit.

The important issues as regards reporting in the IWQM model are:

- CRFs are reported on internally in the management unit;
- CCPs are reported on externally to other management units in the model;
- Reports are important to track the progress in risk mitigation; and
- It is imperative that downstream users are kept informed if the management unit isn't going to meet its targets.

It's also important to know who the reports are sent to and when? This is noted in the business process form, as indicated in Table 5 because the management unit needs to indicate, for its own purposes, the basis for the reports that they will produce – what, who, how often and when.

Table 5: Details of the management unit's reporting framework

Reporting framework	*Give details of other organizations you report to and on what basis:*				
	Report name				
	Date of last report				
	Period (e.g. monthly)				
	Who is the report for				
	What is reported on				

4 THE WEB-ENABLED SYSTEM

One of the recommendations that emanated from the testing of the IWQM model was that the implementation of the model would be greatly enhanced if it is converted into a web-based system into which the various management units can report. It is understood that not all management units will have access to the technology required to enter data into a system and receive reports from it, but the upper levels of the model certainly will. A system for collecting data from those without access to technology should be integrated into the implementation process of the model and adequate feedback loops created to ensure that reports reach all management units even if they are not operating the web-based system.

It was agreed that a web-based system would allow all management units to report against the performance targets for their CCPs and CRFs, and also on progress of mitigation put in place. Analysis of the data, the CCP and CRF targets reports and spatial referencing will allow catchment management agencies to identify problem areas for water quality in the catchment area, on a very short-term basis (monthly reporting). Good spatial referencing of, for example the boundaries of catchments, specific industrial types and land uses within the catchment and the links to say particular water quality or use of a particular chemical will allow better understanding of particular problems emanating from specific areas or land use types.

Furthermore, management units that are unable to implement proposed mitigation can be easily identified and technical capacity from other management units in their area could be identified and deployed efficiently to address problem situations. The web-based system would also include a catchment stakeholder database, because stakeholder information would for part of the management unit details. This could later be extended to more detailed stakeholder characteristics to streamline information dissemination costs and processes. Finally, pockets of excellence can be identified and the initiatives of successful management units replicated in those that are struggling to achieve their performance targets. An electronic system was developed to cover the aspects of the model described in sections 2 and 3 above.

In developing the web-enabled system the following aspects were considered.

- Ease of use; and
- Links to a map facility.

In light of all the other systems and reporting requirements that officials often need to give input to, the system needed to be user friendly and not data intensive. It needed to produce

a simple report that could add value to the officials, environmental officers and managers' report backs to senior management, regulators and to the downstream water users. In other words:

- These are the targets;
- These are the measured values;
- These targets were met (Y);
- These were not met (N); and
- This is what is going to be done about those targets that were not met, all on one page.

In this way a history of problem areas can easily be built up and dealt with. The maps accompanying the system will make it easy for users to ensure that their CCPs and CRFs are correctly located.

In this respect the objectives of the project were met. However, there was still some concern around who should administer such a system and as a start it was decided that the system would be presented on a CD.

For this project, as it was related to aiding the implementation of water use authorisations, it was proposed that the CMA/ DWA Regional Office be the Administrator for those users that have a water use authorisation (IWUL or GA) or who have applied for a water use authorisation. This would mean the CMA/ DWA Regional Office would register these users as MUs and each user would then be issued with a CD so that they can add their CCPs, CRFs and associated targets, measured values and then submit the reports.

4.1 Fields to be completed

The home page (Figure 5) contains links to pages on which the following aspects will be captured by an administrator and from which the user will then be able to choose:

- *Contacts* – these may be based on forum databases, water users, regulators, managers and other stakeholders who would like to register;
- *Sector types* such as:
  - Catchment;
  - Municipalities;
  - Industries; and

- Communities

- *Organisations* which would be a list of those in the catchment; and

- *Catchments* which will be a list of the quaternary catchments.

Screen shots of the various pages with the associated functions are set out in figures below.

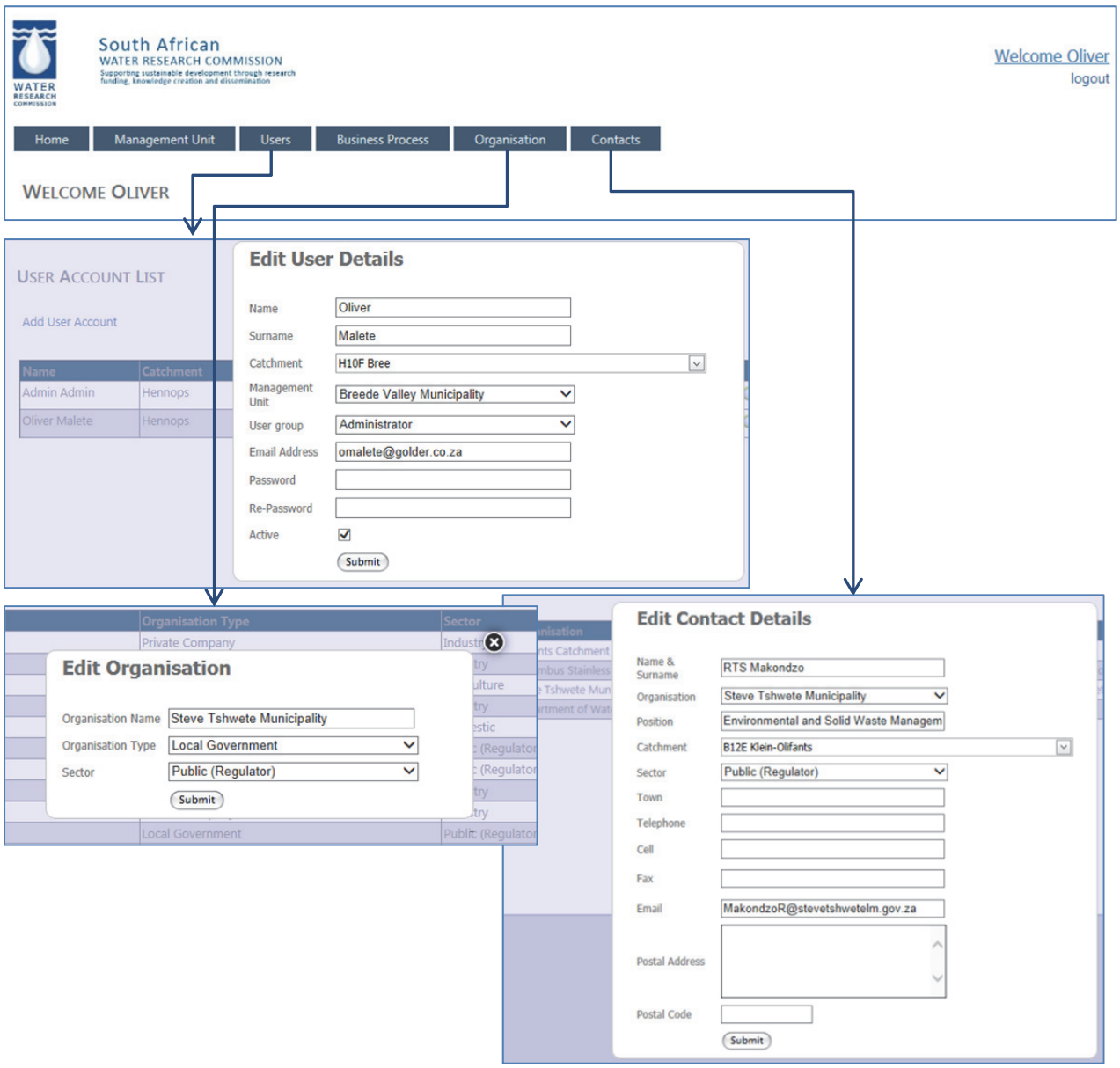


Figure 5: Home page showing links

The user will then need to add details to the following three pages:

- Management unit data;

- User data; and

- The business process data.

The Management Unit List lists those entities that have signed up to be Management Units and gives the option of adding further Management Units (Figure 6). From this page the administrator can delete or edit details of the Management Unit.

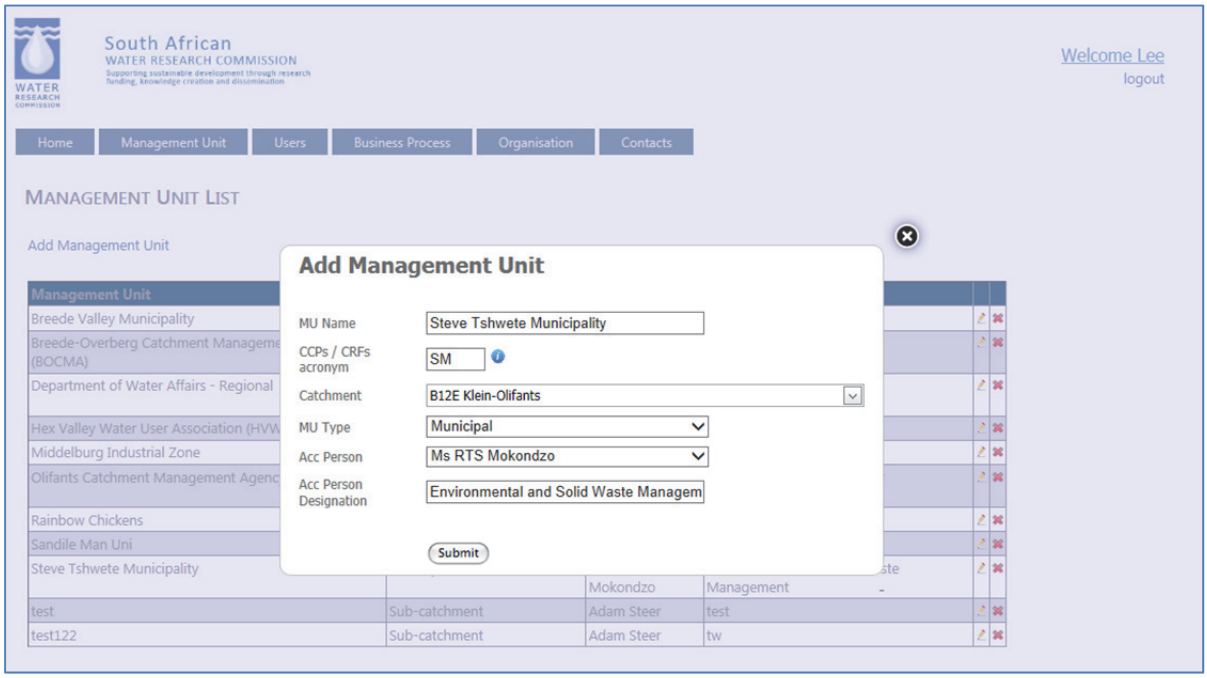


Figure 6: Add Management Unit function

The business process requires information relating to:

- Management unit (MU) name;
- Management unit (MU) type;
- Management mechanism such as a WaSP, Environmental Management System (EMS), Catchment Management Strategy (CMS) or IWWMP*;*
- Regulatory Controls such as a Water Use Licence (WUL) or General Authorisation;
- Audit or Enforcement mechanisms; and
- Accountable person for the management unit. This relates to the designation of the person, such as Environmental Officer, and not the name of the person.
- Critical Control Points (CCP) and / Critical Risk Factors (CRF);

The Business Process List lists the management units showing management unit type, accountable person and organisation, and allows the user to add a new management unit

linking to the Business Process Form (Figure 7). The Business Process page then has links to the CCP and CRF input page (Figure 8).

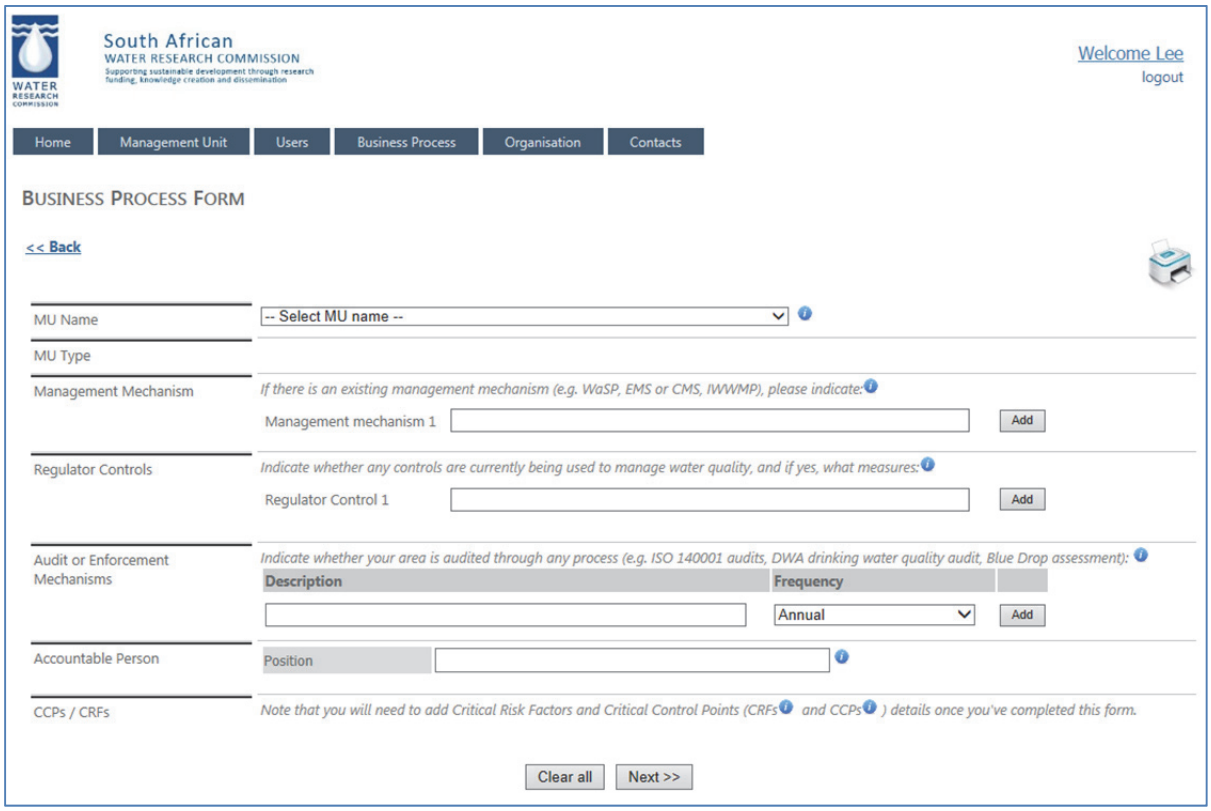


Figure 7: Business Process Form

Once the CCPs are determined, it is important to set targets for them, so that it is clear on how the risks should be managed. To manage risk, performance targets are essential. Thus for each CRF and CCP, the management unit must establish performance targets. In many cases, the performance targets are set by national or local legislation such as municipal by-laws. For example, in the case of a management unit abstracting water to be treated, distributed and provided to consumers, there are likely to be drinking water quality standards required by national legislation, or aligned with international standards under national policy. Often, the performance targets will be set by licenses or permits – for example, for wastewater discharge. In these cases, performance targets do not need to be established but must just be input. However, where there are no regulatory controls, or quality standards, performance targets must be set and input. Figure 8 sets out the CRF/CCP page that will allow input of data to the questions asked and link to the targets page (Figure 9).

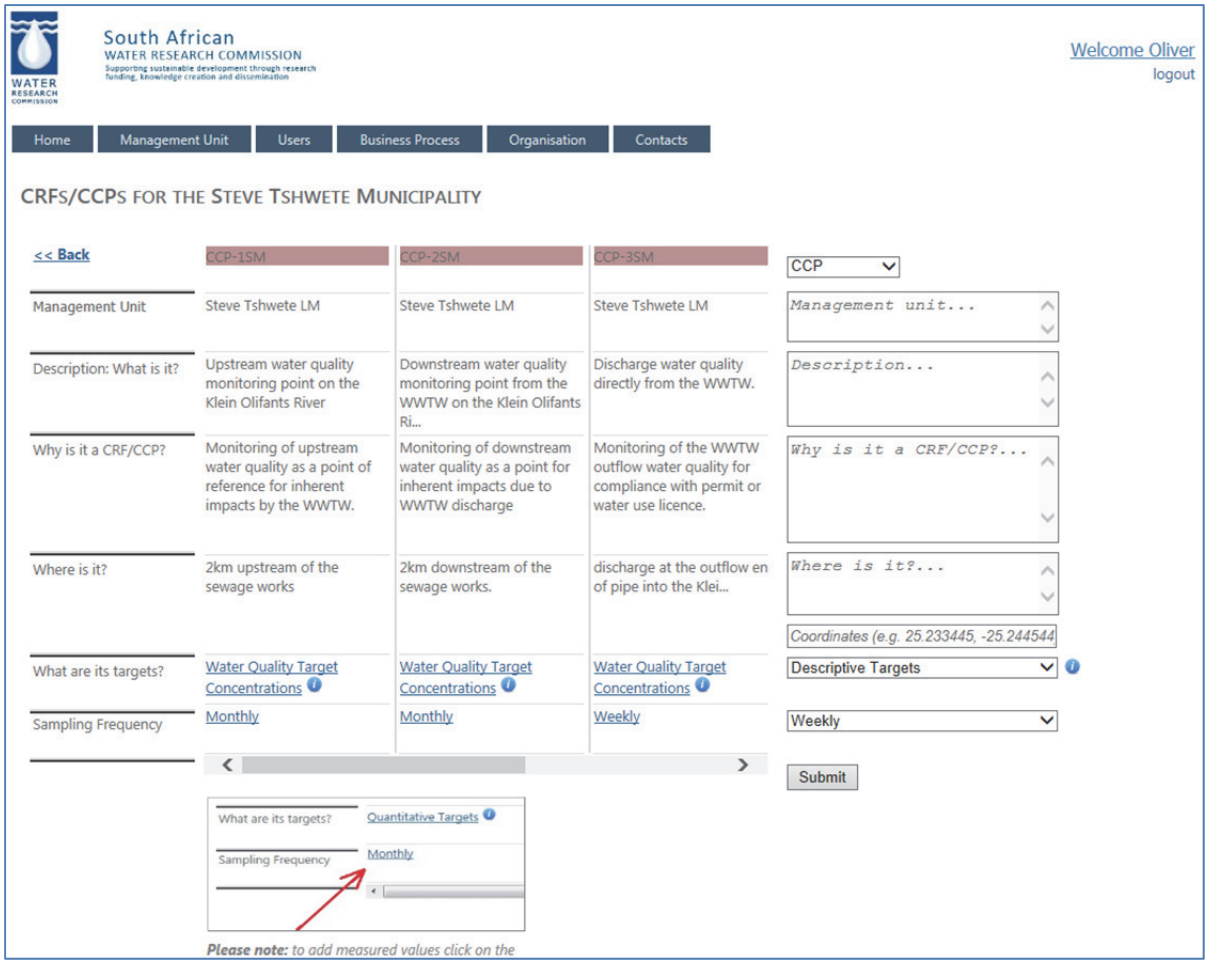


Figure 8: CCP and CRF inputs page

The target type options are:

- Quantitative Targets; and
- Descriptive targets.

These are defined as follows.

Quantitative Targets

Quantitative targets are those for which numerical standards, objectives, or units have been set (for example RWQOs, WUL water quality standards and by-laws) have been or can be set. In this respect the user will be able to choose specific parameters from a list or add it should it not be in the list. It is important at this stage that the user makes sure that correct units are added.

Descriptive Targets

These are targets that if failure occurs (for example a process failure) water quality could be compromised. An example is overflow from a pollution control dam, with a Y/N answer; or rate of fertilizer application (kg/ha/month) and where a numerical value could be included.

While there may be a numerical target there needs to be a more detailed description than just a parameter name.

This page allows for the target parameters to be selected and values to be included and will then compare them against the measured values that will be input, giving a **Y**, compliant, or **N**, non-complaint.

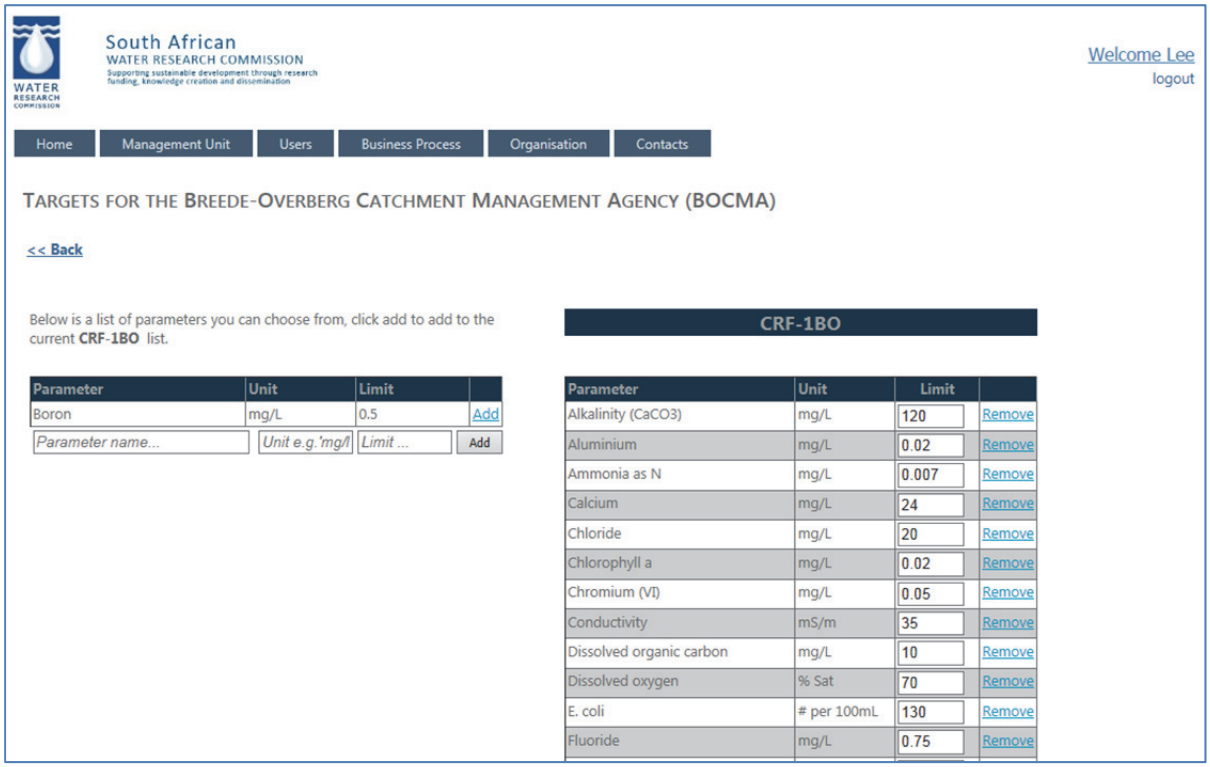


Figure 9: Target inputs page

Measured values are then input by navigating back to the CRF/CCP page and then clicking on the sampling frequency link as this sets up the report dependiong on the frequency of sampling chosen, for exmaple monthly or weekly. Measred values that are input are compared against the targets set and a Y/N answer returned, depending upon it's compliance. It is important to note that if a 'N' results is returned the data capturer must confirm that the value is correct, especially if it is very different from the target.

A field is provided where the reason for the non-compliance and actions to be put in place to remedy the non-compliance should be given.

It should be noted that the previous periods data cannot be changed once the period has rolled over. In the same manner data cannot be added before a month starts.

4.2 Reporting

Reporting will be done from the page on which measured values are input. A box on the right hand side will allow a contact to be added to a list and then will send the report automatically once the envelope icon is clicked on.

As the CCPs are the critical points at which targets will need to be met to ensure a quality and quantity of water that is acceptable it is proposed that reporting is done to the MU management team, regulators and up and downstream management units.

As the CRF points are related more to management options and how these are imlpemented to achieve the CCPs, it is proposed that they be reported on internally within the MU. However, it may be useful to also link the relevant responsible catchment official to both CCP and CRF reporting networks.

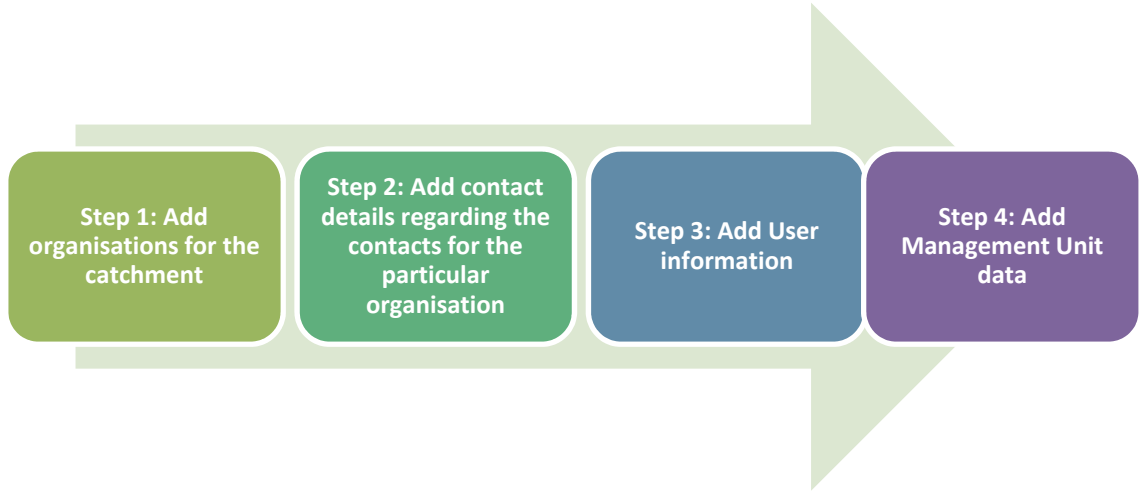
Figure 10: Measured value inputs page from which reporting will be done

4.3 Help functions

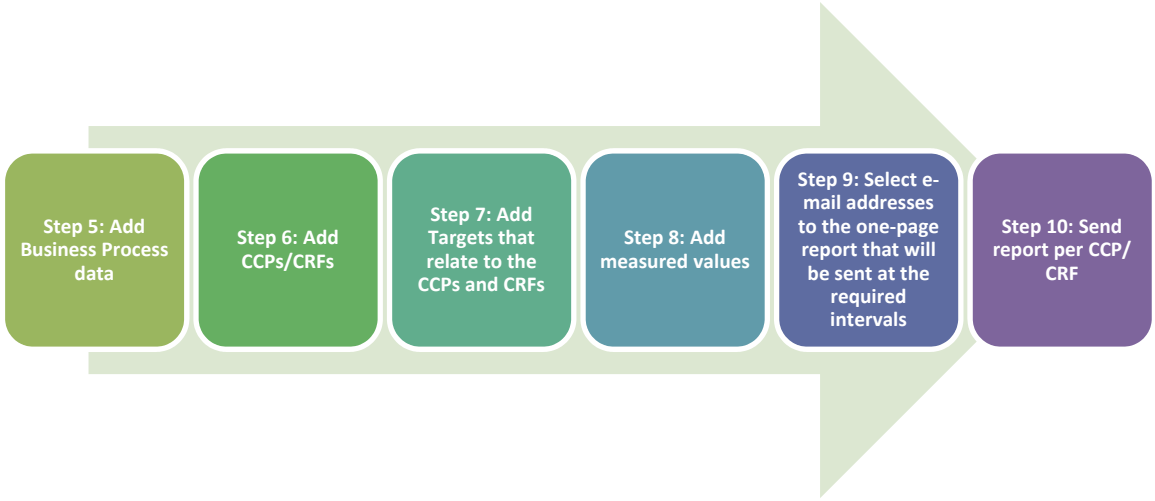
The help functions have been included on the electronic system and are accessed via the information button. When holding the cursor over the information button a description or definition of what is required for a particular item is displayed. The screen shots relating to the help functions are shown in Appendix A.

4.4 SUMMARY OF STEPS TO FOLLOW

The home page contains links to pages on which the following aspects will be captured by an Administrator who is the designated person using the system. It would be preferable that steps 1, 2, 3 and 4 are done by the responsible organisation, such as DWA/ CMA, upfront and that copies of the CD are then made and distributed to each water user. If a water user has a CD and would like to use the system on its own that is also acceptable and the organisation would then allocate an Administrator on their side.



If this is completed by the DWA/ CMA upfront then the water users then receive a CD containing the above-mentioned data for the particular catchment/(s) and will start to add the following information. If the organisation is the Administrator then they will continue to add the data.



A CD containing the installation files including an installation manual for the system as well as for Arc Reader installation is attached as Appendix B to this report.

5 USING THE SYSTEM TO SUPPORT THE IMPLEMENTATION OF WATER USE AUTHORISATIONS

Section 41 of the NWA requires that all water uses listed in Section 21 of the NWA be authorised. A water use authorisation, whether it be under General Authorisation (GA), Existing Lawful Use (ELU) or a water use licence (WUL) contains conditions relating to quality, quantity and management options related to the water use.

The conditions can be related to CCPs and CRFs and are most often associated with standards that need to be met (targets).

5.1 Relevant NWA sections

Chapter 4: Water Use, includes Section 21 that sets out those water uses that require water use authorisation and includes:

(a) taking water from a water resource;

(b) storing water;

(c) impeding or diverting the flow of water in a watercourse;

(d) engaging in a stream flow reduction activity contemplated in section 36;

(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

(g) disposing of waste in a manner which may detrimentally impact on a water resource;

(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

(i) altering the bed, banks, course or characteristics of a watercourse;

(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

(k) using water for recreational purposes.

Part 2 of the Act sets out considerations, conditions and essential requirements of general authorisations and licences.

5.2 Essential requirements and conditions of water use authorisations

Section 28 of the NWA sets out the essential requirements of water use authorisations and Section 29 sets the conditions which need to be met in the authorisations issued. It is these conditions that the IWQM system would help in implementation.

29. (1) A responsible authority may attach conditions to every general authorisation or licence -

(a) relating to the protection of -

(i) the water resource in question;

(ii) the stream flow regime; and

(iii) other existing and potential water users;

(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 aspects 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;

(iv) requiring the payment of charges for water use as provided for in Chapter 5;

(v) requiring the licensee to provide or make water available to a person specified in the licence; and

(vi) in the case of a general authorisation, requiring the registration of the water use with the responsible authority and the payment of a registration fee as a pre-condition of that use;

(c) relating to return flow and discharge or disposal of waste, by -

(i) specifying a water resource to which it must be returned or other manner in which it must be disposed of;

(ii) specifying permissible levels for some or all of its chemical and physical components;

(iii) specifying treatment to which it must be subjected, before it is discharged; and

(iv) specifying the volume which may be returned;

(d) in the case of a controlled activity -

(i) specifying the waste treatment, pollution control and monitoring equipment to be installed, maintained and operated; and

(ii) specifying the management practices to be followed to prevent the pollution of any water resource;

(e) in the case of taking or storage of water -

(i) setting out the specific quantity of water or percentage of flow which may be taken;

(ii) setting out the rate of abstraction;

(iii) specifying the method of construction of a borehole and the method of abstraction from the borehole;

(iv) specifying the place from where water may be taken;

(v) specifying the times when water may be taken;

(vi) identifying or limiting the area of land on which any water taken from a resource may be used;

(vii) limiting the quantity of water which may be stored;

(viii) specifying locations where water may be stored; and

(ix) requiring the licensee to become a member of a water user association before water may be taken;

(f) in the case of a stream flow reduction activity -

(i) specifying practices to be followed to limit stream flow reduction and other detrimental impacts on the water resource; and

(ii) setting or prescribing a method for determining the extent of the stream flow reduction caused by the authorised activity;

(g) which are necessary or desirable to achieve the purpose for which the licence was issued;

(h) which are necessary or desirable to ensure compliance with the provisions of this Act; and

(i) in the case of a licence -

(i) specifying times when water may or may not be used;

(ii) containing provisions for its termination if an authorised use of water is not implemented or not fully implemented;

(iii) designating water for future or contingent use; or

(iv) which have been agreed to by the licensee.

In this respect the system will make the management/ implementation of water use authorisation conditions which can be related to CCPs and CRFs and are most often associated with standards (targets) that need to be met very simple.

6 CONCLUSIONS

In 2008 a project was initiated with the aim of developing a conceptual model for aligning water resource and drinking water quality management. The model that was developed is based on the premise that good water quality is in everyone's best interests. While the current management approaches attach responsibility for good water quality at a high level, the Integrated Water Quality Management (IWQM) approach that was developed divides water management into smaller management units while establishing both a horizontal and vertical reporting framework.

In developing the IWQM model, three main components were identified:

- *Defining principles* which are defined as being generalisations that are accepted as true and that can be used as a basis for reasoning or conduct, such as, water must be properly valued (there is not enough water);
- *Background conditions* which are defined as those conditions external to water quality which support the implementation of this framework and therefore indirectly impact on water quality, such as, management systems and tools; and
- *Management units* which are defined as a geographical area that could be managed as a unit owing to common water use characteristics at the "lower" levels and to institutional responsibilities with regard to the management of water quality at the "higher" levels.

The ultimate goal of IWQM is to achieve specific objectives at a particular management unit taking into consideration the defining principles and background conditions relevant to that specific management unit. There are however, specific elements that must be included for each management unit:

- Water use cycle elements' identification;
- Hazard assessment/risk assessment in which Critical Risk Factors (CRF), Critical Control Points (CCP) each with associated performance targets are set;
- Risk management; and
- Contingency planning.

The IWQM management approach "breaks down" water management into smaller management units while establishing both a horizontal and vertical reporting framework. A further benefit of the model is that responsibility for water quality is based on significantly smaller geographical areas, and accountability to the adjoining areas (horizontal accountability) and to the next level of management (vertical accountability) is established with the establishment of the management unit. This allows accountability for water quality to be focussed on smaller management units, rather than diffused up ever higher levels of

management. In other words, by making all water users aware of their own responsibility to the protection of South Africa's water resources and accountable for the impacts that they have on the resource.

The IWQM approach allows water quality information to be packaged for a broader audience, as reporting is simplified to provide information on whether or not a management unit is within specifications of its CCPs or not; rather than extensive technical reports to national level through the management chain. This addresses the issue of the raising of awareness in the broader community, of the basic premise that good water quality is in everyone's best interests, while providing for "everyone's" involvement in its management through the allocation of responsibility at more localised levels.

6.1 The web-enabled system

In developing the web-enabled system the following aspects were considered.

- Ease of use; and
- Links to a map facility.

In light of all the other systems and reporting requirements that officials often need to give input to, the system needed to be user friendly and not data intensive. It needed to produce a simple report that could add value to the officials, environmental officers and managers' report backs to senior management, regulators and to the downstream water users. In other words;

- These are the targets;
- These are the measured values;
- These targets were met (Y);
- Those were not met (N); and
- This is what is going to be done about it, all on one page.

In this way a history of problem areas can easily be built up and dealt with. The maps accompanying the system will make it easy for users to ensure that their CCPs and CRFs are correctly located.

6.2 Using the system to help with the implementation of NWA water use authorisations

In terms of using the system to help with the implementation of water use authorisations the following National Water Act (Act 36 of 1998)(NWA) sections were considered:

- Section 21 which details both consumptive and non-consumptive water uses;

- Section 41 which requires that all water uses listed in Section 21 of the NWA be authorised; whether it be under General Authorisation (GA), Existing Lawful Use (ELU) or a water use licence (WUL);
- Section 28 of the NWA which sets out the essential requirements of water use authorisations; and
- Section 29 which sets the conditions which need to be met in the authorisations issued. It is these conditions that the IWQM system would help in implementation

All of the authorisations contain conditions relating to quality, quantity and management options related to the water use. The conditions can be related to CCPs and CRFs and are most often associated with standards that need to be met (targets).

7 RECOMMENDATIONS

7.1 Status of current work

At the start of the project the main objective was to set up a web-based system. The web-based system was achieved however there is still some concern around who should administer such a system. In this respect it was decided that the system would be presented on a CD.

As this project was specifically related to aiding the implementation of water use authorisations, it is proposed that the CMA/ DWA Regional Office be the Administrator for those users that have a water use authorisation or who have applied for a water use authorisation.

7.2 Future work

In developing the system the following aspects for future consideration were highlighted.

- Link to the risk based water quality guidelines;
- Export of results to excel so that trend graphs can be more easily generated; and
- Consideration of links to the Green Drop system.

A link to the risk based water quality guidelines would be useful in that where a non-compliant value is recorded then the user would be able to see what impact that particular non-compliance would have on the different users in the catchment, in a way making it more personal.

Currently the system does not allow the export of the results to a spreadsheet format and would require a bit more work. This would be useful in showing the trends for a particular parameter.

Potential links to support the green drop system may also be useful.

7.3 Capacity building

As part of the capacity building for the project the following were undertaken:

- Mr Oliver Malete, a project team member, obtained a bursary through GAA and registered to complete his BSc (Hons) Applied Science. He still has one subject to complete.
- Training sessions were held with the project team members and the system was presented and applied at the DWA Bronkhorstspruit and Gauteng Regional Offices;
- The framework was presented during an Integrated Water Resources Management Course at the Council for Environmental Management at the North West University.
- An abstract was submitted and accepted for a workshop at WISA 2014 in Mpumalanga.

8 LIST OF REFERENCES

Boyd L Tompkins R and Heath R (2010). Integrated Water Quality Management: a mindset change. WRC Report No. TT 450/10

L Boyd R Tompkins D Padayachee O Malete and R Heath (2011). Integrated Water Quality Management: a mindset change. Testing a refined conceptual model

Department of Water Affairs and Forestry (1998). Water Services Act, (Act 108 of 1997)

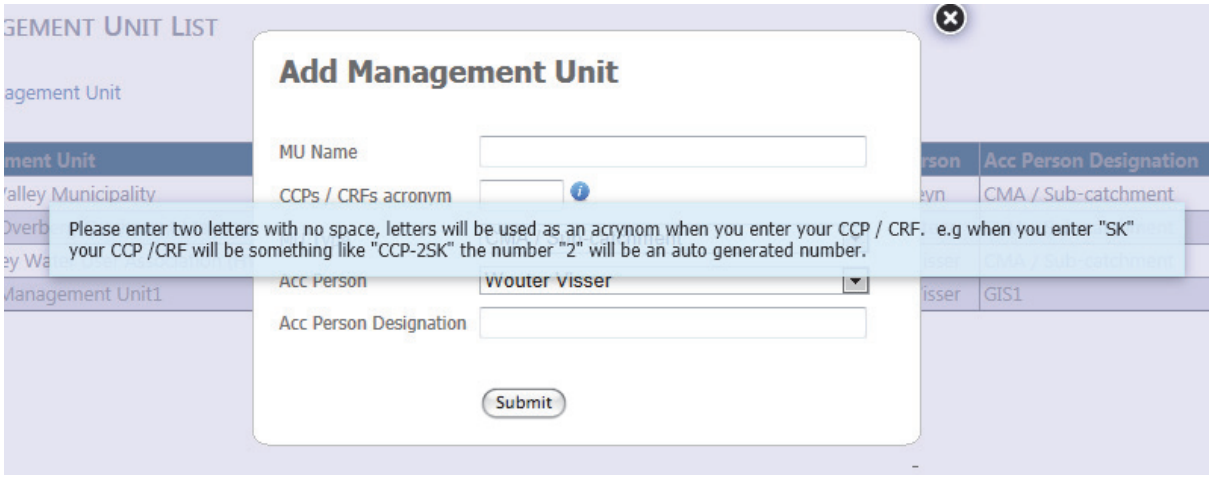
Department of Water Affairs and Forestry (1998). National Water Act (Act 36 of 1998)

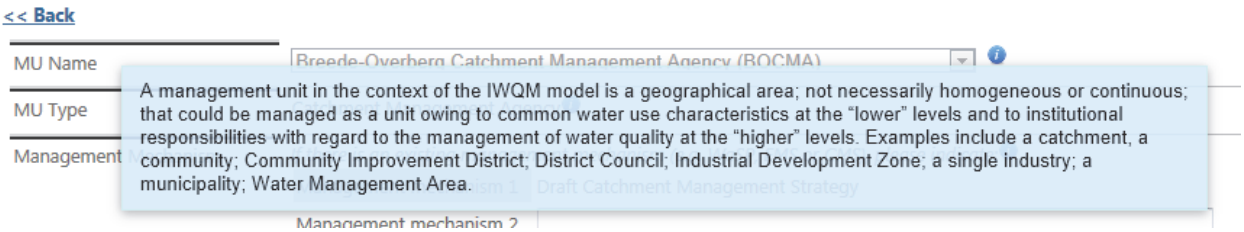
Department of Water Affairs and Forestry (2013) National Water Resources Strategy, Second Edition

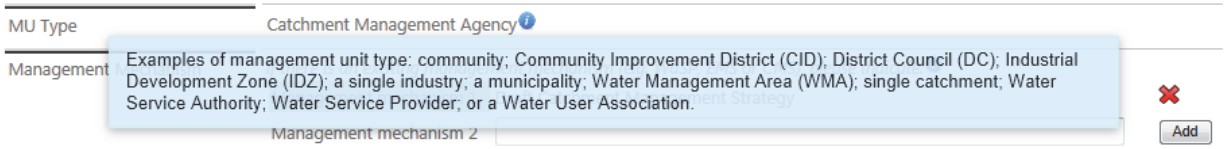
Jack U and de Souza P (2012). Guidelines for Using the Web-enabled Water Safety Plan Tool WRC Report No. TT 515 /12

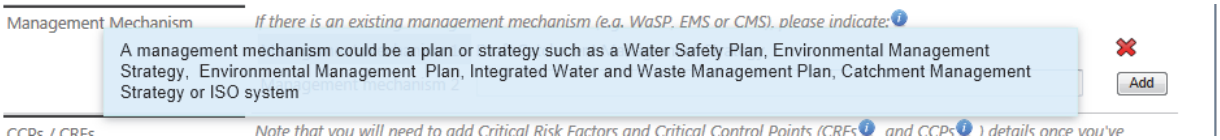
APPENDIX A: HELP FUNCTIONS

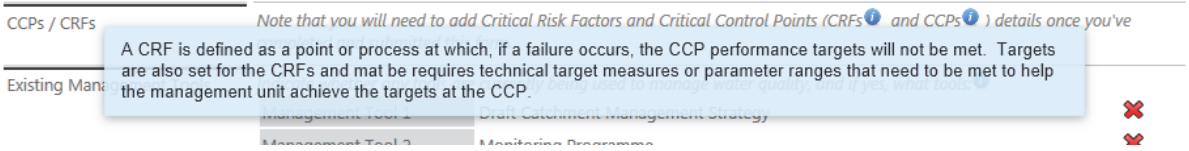
These will show up on the screen as the mouse hovers over the information button

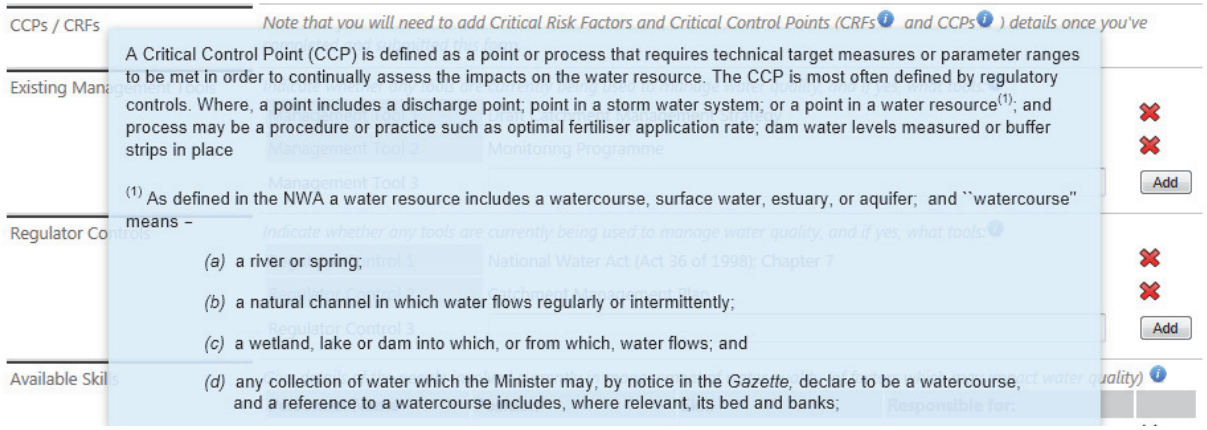

GEMENT UNIT LIST
agement Unit
Add Management Unit
MU Name
CCPs / CRFs acronym
Please enter two letters with no space, letters will be used as an acrynom when you enter your CCP / CRF. e.g when you enter "SK" your CCP /CRF will be something like "CCP-2SK" the number "2" will be an auto generated number.
Acc Person
Wouter Visser
Acc Person Designation
Submit
ment Unit
Acc Person Designation
Management Unit1
GIS1

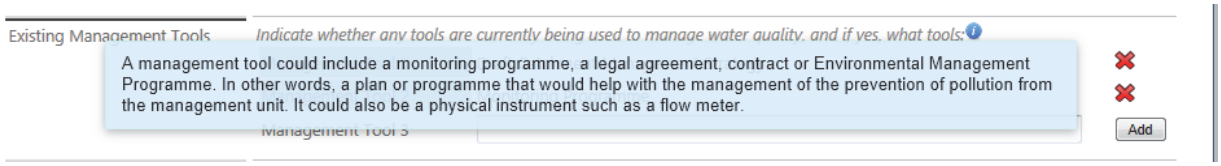

<< Back
MU Name
Breede-Overberg Catchment Management Agency (BOCMA)
MU Type
Management
A management unit in the context of the IWQM model is a geographical area; not necessarily homogeneous or continuous; that could be managed as a unit owing to common water use characteristics at the "lower" levels and to institutional responsibilities with regard to the management of water quality at the "higher" levels. Examples include a catchment, a community; Community Improvement District; District Council; Industrial Development Zone; a single industry; a municipality; Water Management Area.
Management mechanism 2

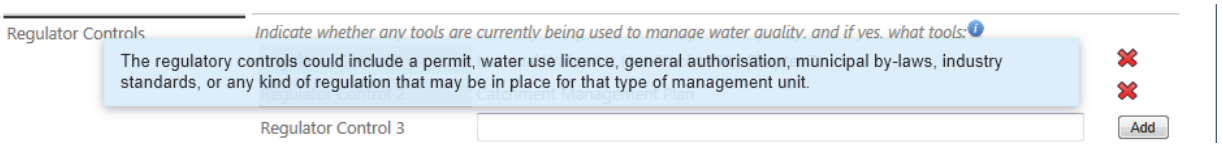

MU Type
Catchment Management Agency
Management
Examples of management unit type: community; Community Improvement District (CID); District Council (DC); Industrial Development Zone (IDZ); a single industry; a municipality; Water Management Area (WMA); single catchment; Water Service Authority; Water Service Provider; or a Water User Association.
Management mechanism 2
Add

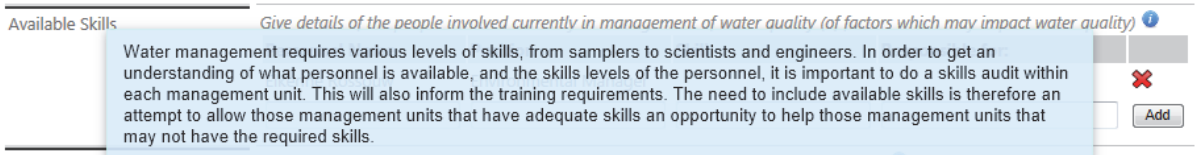

Management Mechanism
If there is an existing management mechanism (e.g. WaSP, EMS or CMS), please indicate:
A management mechanism could be a plan or strategy such as a Water Safety Plan, Environmental Management Strategy, Environmental Management Plan, Integrated Water and Waste Management Plan, Catchment Management Strategy or ISO system
Add
Note that you will need to add Critical Risk Factors and Critical Control Points (CRFs and CCPs) details once you've

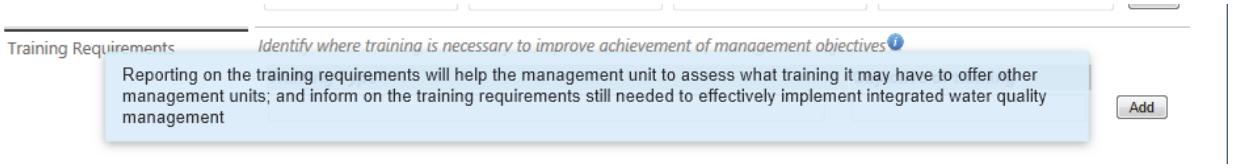

CCPs / CRFs
Note that you will need to add Critical Risk Factors and Critical Control Points (CRFs and CCPs) details once you've
A CRF is defined as a point or process at which, if a failure occurs, the CCP performance targets will not be met. Targets are also set for the CRFs and mat be requires technical target measures or parameter ranges that need to be met to help the management unit achieve the targets at the CCP.

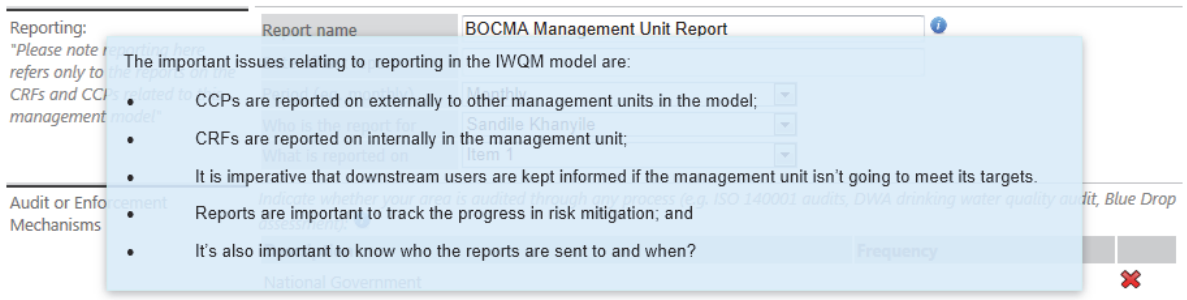

CCPs / CRFs
Note that you will need to add Critical Risk Factors and Critical Control Points (CRFs and CCPs) details once you've
A Critical Control Point (CCP) is defined as a point or process that requires technical target measures or parameter ranges to be met in order to continually assess the impacts on the water resource. The CCP is most often defined by regulatory controls. Where, a point includes a discharge point; point in a storm water system; or a point in a water resource(1); and process may be a procedure or practice such as optimal fertiliser application rate; dam water levels measured or buffer strips in place
(1) As defined in the NWA a water resource includes a watercourse, surface water, estuary, or aquifer; and ``watercourse'' means –
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;
Add

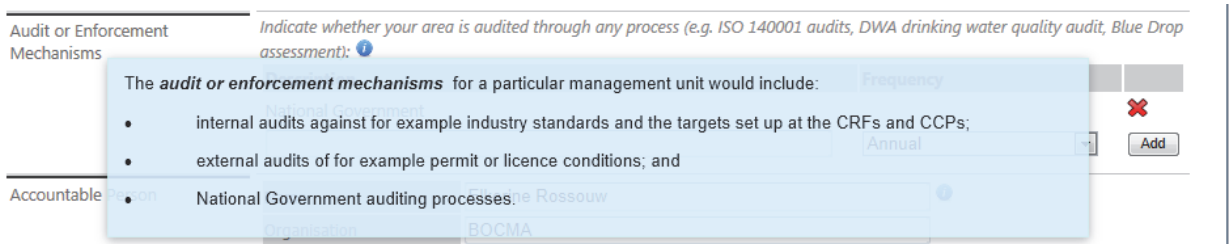

Existing Management Tools
Indicate whether any tools are currently being used to manage water quality, and if yes, what tools:
A management tool could include a monitoring programme, a legal agreement, contract or Environmental Management Programme. In other words, a plan or programme that would help with the management of the prevention of pollution from the management unit. It could also be a physical instrument such as a flow meter.
Add

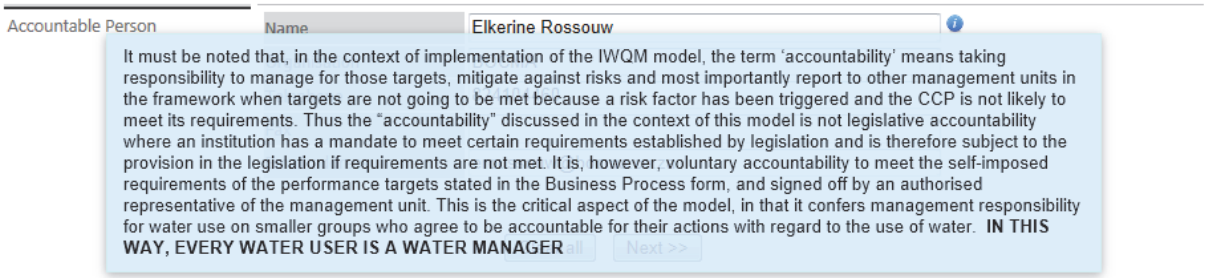

Regulator Controls
Indicate whether any tools are currently being used to manage water quality, and if yes, what tools:
The regulatory controls could include a permit, water use licence, general authorisation, municipal by-laws, industry standards, or any kind of regulation that may be in place for that type of management unit.
Regulator Control 3
Add


Available Skills
Give details of the people involved currently in management of water quality (of factors which may impact water quality)
Water management requires various levels of skills, from samplers to scientists and engineers. In order to get an understanding of what personnel is available, and the skills levels of the personnel, it is important to do a skills audit within each management unit. This will also inform the training requirements. The need to include available skills is therefore an attempt to allow those management units that have adequate skills an opportunity to help those management units that may not have the required skills.
Add
Training Requirements
Identify where training is necessary to improve achievement of management objectives


Training Requirements
Identify where training is necessary to improve achievement of management objectives
Reporting on the training requirements will help the management unit to assess what training it may have to offer other management units; and inform on the training requirements still needed to effectively implement integrated water quality management
Add


Reporting:
Report name
BOCMA Management Unit Report
The important issues relating to reporting in the IWQM model are:
CCPs are reported on externally to other management units in the model;
CRFs are reported on internally in the management unit;
It is imperative that downstream users are kept informed if the management unit isn't going to meet its targets.
Reports are important to track the progress in risk mitigation; and
It's also important to know who the reports are sent to and when?
Audit or Enforcement Mechanisms
Frequency
National Government


Audit or Enforcement Mechanisms
Indicate whether your area is audited through any process (e.g. ISO 140001 audits, DWA drinking water quality audit, Blue Drop assessment):
The audit or enforcement mechanisms for a particular management unit would include:
internal audits against for example industry standards and the targets set up at the CRFs and CCPs;
external audits of for example permit or licence conditions; and
National Government auditing processes.
Frequency
Annual
Add
Accountable Person
Elkerine Rossouw
BOCMA


Accountable Person
Name
Elkerine Rossouw
It must be noted that, in the context of implementation of the IWQM model, the term 'accountability' means taking responsibility to manage for those targets, mitigate against risks and most importantly report to other management units in the framework when targets are not going to be met because a risk factor has been triggered and the CCP is not likely to meet its requirements. Thus the "accountability" discussed in the context of this model is not legislative accountability where an institution has a mandate to meet certain requirements established by legislation and is therefore subject to the provision in the legislation if requirements are not met. It is, however, voluntary accountability to meet the self-imposed requirements of the performance targets stated in the Business Process form, and signed off by an authorised representative of the management unit. This is the critical aspect of the model, in that it confers management responsibility for water use on smaller groups who agree to be accountable for their actions with regard to the use of water. IN THIS WAY, EVERY WATER USER IS A WATER MANAGER

APPENDIX B: CD containing the files to download the IWQM system

The CD can be found in the pocket attached to the inner back sleeve of this report