REPORT NO: RDM/WMA11/00/CON/CLA/1214

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679

VOLUME 6:

SUPPORTING INFORMATION ON THE DETERMINATION OF WATER RESOURCE CLASSES: USER WATER QUALITY CONSEQUENCES OF OPERATIONAL SCENARIOS

MARCH 2015

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

RfA04_2015

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 6: SUPPORTING INFORMATION ON THE DETERMINATION OF WATER RESOURCE CLASSES – USER WATER QUALITY CONSEQUENCES OF OPERATIONAL SCENARIOS

Report Number: RDM/WMA11/00/CON/CLA/1214

MARCH 2015

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water and Sanitation, South Africa, March 2015. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 6: Supporting Information on the Determination of Water Resource Classes – User Water Quality Consequences of Operational Scenarios. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Authored by Scherman, P-A.

DOCUMENT INDEX

Index Number	DWS Report Number	Report Title
1	*Report Number: RDM/WMA11/00/CON/CLA/0112*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Inception Report**
2	*Report Number: RDM/WMA11/00/CON/CLA/0113*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Status Quo assessment, IUA and Biophysical Node delineation and identification.**
3	*Report Number: RDM/WMA11/00/CON/CLA/0213*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **River Resource Units and EWR sites**
4	*Report Number: RDM/WMA11/00/CON/CLA/0313*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Desktop Estuary EcoClassification and EWR**
5	**Rivers EWR report Volumes**	
5.1	*Report Number: RDM/WMA11/00/CON/CLA/0114*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 1: EWR estimates of the River Desktop Biophysical Nodes**
5.2	*Report Number: RDM/WMA11/00/CON/CLA/0214*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 2: EcoClassification and EWR assessment on the Mtamvuna, Lovu, uMngeni, Karkloof and uMnsunduze Rivers**
5.3	*Report Number: RDM/WMA11/00/CON/CLA/0314*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 3: EcoClassification and EWR assessment on the uMkhomazi, uMngeni and Mvoti Rivers**
6	*Report Number: RDM/WMA11/00/CON/CLA/0212*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **BHNR**
7	*Report Number: RDM/WMA11/00/CON/CLA/0514*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Water Resource Analysis Report**
8	**Operational Scenario and Management Class report volumes**	
8.1	*Report Number: RDM/WMA11/00/CON/CLA/0614*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 1: Supporting Information on the Determination of Water Resource Classes - Ecological Consequences of Operational Scenarios.**
8.2	*Report Number: RDM/WMA11/00/CON/CLA/0714*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 2.1: Supporting Information on the Determination of Water Resource Classes - Estuary Ecological Consequences of Operational Scenarios**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 2.2: Supporting Information on the Determination of Water Resource Classes - Estuary Ecological**

Index Number	DWS Report Number	Report Title
		Consequences of Operational Scenarios
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 2.3: Supporting Information on the Determination of Water Resource Classes - Estuary Ecological Consequences of Operational Scenarios**
8.3	*Report Number: RDM/WMA11/00/CON/CLA/0814*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 3.1: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices : Water Quality (available electronically only)**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3.2: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices (available electronically only)**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3.3: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices: Invertebrates (available electronically only)**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3.4: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices: Zooplankton (available electronically only)**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3.5: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices (available electronically only)**
		Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: **Volume 3.6: Supporting Information on the Determination of Water Resource Classes – Estuary specialist appendices (available electronically only)**
8.4	*Report Number: RDM/WMA11/00/CON/CLA/0914*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 4: Supporting Information on the Determination of Water Resource Classes - Economic Consequences of Operational Scenarios**
8.5	*Report Number: RDM/WMA11/00/CON/CLA/1014*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 5: Supporting Information on the Determination of Water Resource Classes - EGSA Consequences of Operational Scenarios**
8.6	**Report Number: RDM/WMA11/00/CON/CLA/1214**	**Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 6: Supporting Information on the Determination of Water Resource Classes – User Water Quality Consequences of Operational Scenarios**
8.7	*Report Number: RDM/WMA11/00/CON/CLA/1314*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in*

Index Number	DWS Report Number	Report Title
		the Mvoti to Umzimkulu Water Management Area: **Volume 7: Recommended Water Resource Classes for the Mvoti and uMkhomazi River Systems.**
10	**Resource Quality Objectives report volumes**	
10.1	*Report Number: RDM/WMA11/00/CON/CLA/0215*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 1: Rivers RQOs**
10.2	*Report Number: RDM/WMA11/00/CON/CLA/0315*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 2: Wetland RQOs**
10.3	*Report Number: RDM/WMA11/00/CON/CLA/0415*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 3: Groundwater RQOs**
10.4	*Report Number: RDM/WMA11/00/CON/CLA/0416*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Volume 4: Estuary RQOs**
11	*Report Number: RDM/WMA11/00/CON/CLA/0417*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Closing Report**
12	*Report Number: RDM/WMA11/00/CON/CLA/0418*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* **Main Report**

DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEMS

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

VOLUME 6: SUPPORTING INFORMATION ON THE DETERMINATION OF WATER RESOURCE CLASSES – USER WATER QUALITY CONSEQUENCES OF OPERATIONAL SCENARIOS

Approved for RFA by:

……

Delana Louw
Project Manager

……

Date

DEPARTMENT OF WATER AND SANITATION (DWS)
Approved for DWS by:

……

Chief Director: Water Ecosystems

……

Date

AUTHOR

This report was compiled by Dr P-A Scherman.

REPORT SCHEDULE

Version	Date
First draft	*March 2015*
Final draft	

EXECUTIVE SUMMARY

The purpose of this short report is to describe and document an approach as to how operational scenarios may impact on water quality for users or water quality role players other than the aquatic ecosystem (for example: Domestic Use, Agriculture - Stock Watering, Agriculture – Irrigation, Industrial - Category 3 and Recreation - Intermediate Contact). The document therefore presents the approach undertaken to include user water quality into the consequences evaluation and the results of this assessment. Note that only sites relevant to scenarios were assessed.

Priority Resource Units or Management Resource Units for the determination of consequences to users are those reaches containing the EWR sites which may potentially be impacted by operational scenarios. The impact of operational scenarios has therefore been assessed at these key biophysical nodes in the study area:

- *uMkhomazi (U1), reaches containing EWR sites 1, 2 and 3*
- *uMngeni (U2), reaches containing EWR sites 2 and 5*
- *Mvoti (U4), reach containing EWR site 2*
- *Lovu (U7), reach containing EWR 1*

The qualitative assessment of the consequences of operational scenarios on user water quality showed that little impact is expected under any of the operational scenarios assessed at selected reaches. For a number of the reaches containing EWR sites, conditions may improve slightly for users due to improved flows (and therefore improved water quality state) under the scenarios. Note that scenarios including increased releases from Phoenix, Mhlanga, Tongati and Darville Waste Water Treatment Works assume that releases will meet required water quality standards.

The ranking of scenario impacts on user water quality was not undertaken for the Mvoti – Umzimkulu study due to the small differences and lack of resolution to differentiate between the scenarios for the various sites.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

TERMINOLOGY AND ACRONYMS

CD: WE	*Chief Directorate: Water Ecosystems*
CS	*Current State*
DO	*Dissolved Oxygen*
DWA	*Department Water Affairs (Name change from DWAF applicable after April 2009)*
DWAF	*Department Water Affairs and Forestry*
DWS	*Department Water and Sanitation (Name change from DWA applicable after May 2014)*
EWR	*Ecological Water Requirement*
IUA	*Integrated Unit of Analysis*
MM	*Metropolitan Municipality*
MRU	*Management Resource Unit*
RQO	*Resource Quality Objective*
RU	*Resource Unit*
SQ	*Sub-quaternary*
TWG	*Technical Working Group*
WMA	*Water Management Area*
WWTW	*Wastewater Treatment Works*

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Water Resource Classes of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011). The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA.

1.2 STUDY AREA

The Mvoti to Umzimkulu WMA encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment "U" and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, uMngeni, uMkhomazi, Umzimkulu and Mtamvuna (DWA, 2011).

Two large river systems, the Umzimkulu and uMkhomazi rise in the Drakensberg. Two medium-sized river systems the uMngeni and Mvoti rise in the Natal Midlands and have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements. Several smaller river systems (e.g. Mzumbe, Mdloti, Tongaat, Fafa, and Lovu rivers) also exist within the WMA (DWAF, 2004). Several parallel rivers arise in the escarpment and discharges into the Indian Ocean and the water courses in the study area display a prominent southeasterly flow direction (DWA, 2011).
The WMA is very rugged and very steep slopes characterise the river valleys in the inland areas for all rivers and moderate slopes are found but comprise only 3% of the area of the WMA (DWAF, 2004).

1.3 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs are supplied in Table 1.1.

Table 1-1 Integrated study steps

Step	Description
1	*Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).*

2	Initiation of stakeholder process and catchment visioning (on-going).
3	Quantify the Ecological Water Requirements and changes in non-water quality ecosystem goods, services and attributes.
4	**Identify and evaluate scenarios within the integrated water resource management process.**
5	Evaluate the scenarios with stakeholders and determine Water Resource Classes.
6	Develop draft RQOs and numerical limits.
7	Gazette and implement the class configuration and RQOs.

*This report forms **part** of the outcomes of Step 4 (red above) within the integrated approach (DWA, 2012). The objective of this task was to provide the scenario analysis, assumptions and results and document the consequences of the scenarios for the various components under Task D4 (i.e. the identification and evaluation of operational scenarios to identify consequences) which are provided as seven report volumes under Report 8. All the report volumes apart from Report 8.7 are supporting information that feeds into Report 8.7 and will integrate all this information to derive at Water Resource Classes for the various scenarios.*

The purpose of this short report is to describe and document an approach as to how operational scenarios may impact on water quality for users or role players other than the aquatic ecosystem (for example: Domestic Use, Agriculture - Stock Watering, Agriculture – Irrigation, Industrial - Category 3 and Recreation - Intermediate Contact). The document therefore presents the approach undertaken to include user water quality into the consequences evaluation and the results of this assessment. Note that only sites relevant to scenarios were assessed.

1.4 OUTLINE OF REPORT

The report structure is outlined below.

Chapter 1: Introduction
This Chapter provides general background to the project Task.

Chapter 2: Approach
This Chapter outlines the general approach to the consequences assessment for user water quality.

Chapter 3: Overview and Data collection
This Chapter outlines the Data collection process and results per step.

Chapter 4: Results
This Chapter outlines the Results of the consequences assessment.

Chapter 5: Discussion and Conclusions
This Chapter briefly summarizes the main points from the assessment.

Chapter 6: Appendix A: Report Comments
Report comments from the Client.

2 APPROACH

In the Mvoti - Umzimkulu Classification study water quality consists of the following two broad components:

- *Ecological, i.e. as part of the Ecological Water Requirement (EWR) or Reserve process. A standard process is followed for scenario evaluation. Ecological Specifications or EcoSpecs are the output of the Reserve process.*
- *Users, i.e. water quality related to users or role players other than ecology, for example: Domestic Use, Agriculture - Stock Watering, Agriculture – Irrigation, Industrial - Category 3 and Recreation - Intermediate Contact. UserSpecs are defined.*

Water quality is therefore incorporated in the consequence assessment as:

- *Part of ECOLOGICAL consequences;*
- *a service identified in ECOSYSTEM SERVICES;*
- *indirectly in the ECONOMICS in terms of water treatment costs; and*
- *USER WATER QUALITY consequences assessment (this document).*

The approach undertaken for the study area is listed below as bullet points.

-
- *Identify the Resource Units (RUs) or Management Resource Units (MRUs) or nodes of interest (nested within the Integrated Units of Analysis (IUAs)) which may potentially be impacted by the scenarios.*
- *Gather background information on water users in the catchment and previously set objectives for water quality (where available).*
- *Use land use information, the Water Quality Status Quo task conducted for the study and other background information to identify which users are located where, and where the water quality hotspot areas are found.*
- *Link users to the RUs or nodes of interest which may potentially be impacted by the scenarios.*
- *Identify the user groups' water quality requirements and drivers of water quality.*
- *Utilise the ecological information from the Reserve study to describe aquatic ecosystem requirements.*
- *Identify primary users and driving water quality variables.*
- *Test this information with the Technical Working Group (TWG) and update as required. Two TWG meetings were held; one in October 2014 (U1 and U4 catchments) and January 2015 (the rest of the study area).*
- *Provide an impact rating of selected scenarios on water quality at identified sites for the driving user(s) or role players.*
- *Weight sites to achieve ranks relative to each other and rank the scenarios in terms of water quality impact, if required.*

To summarize, user water quality state per scenario and per relevant RU/MRU and IUA was scored using the <u>driving</u> water quality variables linked to the <u>primary</u> water quality role players. Note that although the aquatic ecosystem is the resource base rather than a "user", it was grouped and evaluated with other users for purposes of this step of the Classification process.

The identified IUAs or RUs/MRUs were evaluated by specialists for a range of consequences (ecological, ecosystem services and economic). The scenario evaluation process therefore

estimates the consequences that a set of plausible scenarios will have on these elements by quantifying selected metrics to compare the scenarios on relative bases with one another. The scenarios were ranked, first, for the individual variables and secondly an overall integrated ranking was derived based on multi-criteria analysis methods. Consequences on user water quality were evaluated using a qualitative process and any problem areas identified.

Figure 2.1 is a diagrammatic representation of the steps shown in the approach. The various steps are referred to as Phases 1 to 5. This notation is followed during the explanation of data collection and results (see Chapter 3).

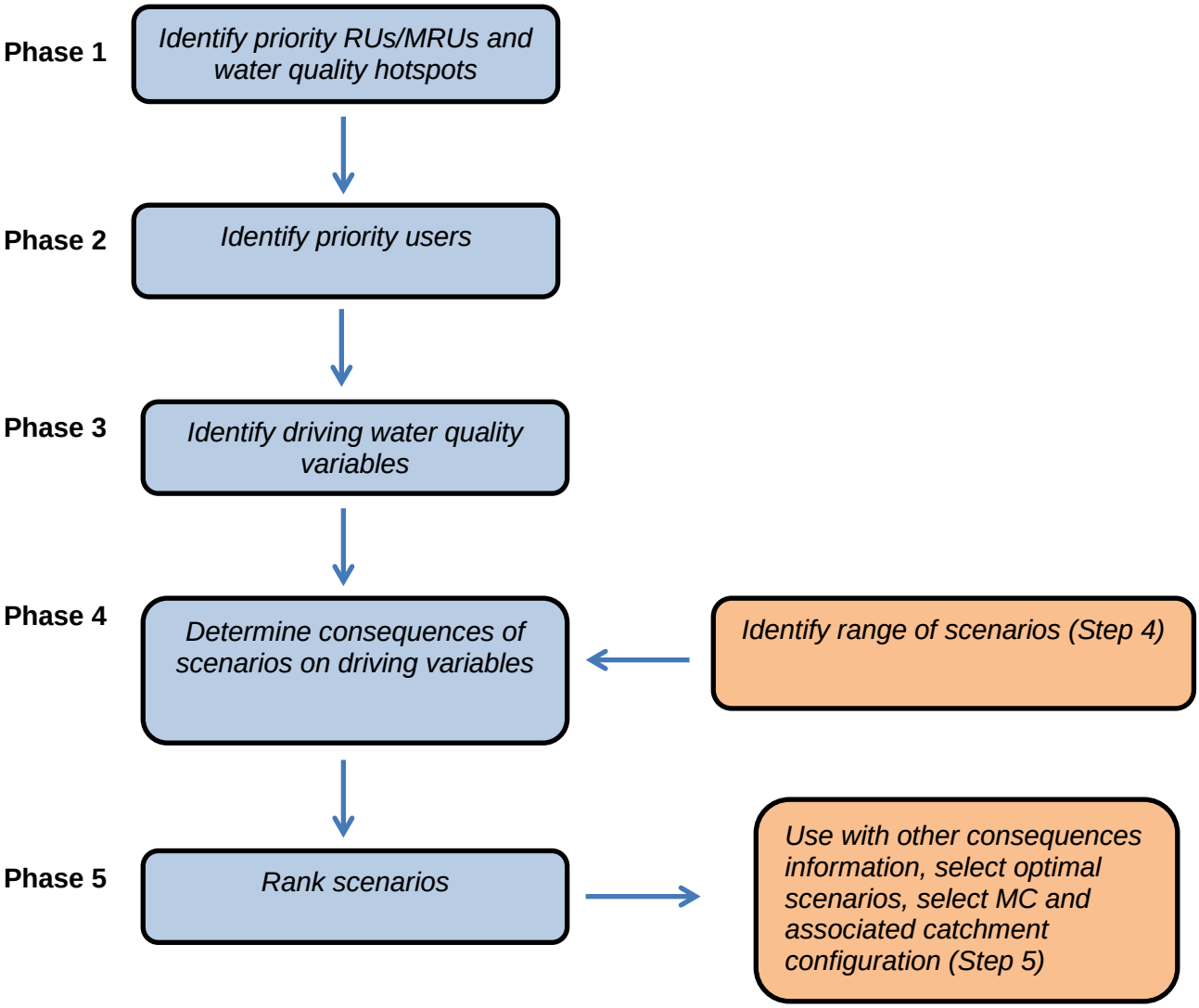


Figure 2.1 A diagrammatic representation of the approach followed for determining consequences of scenarios to user water quality

3 OVERVIEW AND DATA COLLECTION

3.1 WATER QUALITY OVERVIEW

The following summary provides a description of general water quality state in WMA11 (taken from the National Water Resources Strategy of 2004):

- *The quality of surface water in WMA is of a high standard under natural conditions.*
- *There is wash-off from areas with insufficient sanitation infrastructure and services, resulting in unacceptable bacteriological pollution, particularly at rural villages and dense settlements.*
- *Intensive farming operations impacts on water quality in some catchments, particularly the uMnsunduze, lower uMngeni and Mlazi rivers.*
- *There is localised bacteriological pollution of streams in some rural areas.*
- *Quality of groundwater is generally of a very high standard, with no pollution of groundwater recorded.*
- *Note the importance of the Durban-Pietermaritzburg metropolitan and industrial area in socio-economy of the WMA, and already over-commitment of water from uMngeni River System as the source of water supply to the region.*
- *Note that the DWS Development Strategy to Control Eutrophication in SA (2003), prepared by the Directorate: Water Quality Management, identified all estuaries, including all farm dams and watercourses in WMA11, as having infrequently severe eutrophication problems due to sewage discharge, and non-point source pollution respectively.*

Data collection steps for the priority RUs are shown for Phases 1 to 3 – see Figure 2.1.

3.2 PHASE 1: IDENTIFY PRIORITY RUs/MRUs AND WATER QUALITY HOTSPOTS

Priority RUs or MRUs for the determination of consequences to users are those reaches containing the EWR sites which may potentially be impacted by operational scenarios. The impact of operational scenarios has therefore been assessed at these key biophysical nodes in the study area:

- *uMkhomazi (U1), reaches containing EWR sites 1, 2 and 3.*
- *uMngeni (U2), reaches containing EWR sites 2 and 5.*
- *Mvoti (U4), reach containing EWR site 2.*
- *Lovu (U7), reach containing EWR 1.*

All consequences, i.e. ecological, economic, ecological services and user water quality, were therefore assessed at these driving nodes or reaches of the rivers. Water quality hotspots per relevant area are also depicted - information is taken from DWA (2013).

3.2.1 uMkhomazi (U1)

- *This reach is MRU uMkhomazi B in IUA U1-2 and includes MK_I_EWR1. This IUA consists of the uMkhomazi and Luhane rivers, which are dominated by non-flow related impacts (mainly forestry and rural settlements with informal agriculture), while the Elands and its tributaries are dominated by both flow (mainly small dams and some irrigation) and non-flow related (mainly forestry and rural settlements with informal agriculture) impacts.*
- *This reach is MRU uMkhomazi C in IUA U1-3 and includes MK_I_EWR2. The storage regulation in this IUA is low. Land use activities are predominantly community water use from low density rural settlements.*

- *This reach is MRU uMkhomazi D in IUA U1-4 and includes MK_I_EWR3. This IUA includes the Xogho and uMkhomazi rivers. Storage regulation in this IUA is low. The development of the upstream uMkhomazi River Development Project (Smithfield Dam) will have a significant impact on the uMkhomazi River in the water resource IUA. The landuse activities are predominantly community water use from low density rural settlements.*

No water quality hotspots were identified in this catchment area.

3.2.2 uMngeni (U2)

- *This reach is MRU uMngeni B in IUA U2-2 and includes Mg_I_EWR2. This IUA contains Midmar Dam upstream and Albert Falls Dam at the lower end of the IUA. The IUA is highly regulated, with land-use being forestry, irrigation and dry land agriculture. Howick is located below Midmar Dam.*
- *This reach is MRU uMngeni D in IUA U2-5 and includes Mg_I_EWR5. The IUA is regulated by the upstream Midmar and Albert Falls dams, Nagle Dam as well as Inanda Dam located at the lower end of the IUA. Impact are forestry, dams and agriculture (mostly dryland), and poor quality water from the uMnsunduze River.*

Water quality hotspots

Water quality hotspots across U20 are shown in the table below. Shaded areas indicate water quality hotspots within IUA U2-2 and IUA U2-5.

Sub-quaternary (SQ) reach	River name	Water quality impact (rating)	Water quality issues
U20C-04340	*Nguklu*	*Large (3)*	*Elevated nutrient loads.*
U20E-04243	*uMngeni*	*Large (3)*	*Elevated nutrient loads; urban run-off.*
U20F-04224	*Mpolweni*	*Large (3)*	*High nutrient load.*
U20G-04194	*Mkabela*	*Large (3)*	*High nutrient load; toxics may be present.*
U20G-04215	*Cramond Stream*	*Large (3)*	*High nutrient load; toxics may be present.*
U20G-04240	*uMngeni*	*Large (3)*	*High nutrient load.*
U20G-04385	*uMngeni*	*Large (3)*	*High nutrient load; urban impacts.*
U20J-04364	*uMnsunduze*	*Serious (4)*	*Industrial discharges; elevated nutrients and salts.*
U20J-04391	*uMnsunduze*	*Critical (5)*	*Wastewater Treatment Works (WWTW); industrial discharges; elevated nutrients and salts.*
U20J-04401	*uMnsunduze*	*Critical (5)*	*Industrial discharges; elevated nutrients and salts.*
U20J-04461	*Slang Spruit*	*Critical (5)*	*Urban and industrial discharges.*
U20J-04488	*Mshwati*	*Large (3)*	*Urban impacts; nutrient elevations.*
U20L-04435	*uMngeni*	*Large (3)*	*Urban impacts; nutrient elevations.*
U20M-04396	*uMngeni*	*Serious (4)*	*Urban impacts; nutrient elevations; aquatic plants in upstream dam so low Dissolved Oxygen (DO) levels; treated effluent coming in from the Piesang in the north (below Inanda). Note the input of the Mhlangane River, which is a hotspot identified by eThekweni Metropolitan Municipality (MM).*
U20M-04639	*Palmiet*	*Large (3)*	*Elevated nutrients.*
U20M-04642	*Palmiet*	*Serious (4)*	*Elevated nutrients and industrial discharges.*
U20M-04653	*Palmiet*	*Large (3)*	*Elevated nutrients.*

3.2.3 Mvoti (U4)

This reach is MRU Mvoti C in IUA U4-3 and includes MV_I_EWR2. Main impacts in this IUA are non-flow related, especially sedimentation, overgrazing, trampling and vegetation removal. KwaDukuzu (Stanger) is situated in the lower end of the reach.

Water Quality hotspots

Water quality hotspots across U4 are shown in the table below. Shaded areas indicate water quality hotspots within IUA U4-3.

SQ reach	River name	Water quality impact (rating)	Water quality issues
U40B-03770	*Heinespruit*	*Serious (4)*	*Pesticides and nutrients; WWTW*
U40B-03832	*Mvozana*	*Large (3)*	*Elevated nutrients and salts*
U40J-03998	*Mvoti*	*Large (3), especially around KwaDukuzu*	*Sugar (Illovo) and paper mill effluents; WWTW so elevated nutrients; high turbidity levels; urban impacts (Stanger)*

3.2.4 Lovu (U7)

This reach is MRU Lovu D in IUA U7-1 and includes LO_R_EWR1. This IUA includes the valleys of the Lovu and Nungwane rivers, with forestry, sugar cane, rural development ad dams impacting on the area. Richmond is also on the Lovu system.

Water quality hotspots

Water quality hotspots across U70 are shown in the table below. Shaded areas indicate water quality hotspots within IUA U7-1.

SQ reach	River name	Water quality impact (rating)	Water quality issues
U70B-4655	*Lovu*	*Serious (4) - around Richmond only*	*WWTW and urban centre; fertilizers and pesticides.*
U70D-4905	*Lovu*	*Large (3)*	*Oil and diesel pollution; sugar mill; elevated nutrients.*

3.3 PHASE 2: IDENTIFY PRIMARY WATER USERS / ROLE PLAYERS IN PRIORITY REACHES

Water quality role players in the priority river reaches are shown in Tables 3.1 to 3.4 for the uMkhomazi, uMngeni, Mvoti and Lovu systems respectively.

Table 3-1 Primary users groups in river reaches considered during the scenario impact assessment process – uMkhomazi (U1)

Reach number	Priority river reaches	Primary role players
1	*MRU uMkhomazi B, including MK_I_EWR1*	*Some agriculture; erosion.*
2	*MRU uMkhomazi C, including MK_I_EWR2*	*Agriculture.*
3	*MRU uMkhomazi D, including MK_I_EWR3*	*Agriculture; settlements.*

Table 3-2 Primary users groups in river reaches considered during the scenario impact assessment process – uMngeni (U2)

Reach number	Priority river reaches	Primary role players
1	*MRU uMngeni B, including Mg_I_EWR2*	*Agriculture; urban impacts (Howick, including WWTW; U20E-04243).*
2	*MRU uMngeni D, including Mg_I_EWR5*	*Settlements; sand-mining; urban impacts incl. WWTW.*

Table 3-3 Primary users groups in river reaches considered during the scenario impact assessment process – Mvoti (U4)

Reach number	Priority river reaches	Primary role players
1	*MRU Mvoti C, including MV_I_EWR2.*	*Low density rural settlements; over-grazing.*

Table 3-4 Primary users groups in river reaches considered during the scenario impact assessment process – Lovu (U7)

Reach number	Priority river reaches	Primary role players
1	*MRU Lovu D, including LO_R_EWR1.*	*Settlements.*

3.4 PHASE 3: IDENTIFY DRIVING WATER QUALITY VARIABLES PER PRIMARY USER / WATER QUALITY ROLE PLAYER

Driving water quality variable per user group are shown in Tables 3.5 to 3.8 for the uMkhomazi, uMngeni, Mvoti and Lovu systems respectively. The present state for water quality is also shown.

Table 3-5 Driving water quality variable per primary user groups in identified river reaches – uMkhomazi (U1)

Reach number	Priority river reaches	Primary role players	Driving water quality variables	Current State
1	*MRU uMkhomazi B, including MK_I_EWR1*	*Some agriculture; erosion.*	*Nutrients, turbidity.*	*Near natural - Good (A/B)*
2	*MRU uMkhomazi C, including MK_I_EWR2*	*Agriculture.*	*Nutrients, salts.*	*Near natural - Good (A/B)*
3	*MRU uMkhomazi D, including MK_I_EWR3*	*Agriculture; settlements.*	*Nutrients, salts, coliforms / E.coli.*	*Near natural - Good (A/B)*

Table 3-6 Driving water quality variable per primary user groups in identified river reaches – uMngeni (U2)

Reach number	Priority river reaches	Primary role players	Driving water quality variables	Current State
1	*MRU uMngeni B, including Mg_I_EWR2*	*Agriculture; urban impacts (Howick, incl. WWTW; U20E-04243).*	*Nutrients, salts, toxics, coliforms / E.coli.*	*Fair – Poor (C/D)*
2	*MRU uMngeni D, including Mg_I_EWR5*	*Settlements; sand-mining; urban impacts including WWTW.*	*Nutrients, salts, turbidity, DO, coliforms / E.coli.*	*Fair – Poor (C/D)*

Table 3-7 Driving water quality variable per primary user groups in identified river reaches – Mvoti (U4)

Reach number	Priority river reaches	Primary role players	Driving water quality variables	Current State
1	*MRU Mvoti C, including MV_I_EWR2*	*Low density rural settlements; over-grazing*	*Turbidity*	*Fair (C)*

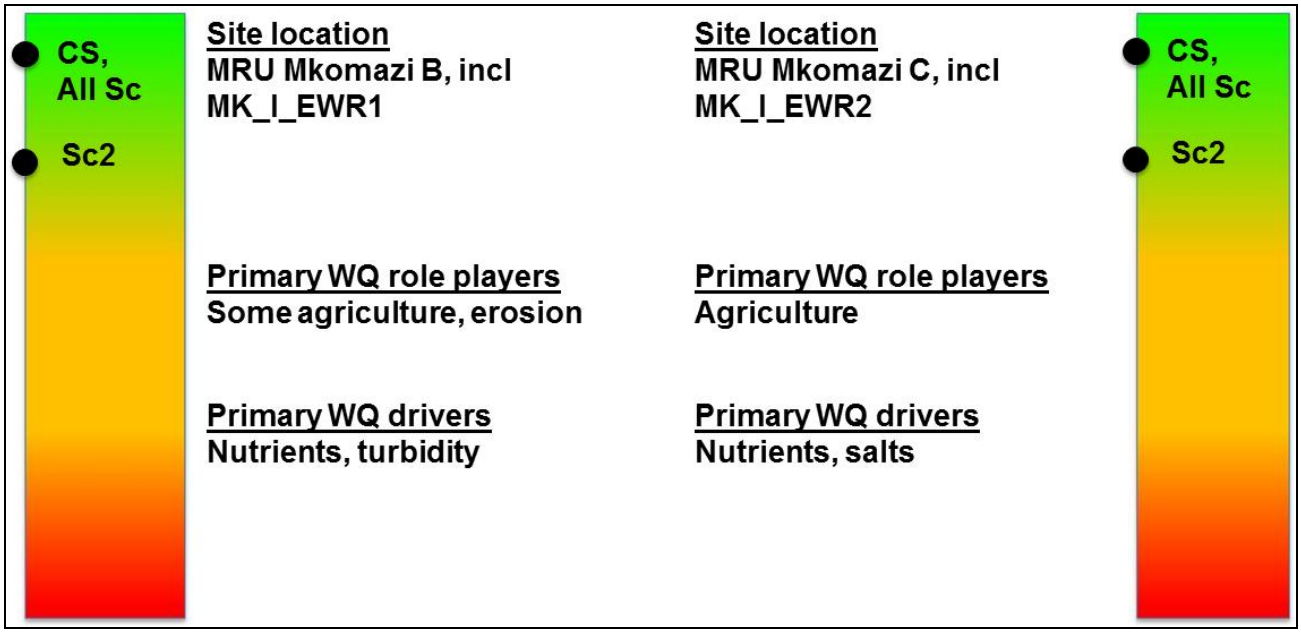
Table 3-8 Driving water quality variable per primary user groups in identified river reaches – Lovu (U7)

Reach number	Priority river reaches	Primary role players	Driving water quality variables	Current State
1	*MRU Lovu D, including LO_R_EWR1*	*Settlements*	*Turbidity*	*Good - Fair (B/C)*

4 RESULTS

Results are presented as bar diagrams (Figures 4.1 to 4.4) per identified reach and per system. Note the following explanatory points:

- *No scale is shown on the bars as the process undertaken was qualitative and in relation to Current State (CS).*
- *CS shown on the bar relates to the water quality state, for example, a Good CS will be located along the upper third and in the green portion of the bar.*
- *CS per river reach can therefore be assessed comparatively, that is, if CS is lower on one bar than the other, then water quality is assumed to be poorer at that site.*
- *The impact of operational scenarios (denoted as Sc x) have been considered in relation to CS. So therefore, if Sc 1 (for example) results in a small impact on the water quality of the primary user in the river reach, the small impact of that scenario will be shown by placing the symbol for the scenario close or alongside that denoting the Current State.*
- *It is assumed that if a scenario has little impact on ecological water quality, it is unlikely to have a large impact on the water quality linked to any user.*
- *Scenarios relevant to the site are shown on the bars. See DWS (2014a) for an explanation of operational scenarios; summary tables are also shown in Appendix A.*
- *As a water quality model and load calculations were not available for the catchments at the time of assessment, a qualitative assessment was conducted for the scenario assessment phase of the study.*



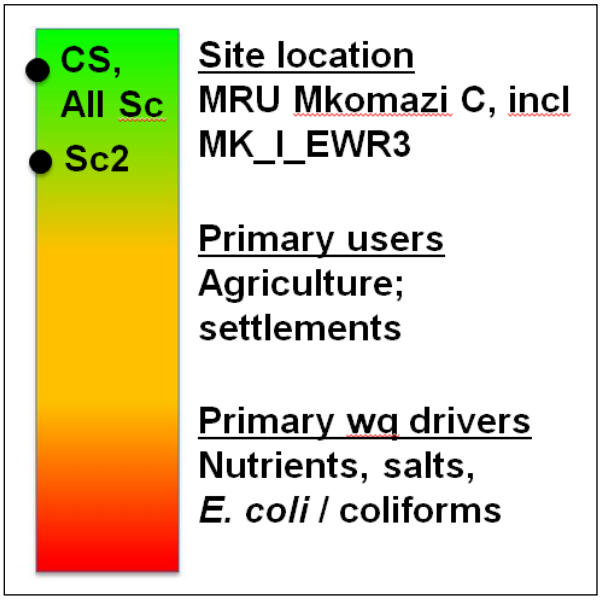


Figure 4.1 **Consequences of selected scenarios on user water quality drivers of selected reaches of the uMkhomazi River (U1)**

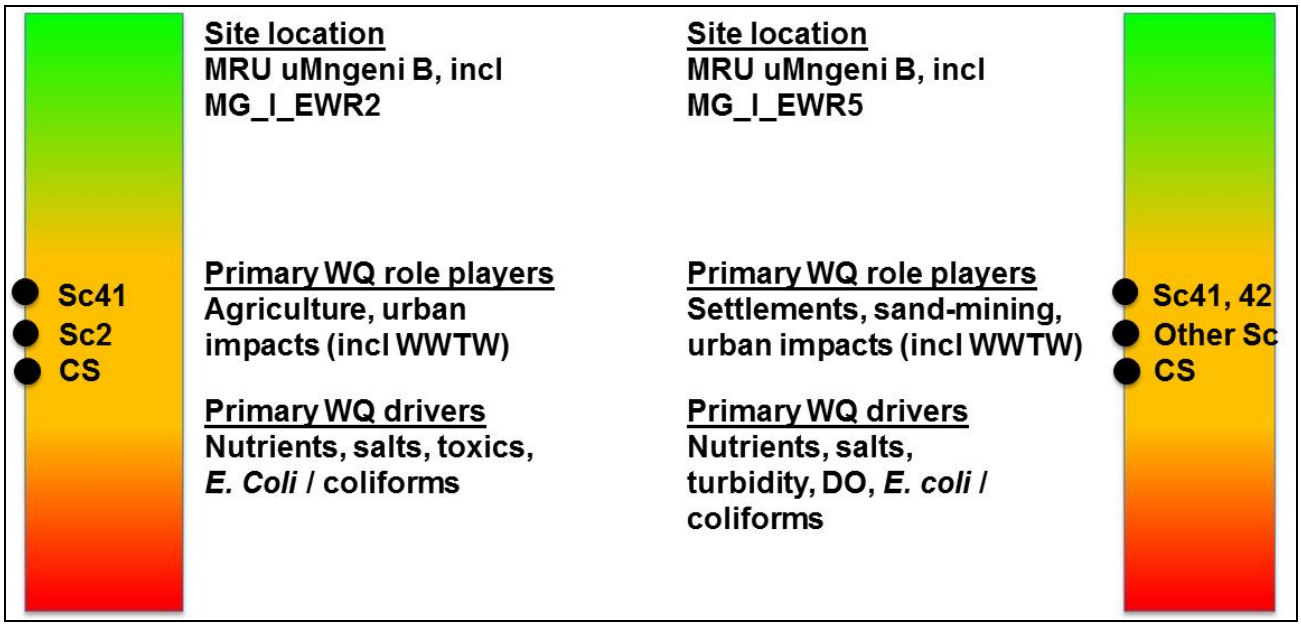


Figure 4.2 **Consequences of selected scenarios on user water quality drivers of selected reaches of the uMngeni River (U2)**

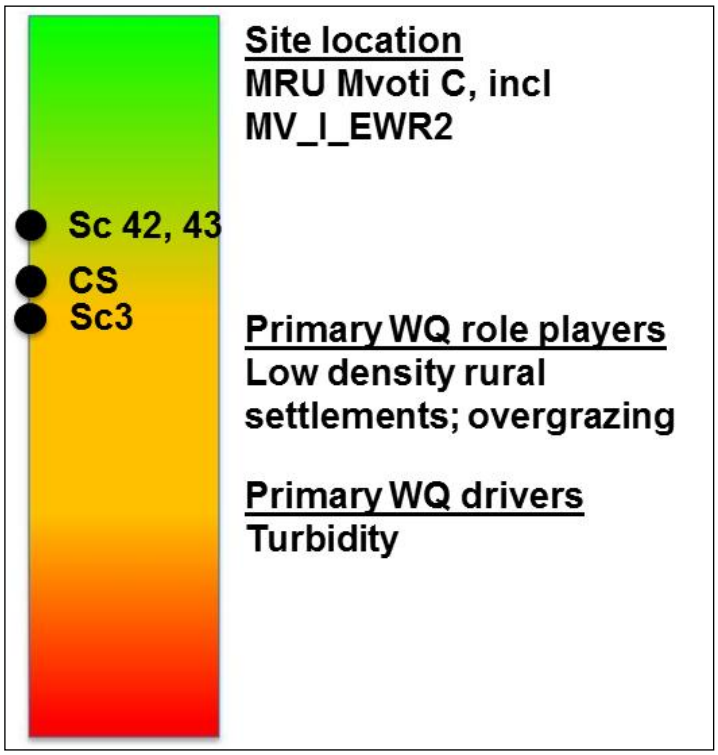


Figure 4.3 Consequences of selected scenarios on user water quality drivers of selected reaches of the Mvoti River (U4)

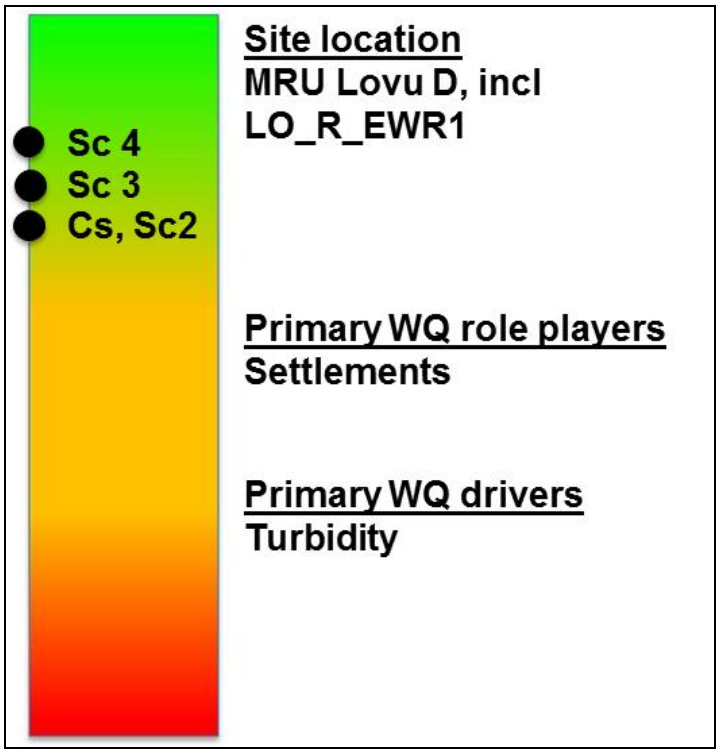


Figure 4.4 Consequences of selected scenarios on user water quality drivers of selected reaches of the Lovu River (U7)

5 DISCUSSION AND CONCLUSIONS

The qualitative assessment of the consequences of operational scenarios on user water quality, i.e. users / water quality role players such as agriculture – irrigation and stock-watering to urban and rural settlements, showed that little impact is expected under any of the operational scenarios assessed at selected reaches. For a number of the reaches containing EWR sites, conditions may improve slightly for users due to improved flows (and therefore improved water quality state) under the scenarios. Note that scenarios including increased releases from Phoenix, Mhlanga, Tongati and Darvill WWTWs assume that releases will meet required water quality standards.

Detail on the water quality status of the EWR sites can be reviewed in DWS (2014b).

Phase 5 of the scenario evaluation process for user water quality would be to rank the scenarios. This step was not undertaken for the Mvoti – Umzimkulu study due to the lack of resolution to actually differentiate between the scenarios for the various sites.

6 REFERENCES

Department of Water Affairs and Forestry (DWAF). 2003. Development Strategy to Control Eutrophication in SA. Prepared by the Directorate: Water Quality Management

Department of Water Affairs and Forestry (DWAF). 2004. National Water Resources Strategy. Final Draft, September 2004.

Department of Water Affairs (DWA), South Africa. 2011a. Classification of Significant Water Resources in the Mvoti to Umzimkulu Water Management Area (WMA 11): Scoping Report. Report No: RDM/WMA11/00/INT/CLA/0112. September 2011.

Department of Water Affairs (DWA), South Africa. 2011b. Procedures to Develop and Implement Resource Quality Objectives. Department of Water Affairs, Pretoria, South Africa.

Department of Water Affairs (DWA), South Africa. 2012. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Mzimkhulu Water Management Area. Inception Report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. September 2012.

Department of Water Affairs (DWA). July 2013. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Status quo assessment, IUA delineation and biophysical node identification. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd.

Department of Water and Sanitation (DWS). 2014a. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 1: Supporting Information on the Determination of Water Resource Classes - Ecological Consequences of Operational Scenarios. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. September 2014.

Department of Water and Sanitation (DWS). 2014b .Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area: Volume 3: EcoClassification and EWR assessment on the uMkhomazi, uMngeni and Mvoti Rivers. Appendix A: Water Quality. Prepared by: P-A Scherman of Scherman Colloty and Associates for Rivers for Africa eFlows Consulting (Pty) Ltd. July 2014.

7 APPENDIX A: SCENARIO SUMMARY

Table 7-1 Scenarios for ecological consequences determination: Lovu River

Scenario	Scenario Variables			EWR Drivers
	Update water demands	Ultimate development demands and return flows (2040)	Reduced abstraction and afforested areas	Lo_R_EWR1
LO1	*Yes*	*No*	*No*	*Yes*
LO2	*Yes*	*Yes*	*No*	*Yes*
LO3	*Yes*	*Yes*	*Yes (25%)*	*Yes*
LO4	*Yes*	*Yes*	*Yes (50%)*	*Yes*

Table 7-2 Scenarios for ecological consequences determination: uMkhomazi River

Scenarios	Scenario Variables					EWR Drivers		
	Update water demands	Ultimate development demands and return flows (2040)	EWR	Mkomazi Water Project (MWP) (Smithfield Dam)	Ngwadini Off-channel Dam (OCD)	Mk_I_EWR1	Mk_I_EWR2	Mk_I_EWR3
MK1	*Yes*	*No*	*No*	*No*	*No*	*Yes*	*Yes*	*Yes*
MK2	*Yes*	*Yes*	*No*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK21	*Yes*	*Yes*	*REC tot[1] (EWR 2)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK22	*Yes*	*Yes*	*REC low (EWR 2)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK23	*Yes*	*Yes*	*REC low[2]+ (EWR 2)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK31	*Yes*	*Yes*	*REC tot (EWR 3)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK32	*Yes*	*Yes*	*REC low (EWR 3)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK33	*Yes*	*Yes*	*REC low+ (EWR 3)*	*Yes*	*Yes (no support)*	*Yes*	*Yes*	*Yes*
MK4	*Yes*	*Yes*	*No*	*Yes*	*Yes (with support)*	*Yes*	*Yes*	*Yes*
MK41	*Yes*	*Yes*	*REC tot (EWR 2)*	*Yes*	*Yes (with support)*	*Yes*	*Yes*	*Yes*
MK42	*Yes*	*Yes*	*REC low (EWR 2)*	*Yes*	*Yes (with support)*	*Yes*	*Yes*	*Yes*

1 Total REC requirements.

2 Based on total flows for January, February, March and low flows for remaining months.

Table 7-3 Scenarios for ecological consequences determination: Mvoti River

Scenarios	Scenario Variables					EWR Drivers	
	Update water demands	Ultimate development demands and return flows (2040)	EWR	Isithundu Dam	Imvutshane Dam	Mv_I_EWR1	Mv_I_EWR2
MV1	*Yes*	*No*	*No*	*No*	*No*	*Yes*	*Yes*

MV3	Yes	Yes	No	Yes	Yes	Yes	Yes
MV41	Yes	Yes	REC tot (EWR 2)	Yes	Yes	No	Yes
MV42	Yes	Yes	REC low (EWR 2)	Yes	Yes	No	Yes
MV43	Yes	Yes	REC low[1]+ (EWR 2)	Yes	Yes	No	Yes

1 Based on total flows for Jan - Mar and low flows for remaining months.

Table 7-4 Scenarios for ecological consequences determination: uMngeni River

Scenarios	Scenario Variables								EWR Drivers	
	Update water demands	Demands and return flows (2023)	Ultimate development demands and return flows (2040)	EWR	MMTS2	MWP	Darvill Re-use	Ethekwini Re-use	Mg_I_EWR2	Mg_I_EWR5
UM1	Yes	No	No	No	No	No	No	No	Yes	Yes
UM2	No	Yes	No	No	Yes	No	No	No	Yes	Yes
UM41	Yes	No	Yes	No	Yes	Yes	No	No	Yes	Yes
UM42	Yes	No	Yes	No	Yes	Yes	No	No	Yes	Yes
UM51	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
UM52	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

8 APPENDIX B: REPORT COMMENTS

Page / Section	Report statement	Comments	Changes made?	Author comment
Comments from Geert Grobler, DWS: 27 March 2015				
Pg 4-1, Sec 4	*It is expected that if a scenario has little impact on ecological water quality, it is unlikely to have a large impact on the water quality linked to any user.*	*Recommended to change "it is expected" to "it is assumed"*	*Yes*	
Pg 5-1, Sec 5	*"…little impact is expected under any of the operational scenarios"*	*I'll accept that, but can you add a section on the reasons for the less than perfect water quality. Probably due to the mentioned land use impacts and how that should be managed. Otherwise achieving RQOs might not be possible.*	*Text added to Sec 5*	*Water quality present state is described in the following document: Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu Water Management Area:* ***Volume 3: EcoClassification and EWR assessment on the uMkhomazi, uMngeni and Mvoti Rivers.*** *Appendix A: Water Quality. Report Number: RDM/WMA11/00/CON/CLA/0314, July 2014.*
Comment from Mmaphefo Thwala, DWS: 5 May 2015				
Front page		*Correct front page: Remove extra space after colon in the subtitle, also rectify to "Support***ing** *information..."*	*Yes*	
Pg 1-2	*Reference to Task D4*	*Define what Task D4 is about*	*Yes*	*Task D4 (i.e. the identification and evaluation of operational scenarios to identify consequences).*
Pg 3-1		*Check that river names are correct*	*Yes*	
Pg 4-1		*Consistency in the use of terminology, current state vs present state?*	*No*	*Current State (CS) was selected specifically so as to distinguish it from Present Ecological State. CS then refers to water quality here, and not ecological state.*
Pg 4-1		*Can't we include a summary of the relevant scenarios so that one doesn't*	*Yes*	*Summary tables included*

Page / Section	Report statement	Comments	Changes made?	Author comment
		have to jump to and fro between the reports to remember what Sc 2 etc. entails?		
Fig 4-1		*Include wq role players*	*Yes*	*Figure 4-1 corrected.*
Pg 5-1	*For a number of the reaches containing EWR sites, conditions may improve slightly for users due to improved flows (and therefore improved water quality state) under the scenarios. Note that scenarios including increased releases from Phoenix, Mhlanga, Tongati and Darvill WWTWs assume that releases will meet required water quality standards.*	*What is the reason for the increased flows? If due to increased releases from WWTWs then how does this lead to improved WQ state when it is uncertain if the WWTWs releases meet the required WQ standard?*	*No*	*Improved flows are from increased discharges from WWTWs. The following sentence in the document clarifies the assumption that an improvement in water quality state is based on the ASSUMPTION that required discharge standards will be met:* *Note that scenarios including increased releases from Phoenix, Mhlanga, Tongati and Darvill WWTWs assume that releases will meet required water quality standards.*