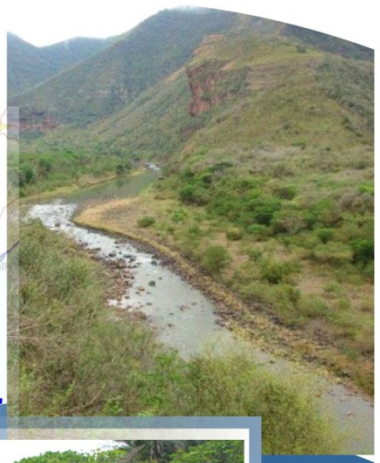
REPORT NO: RDM/WMA11/00/CON/CLA/0914

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

PROJECT NUMBER: WP 10679

VOLUME 4: SUPPORTING INFORMATION ON THE DETERMINATION OF WATER RESOURCE CLASSES - ECONOMIC CONSEQUENCES OF OPERATIONAL SCENARIOS



OCTOBER 2014

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

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

VOLUME 4: ECONOMIC CONSEQUENCES

Report Number: RDM/WMA11/00/CON/CLA/0914

OCTOBER 2014

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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**
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DEPARTMENT OF WATER AND SANITATION

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

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

VOLUME 4: ECONOMIC CONSEQUENCES

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Approved for DWS by:

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ACKNOWLEDGEMENTS

REPORT SCHEDULE

Version	Date
First draft	*October 2014*

EXECUTIVE SUMMARY

BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) 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 Water Management Area (WMA). Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

*This report forms **part** of the outcomes of Step 4 (Identify and evaluate scenarios within the integrated water resource management process) 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 which is to be part of the seven report volumes under Report 8. All the report volumes, apart from Report 8.7, serve as supporting information that feeds into Report 8.7 which will integrate all this information to derive at the Water Resource Classes for the various scenarios.*

The purpose of this report is to describe and document the economic consequences of the operational scenarios in the Mvoti, uMngeni, Lovu and Mkomazi catchments. This report presents the approach and methodology used to evaluate the different operational scenarios as well as the results obtained in terms of economic variables.

APPROACH

The economic evaluation of the impact of the different scenarios was based on the broad assumption that the utilisation of any additional or current water allocation was utilised at maximum efficiency.

Currently the following main water users are identified in the catchment or WMA, or are dependent on the water in the river:

- *Irrigation.*
- *Commercial forestry.*
- *Mining.*
- *Electricity generation.*
- *Heavy Industry.*
- *Urban and domestic household use.*
- *Light Industry and sectors not dependent on water for production purposes; and*
- *Tourism.*

It was decided to use, in both the baseline as well as the different scenarios, two macro-economic indicators, namely Gross Domestic Product (GDP) and Employment. The identified operational scenarios involve water provision from the proposed Smithfield Dam in the Mkomazi River and the Imvutshane Dam in the Mvoti River as well as additional re-use volumes from the Darvill works and the eThekwini works. This necessitates an approach that takes into consideration the cost of the infrastructure to provide the additional water as well as the potential benefits that can be derived from the additional available water.

The approach followed in the evaluation process of the different scenarios is in line with the manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource

Development – Third Edition (Updated and Revised) (Mullins et al., 2014). The Cost benefit Analysis (CBA) method provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process. A standard CBA consists of costs and benefits:

- *The costs used are the cost estimates for the different proposed dams as well as the operational and management costs as sourced from the different reports made available.*
- *The benefits derived from the water are calculated in terms of the estimated GDP and the number of new employment opportunities that can be created. The GDP is expressed in terms of R/m^3 and the water in m^3; by multiplying the two an answer in Rand is provided. The GDP is available per catchment as it was calculated as part of the economic status quo.*

The employment is expressed in terms of Number/mm^3 and the water in m^3; by multiplying the two an answer in employment numbers is provided. The employment is available per catchment as it was calculated as part of the economic status quo.

The following economic activities were used to evaluate the scenarios in the different catchments:

- *Irrigation.*
- *Commercial forestry.*
- *Urban population – certain water related activities are performed in the different domestic suburbs like plumbing, car washes and others.*
- *"Wet" industry – these are the industries using water as an integral part of their production process.*
- *"Dry" industry – these are the industries not using water as an integral part of their production process.*

DISCOUNTING – WHAT IT IS AND WHY IT IS DONE

Discounting is the reverse of adding (or compounding) interest. It reduces the monetary value of future costs and benefits back to a common time dimension – the base year/date. Discounting satisfies the view that people prefer immediate benefits over future benefits (social time preference) and it also enables the opportunity cost to be reflected (opportunity cost of capital).

RESULTS

The results of the different operational scenarios for each of the catchments are presented in terms of the total discounted GDP and employment values and the URV[1] values. The URV approach is a standard methodology followed in the cost evaluation of projects. It is listed here to compare the results with the typical CBA methodology. It is important to remember that in the evaluation process the results can only be compared in a specific catchment but not across different catchments.

Mvoti Catchment

The results of the different operational scenarios for the Mvoti catchment are reflected below.

Results of the operational scenarios in the Mvoti Catchment

Sc	Projected GDP growth (R million)	Projected additional labour	URV (R/m^3)	URV (Number/mm^3)
MV3	*R 39 637.65*	*21 661*	*R140.30*	*749*
MV41	*R 15 808.43*	*6 427*	*R180.00*	*967*
MV42	*R 25 713.48*	*11 360*	*R170.75*	*899*

[1] *URV – Unit Reference Value*

MV43	*R 23 996.70*	*10 412*	*R173.02*	*913*

The results in terms of economic preference are provided below.

Ranked Mvoti results

Position	Total values	URV values
1	*MV3*	*MV41*
2	*MV42*	*MV43*
3	*MV43*	*MV42*
4	*MV41*	*MV3*

The above results indicate that, depending on the terms of methodology applied, the economic preferences differ; in this case the "Total Value" approach is preferable as it projects the largest economic impact.

uMngeni Catchment

The results of the different operational scenarios for the uMngeni catchment are provided below.

Results of the operational scenarios in the uMngeni Catchment

Sc	Additional allocation (million m^3/a)	Projected GDP growth (R million)	Projected additional labour	URV (R/m^3)	URV (Number/mm^3)
UM41	*142.2*	*R 13 927*	*208 611*	*R15.95*	*239*
UM51	*205*	*R 11 942*	*232 725*	*R10.73*	*209*

Both methodology approaches favour UM41 as the preferable option when compared to UM52.

Lovu Catchment

The results of the different operational scenarios for the Lovu catchment are provided below.

Results of the operational scenarios in the Lovu Catchment

Sc	Additional allocation (mm^3/a)	Projected GDP growth (R million)	Projected additional labour	URV GDP (R/m^3)	URV Labour (Number/mm^3)
LO3	*2.65*	*R15 429*	*78 524*	*R737*	*3 752*
LO4	*5.30*	*R23 864*	*120 476*	*R732*	*3 695*

The Total Results differ from the URV approach. Overall the Total Value approach is the preferred approach with LO4 the preferred option.

Mkomazi Catchment

The table below presents the results of the different operational scenarios for the Mkomazi catchment. The results represent not only the possible impact in the Mkomazi but also the impact of the different volumes that can be transferred.

Results of the operational scenarios in the Mkomazi Catchment

Sc	Smithfield HFY	Ngwadini HFY	Projected GDP growth (R million)	Projected additional labour	URV GDP (R/m^3)	URV Labour (Number/mm^3)
MK2	*196.00*	*11.99*	*R 386 158*	*402 685*	*R 649*	*3 668*
MK21	*142.20*	*8.03*	*R 348 392*	*342 577*	*R 656*	*3 783*
MK22	*150.60*	*8.03*	*R 354 093*	*353 837*	*R 661*	*3 806*
MK23	*150.60*	*8.03*	*R 354 093*	*353 837*	*R 661*	*3 806*
MK31	*150.10*	*5.98*	*R 351 204*	*351 777*	*R 686*	*3 948*
MK32	*161.00*	*6.63*	*R 358 397*	*365 594*	*R 682*	*3 925*
MK33	*161.00*	*6.63*	*R 358 397*	*365 594*	*R 682*	*3 925*
MK4	*142.50*	*54.80*	*R 357 056*	*346 582*	*R 584*	*3 378*
MK41	*84.10*	*54.80*	*R 290 228*	*243 680*	*R 535*	*3 130*
MK42	*92.50*	*54.80*	*R 303 646*	*261 266*	*R 545*	*3 180*

The results in terms of economic preference are presented below.

Ranked Mkomazi results

Position	Total Values	URV values
1	*MK2*	*MK 31*
2	*MK 32 and MK 33*	*MK 32 and MK 33*
3	*MK 4*	*MK 22 and MK 33*
4	*MK 22 and MK 33*	*MK21*
5	*MK 31*	*MK 2*
6	*MK 21*	*MK 4*
7	*MK 42*	*MK 42*
8	*MK 41*	*MK 41*

Again the two approaches provide different rankings and the "Total Value Approach" is the more acceptable in terms of economic variables. Scenario MK2 is the most preferable scenario in economic terms followed by MK32 and MK 33.

CONCLUSION

The various operational scenarios all present positive answers and should all make a positive contribution to the economic growth and employment creation in the four catchments. The final preferred option will depend on the interaction between the economic values, the goods and services and the environmental impacts.

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TERMINOLOGY AND ACRONYMS

CD: RDM	*Chief Directorate: Resource Directed Measures*
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*
GAAP	*Generally Accepted Accounting Principles*
HFY	*Historic Firm Yield*
MCDA	*Multi Criteria Decision Analysis*
MCDM	*Multi Criteria Decision Making*
MMTS2	*Mooi-Mgeni Transfer Scheme – Phase 2*
MWP	*Mkomazi Water Project*
NDP	*National Development Plan*
O&M	*Operational and Maintenance*
PSP	*Professional Service Provider*
PV	*Present value*
REC	*Recommended Ecological Category*
RQO	*Resource Quality Objective*
Saiccor	*Saiccor Mill, Sappi*
SALGA	*South Africa Local Government Agency*
SAPPI	*South African Paper and Pulp Industry*
Sc	*Scenario*
URV	*Unit Reference Value*
WMA	*Water Management Area*
WWTW	*Waste Water Treatment Works*

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) 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 Water Management Area (WMA). Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 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 (highlighted in 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 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 report is to describe and document the economic consequences of the operational scenarios in the Mvoti, uMngeni, Lovu and Mkomazi catchments. This report presents the approach and methodology used to evaluate the different operational scenarios as well as the results obtained in terms of economic variables.

1.3 REPORT STRUCTURE

The report outline is provided below.

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

Chapter 2: Background
This Chapter provides a summary of the different scenarios assessed.

Chapter 3: Approach and Methodology

This chapter sets out the approach used during this study to determine the economic consequences of the operational scenarios. The presentation of results is also discussed.

Chapter 4: Results

The results of the different operational scenarios for each of the catchments are presented in terms of the total discounted GDP, employment values and the URV values.

Chapter 5: References

Shows the references consulted during the study.

Chapter 6: Appendix A: Report Comments

The comments received from the Client are provided.

2 BACKGROUND

2.1 INTRODUCTION

The main aim of the scenario (Sc) evaluation process is to determine the appropriate balance between the level of environmental protection and the use of the water to sustain the status quo socio-economic activities. Once the preferred scenario has been selected the Water Resource Class is defined by the level of environmental protection embedded in that scenario.

There are three main variables to consider in this integration process, namely the Ecology, Ecosystem Services and the Economic benefits, obtained from the use of a portion of the water resource. The scenario evaluation process therefore estimates the consequences each scenario, from a plausible set of scenarios, will have on these variables. The evaluation process uses the quantification of selected metrics to compare the scenarios on a relative basis with one another.

2.2 CATCHMENTS AND SCENARIOS

The investigation focused on the impact of the different operational scenarios in the following four catchments:

- *Mvoti.*
- *UMngeni.*
- *Lovu; and*
- *Mkomazi.*

In the following paragraphs the different operational scenarios are presented.

2.2.1 Mkomazi River Catchment

Table 2.1 provides a summary of the operational scenarios identified for the Mkomazi catchment. Detail regarding the scenarios and the yield modelling is given in Report 7. During the analysis of these scenarios it was necessary to take into consideration that two different sets of scenarios exist in terms of the supply of water to the UMngeni River and the use in the Mkomazi River.

Table 2.1 Scenarios for economic consequences determination: Mkomazi River

Sc	EWR[1]	Benefit to industries and households			Benefit to Saiccor		
		Supply to eThekwini			Off channel Sappi water supply		
		Smithfield HFY[2] (no support to Ngwadini Dam)			Ngwadini HFY (no support from Smithfield Dam)		
		No EWR (mm^3)	With EWR (mm^3)	Difference (mm^3)	No EWR (mm^3)	With EWR (mm^3)	Difference (mm^3)
MK1	*No*						
MK2	*No*	*196.0*			*11.99*		
MK21	*REC tot*		*142.2*	*53.8*		*8.03*	*3.96*
MK22	*REC low*		*150.6*	*45.4*		*8.03*	*3.96*
MK23	*REC low+[3]*		*150.6*	*45.4*		*8.03*	*3.96*
MK31	*REC tot*		*150.1*	*45.9*		*5.98*	*6.01*
MK32	*REC low*		*161.0*	*35.0*		*6.63*	*5.36*
MK33	*REC low+*		*161.0*	*35.0*		*6.63*	*5.36*
		Smithfield HFY (with support to Ngwadini Dam)			Ngwadini HFY (with support from Smithfield Dam)		
MK4	*No*	*142.5*			*54.8*		
MK41	*REC tot[4]*		*84.1*	*58.4*		*54.8*	*0.0*
MK42	*REC low*		*92.5*	*50.0*		*54.8*	*0.0*

1 Ecological Water Requirement.
2 Historic Firm Yield.
3 Recommended Ecological Category. Based on total flows for January, February, March and low flows for remaining months.
4 Total REC requirements.

During the analysis of the scenarios it was established that there are a number of scenarios where the impact in the Mkomazi catchment that were not influenced by the different volumes transferred from the Smithfield Dam, only four different economic impact calculations were necessary as a number of scenarios shared the same additional volumes:

- **Sc MK2 – additional volume 11.99 mm^3;**
- **Sc MK21 - additional volume 8.03 mm^3;**
- *Sc MK22 - additional volume 8.03 mm^3;*
- *Sc MK23 - additional volume 8.03 mm^3;*
- **Sc MK31 - additional volume 5.98 mm^3;**
- **ScMK32 - additional volume 6.63 mm^3.**
- *Sc MK33 - additional volume 6.63 mm^3.*

During the analysis of the scenarios that were influenced by the Smithfield Dam all scenarios shared the same additional volumes and only one economic impact calculation was necessary:

- *Sc MK4 - additional volume 54.80 mm^3;*
- *Sc MK41 - additional volume 54.80 mm^3;*
- *Sc MK42 - additional volume 54.80 mm^3.*

The volumes transferred to the Umgeni catchment varies and the following calculations were done:

- *Sc MK2 – 196.0 mm^3;*
- *Sc MK21 – 142.2 mm^3;*
- *Sc MK22/23 – 150.6 mm^3;*
- *Sc MK31 – 150.1 mm^3;*
- *SC MK32/33 – 161.0 mm^3;*

- *Sc MK 4 – 142.5 mm^3;*
- *Sc MK41 – 84.0 mm^3;*
- *Sc MK42 – 92.5 mm^3.*

2.2.2 Lovu River Catchment

Table 2.2 provides a summary of the operational scenarios identified for the Lovu catchment. The basis of these scenarios is percentage reduction in abstraction and a reduction in the commercial forestry sector.

Table 2.2 Scenarios for economic consequences determination: Lovu River

Sc	Scenario Variables			EWR Driver	Comments
	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*	*Reduce abstraction and commercial forestry areas by 25%.*
LO4	*Yes*	*Yes*	*Yes (50%)*	*Yes*	*Reduce abstraction and commercial forestry areas by 50%.*

2.2.3 Mvoti Catchment

Table 2.3 provides a summary of the operational scenarios identified for the Mvoti catchment. In this catchment the impact of all four scenarios were estimated as they all represent different additional volumes of water.

Table 2.3 Scenarios for economic consequences determination: Mvoti River

Sc	Isithundu excess firm yield – No EWR (Mm^3/a)	Isithundu excess firm yield – With EWR (Mm^3/a)
MV3	*34.88*	
MV41		*8.08*
MV42		*15.22*
MV43		*13.77*

2.2.4 UMngeni Catchment

Table 2.4 provides a summary of the operational scenarios identified for the Mkomazi catchment. The analysis indicated that only Sc UM41 and Sc UM51 required impact estimations in terms of the impact by the re-use volumes from the Darvill and eThekwini waste water facilities. However, this is not the complete picture because of the different volumes allocated from the Smithfield Dam in terms of the operational scenarios defined in the Mkomazi for transfer purposes.

Table 2.4 Scenarios for economic consequences determination: uMngeni River

Sc	Updated water demands	Ultimate development demands and return flows (2040)	Spring Grove	Smithfield	Darvill re-use	eThekwini re-use
			MMTS2[1]	MWP[2]		
UM1	*Yes*	*No*	*No*	*No*	*No*	*No*
UM2	*Yes*	*No*	*Yes*	*No*	*No*	*No*
UM41	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*
UM42	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*
UM51	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
UM52	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

1 Mooi-Mgeni Transfer Scheme – Phase 2
2 Mkomazi Water Project

2.3 RELATIONSHIP BETWEEN ECONOMIC, ENVIRONMENTAL AND SOCIAL IMPACT

None of the rivers in the specific WMA are still in the original virgin state, and therefore they are in different stages of utilisation by the local population, irrigation activities, commercial forestry, mining or other economic activities. The reality is that if the resource is not well looked after the volume and quality of the water will deteriorate over time and the current activities will decline with the resulting negative impacts on the environment and the population.

The main purpose of the different scenarios is to at least maintain the current condition of the river catchment and, if possible, improve it. The role of the economic analysis is to estimate the impact of the different scenarios on the status quo economic activities, either positive or negative.

3 APPROACH AND METHODOLOGY

3.1 APPROACH

The economic evaluation of the impact of the different scenarios is based on the broad assumption that the utilisation of any additional or current water allocation is utilised at maximum efficiency.

Any economic evaluation takes place within the specific current situation, not an empty undeveloped river catchment, and it is necessary that the current situation be taken into consideration in the evaluation of any of the operational scenarios. Currently the following main water users are identified in the catchment or WMA, or are dependent on the water in the river:

- *Irrigation.*
- *Commercial forestry.*
- *Mining.*
- *Electricity generation.*
- *Heavy Industry.*
- *Urban and domestic household use.*
- *Light Industry and sectors not dependent on water for production purposes; and*
- *Tourism.*

The tourist activity depends on the availability and quality of the water in the river or estuary and the overall condition of the environment. As the main aim of the classification process is to stabilise the river or estuary class, the possibility that the water in the river will be reduced is not always an acceptable option. Therefore, the tourist activities can only be positively impacted on, and the worst case option is that the sector will remain as it is at present.

The commercial forestry sector is regulated by a permit system, and we could not find any evidence that any reduction in the commercial plantation area is considered. For this reason it was accepted that on the medium term the forestry sector will not be impacted on by any operational scenarios.

The irrigation, mining, electricity and heavy industry sectors will only be impacted by scenarios which result in available volumes increasing or decreasing. However, currently no electricity generation takes place and only quarrying as a mining activity takes place.

3.1.1 Measuring Parameters

It was decided to use, in both the baseline as well as the different scenarios, two macro-economic indicators, namely Gross Domestic Product (GDP) and Employment. Although the use of the GDP created is generally accepted as an economic growth indicator, it sometimes does not present the full picture. In the case of irrigation agriculture irrigated maize provides a very large GDP contribution, maize is a very strategic product in the national food security picture as well as household food security. However, because of the high levels of mechanisation very few employment opportunities are created in the primary sector. If the area is highly rural and impoverished then employment creation is perhaps more important than GDP creation.

A second factor to consider is the value added process in the production area, as an example, sugarcane mills create a service point in the primary area of production. Many social services start

to concentrate around sugarcane mills, such as health clinics, pension pay points and police stations.

On the opposite side is, possibly, citrus production which creates a large number of jobs in the primary production activity, but very little value added takes place in the primary production area as most of the fruit is exported. This is not always the complete picture as juice facilities and other value added processes can be added. However, it has a positive impact on the Balance of Payments.

In the final instance it is necessary to take into consideration the current situation; a certain economic sector is in operation while some of the others are based on assumptions and projections. There is always the risk that the projected benefits will not materialise because of a number of reasons, e.g. government policy, economic circumstances or lack of entrepreneurial skills.

3.1.2 Cost Benefit Analysis Approach

The identified operational scenarios involve water provision from the proposed Smithfield Dam in the Mkomazi River and the Imvutshane Dam in the Mvoti River as well as additional re-use volumes from the Darvill and the eThekwini works. This necessitates an approach that takes into consideration the cost of the infrastructure to provide the additional water as well as the potential benefits that can be derived from the additional available water.

The evaluation of projects is often a difficult task since costs and benefits do not occur only once but appear over time. Furthermore, costs and benefits are often hidden, making them difficult to identify, and frequently difficult to measure. The same problems occur when the decision maker has to make a choice between numbers of mutually exclusive projects intended to achieve the same goal via a number of different routes. These problems are not limited to capital projects; they also occur when decisions have to be made regarding the merits of current expenditure programmes. The Cost Benefit Analysis (CBA) method provides a logical framework by means of which projects can be evaluated, serving as an aid in the decision making process.

The approach followed in the evaluation process of the different scenarios is in line with the manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource Development – Third Edition (Updated and Revised) (Mullins et al., 2014).

It is necessary that the difference between decision making in the Public Sector and the Private Sector using the CBA approach is explained (Table 3.1).

Table 3.1 The difference in evaluating a project between the public sector and private sector

	CBA	Profit determination
1. From the point of view of	*Community.*	*Shareholders.*
2. Goal	*Apply scarce resources effectively and efficiently.*	*Maximise net value of firm.*
3. Discount rate	*Social time-preference rate.*	*Market rate or weighted marginal cost of capital plus uncertainty and risk premium.*
4. Value unit	*Opportunity cost.*	*Market price.*
5. Dimensions	*All aspects necessary for a rational decision.*	*Limited to aspects of decision-making that may affect profits.*
6. "Advantages"	*Additional goods, services, products, income and/or cost savings.*	*Money income.*
7. "Disadvantages"	*Opportunity costs in terms of goods and services foregone.*	*Money payments and depreciation calculated according to generally accepted accounting principles (GAAP).*

From the above it is obvious that in a CBA the public sector is approached from the point of view of the total community and not only the shareholders as in the case of a private sector company. It is also necessary to highlight that a CBA does not provide answers about affordability, tariffs and funding. That eventually is part of the Multi Criteria Decision Making (MCDM) process by the implementing authority, local or regional.

In general a CBA is aimed at decision-making in respect of projects to be undertaken in the future and therefore involves projections and assumptions regarding future developments. This implies that a boundary of uncertainty will necessarily exist, thereby affecting decisions with respect to the future taken on the grounds of this methodology. It is therefore desirable that a CBA should, where necessary, be supplemented by the analysis of risk and uncertainty, as well as related information. It is also necessary to emphasise that this evaluation is in terms of economic principles and does not address issues like affordability, funding and tariffs in terms of the implementing authority.

3.2 METHODOLOGY

A standard CBA consists of costs and benefits, which are discussed in the following sections.

3.2.1 Costs

The costs used is the cost estimates for the different proposed dams as well as the operational and management costs as sourced from the different reports made available. The different values used are discussed in the Data Section of the report (Section 3.4).

3.2.2 Benefits

The benefits derived from the water are calculated in terms of the estimated GDP and the number of new employment opportunities that can be created. The GDP is expressed in terms of R/m^3 and the water in m^3; by multiplying the two an answer in Rand is provided. The GDP is available per catchment as it was calculated as part of the economic status quo.

Where a volume of water is removed from a certain catchment and transferred to another catchment the benefits created by the water is added to the receiving catchment. However, to

obtain a true value of the water transferred from the Smithfield Dam it will be necessary to add the benefits created in the Mkomazi to the benefits created in the receiving catchment.

The employment is expressed in terms of Number/mm^3 and the water in m^3; by multiplying the two an answer in employment numbers is provided. The employment is available per catchment as it was calculated as part of the economic status quo.

3.2.3 Economic Sections

The following economic activities were used to evaluate the scenarios in the different catchments:

- *Irrigation.*
- *Commercial forestry.*
- *Urban population – certain water related activities are performed in the different domestic suburbs like plumbing, car washes and others.*
- *"Wet" industry – these are the industries using water as an integral part of their production process.*
- *"Dry" industry – these are the industries not using water as an integral part of their production process.*

3.2.4 Discounting – What it is and why it is done

Discounting is the reverse of adding (or compounding) interest. It reduces the monetary value of future costs and benefits back to a common time dimension – the base year/date. Discounting satisfies the view that people prefer immediate benefits over future benefits (social time preference) and it also enables the opportunity cost to be reflected (opportunity cost of capital).

Costs that are immediately incurred and benefits that are gained in the present time are judged differently by the community from costs and benefits that materialise over a period of time. The community prefer to receive a benefit today rather than in the future, while deferred costs are more attractive than immediate payment. Therefore the money value of costs and benefits over time cannot simply be added; the time preference of the community has to be taken into account through the use of a weighting process. This weighting by the community is done with the aid of a rate that reflects the value of a benefit or cost over time. It is known as the social discount rate.

3.3 RESULTS PRESENTATION

The results can be displayed in two formats namely:

- *The discounted total GDP and employment calculated;*
- *As a Unit Reference Values (URV).*

The two result formats are discussed below in the following sections.

3.3.1 Discounted Values

As already explained the total capital cost of the proposed project is entered together with the annual operational and maintenance costs, to provide a total annual cost for the future - 40 years. The total GDP from the different benefits are calculated over the period. The two sets of values are subtracted to provide a Present Value (PV); this value is then discounted over the period to provide a GDP Net Present Value expressed in Rands. This is then presented as the GDP benefit from the additional water.

The total estimated number of jobs is also calculated and then discounted and presented as the employment benefit of the additional water.

3.3.2 Unit Reference Value

The following explains the Unit Reference Value Concept (URV) (Hoffman and du Plessis, 2008):

The unit reference value method was developed for the evaluation of projects in the water services sector and is widely use to evaluate the development of new resources. The cost and the capacity of the alternative new resources under investigation is rarely the same and comparing projects under these situations is difficult.

The unit reference value allocates a unit value to each scheme as a cost per kilolitre of water over the total life-cycle of the scheme. The URV evaluate all the life-cycle costs associated with the scheme in terms of its present value. The method also takes the yield of the scheme over the life-cycle of the scheme into consideration. The yield of the scheme is calculated on a year to year basis and only includes that portion of the yield of the scheme that is actually supplied by the scheme in each specific year. It therefore assumes that the yield of the scheme is equal to the shortage that would occur if the scheme was not implemented.

The discounted rate used for the calculation of the present value represents the interest rate that is associated with the spending of government funds.
To evaluate the sensitivity of this discounting rate, a low, medium and high value is used to calculate the actual URV.

The URV of different projects can then be evaluated against each other as part of the decision making process for the implementation of a next scheme to be developed. It is important to note that the URV do not represent a fixed value.

The URV is time and site specific, as it uses the shortage of supply of existing schemes due to the demand under that specific condition, to calculate the unit reference value. This means that for each new development with a specific associated water demand, a new URV must be calculated for each option or alternative. In the evaluation of options with different implementation phases, the order of implementing these projects also affects the URV.

The answers are then presented as follows:

- *URV (GDP) = A (Rand/m^3).*
- *URV (Employment) = B (Number/mm^3).*

The discount rate used is 8% as recommended by the CBA manual (Mullins et al., 2014).

3.3.3 MCDA Integration

Multiple-criteria decision-making or Multi Criteria Decision Analysis (MCDA) is a sub-discipline of operations research that explicitly considers multiple criteria in decision-making environments. In our daily lives or in professional settings, there are typical multiple conflicting criteria that need to be evaluated in making decisions. Cost or price is usually one of the main criteria. Some measure of quality is typically another criterion that is in conflict with the cost. In purchasing a car, cost, comfort, safety, and fuel economy may be some of the main criteria we consider.

In our daily lives, we usually weigh multiple criteria implicitly and we may be comfortable with the consequences of such decisions that are made based on only intuition. On the other hand, when stakes are high, it is important to properly structure the problem and explicitly evaluate multiple criteria. In making the decision of whether to build a nuclear power plant or not, and where to build it, there are not only very complex issues involving multiple criteria, but there are also multiple parties who are deeply affected by the consequences.

Structuring complex problems well and considering multiple criteria explicitly lead to more informed and better decisions. There have been important advances in this field since the start of the modern multiple-criteria decision-making discipline in the early 1960s. Economic evaluation is one of the criteria used to make a well balanced decision.

3.4 DATA AND DATA SOURCES

3.4.1 Economic and Water Demand Volume Growth Rates

The water demand growth used in the CBA models is based on the approach by AECOM Engineering to obtain the latest water requirement projections for the current Reconciliation Strategy study - uMngeni. This rate was applied in all four catchments for the following economic activities:

- *Population growth and urban activities.*
- *Industry.*

In the Mvoti and Mkomazi catchments water, to be fully taken up in 4 years, was allocated to irrigation as follows:

- *Year 1 – 10%.*
- *Year 2 - 20%.*
- *Year 3 – 30%.*
- *Year 4 - 50%.*

The purpose of this study is not to investigate and comment on the future growth of the eThekwini Municipality, however, some desktop investigation was necessary to understand current trends and take a position on future developments. The following assumptions were formulated and applied in the different models:

- *Most of the future industrial development will be "dry".*
- *Large developments are planned along the N2 North towards the King Shaka airport and the Mvoti and Mdloti rivers.*
- *Development along the N3 axis towards Pietermaritzburg, roughly following the uMngeni.*
- *The area along the Lovu River will be influenced by the planned dugout port at the old Louis Botha airport site. The Prospection area is very nearly fully developed.*
- *Industrial growth further to the South will be slow. Population growth will stay on course.*

The above assisted the decision on the following growth rates using the AECOM study as basis and the overall official population growth for the eThekwini area:

- *Population growth – 1.08% per annum (SALGA, 2014).*
- *Water demand – 1.436% per annum[2].*

[2] *Reconciliation Strategy Study – uMngeni currently undertaken by AECOM Engineers.*

- *GDP - 6% per annum. This is the target set by the National Development Plan, which could be reached if the "dugout" port is constructed.*

3.4.2 GDP and Employment Multipliers

Table 3.2 provides the respective GDP and employment multipliers applied in the CBA models as calculated as part of the Economic Status Quo.

Table 3.2 GDP and Employment multipliers used in the CBA models

Sector	River	GDP R/m^3	Employment Number/mm^3
Irrigation	*Mvoti*	*R 4.24*	*117*
	Mkomazi	*R 4.79*	*81*
Forestry	*Lovu*	*R 18.52*	*199*
Industry	*Mvoti*	*R 836.94*	*2600*
	uMngeni	*R2 287.05*	*12 658*
	Lovu	*R 2 275.39*	*12658*
	Mkomazi (SAICOR)	*R 154.56*	*709*
Domestic	*Mvoti*	*R 12.14*	*38*
	uMngeni	*R 12.14*	*38*
	Lovu	*R 12.14*	*38*
	Mkomazi	*R 12.14*	*38*

As far as the irrigation is concerned the difference in crop mix between the Mvoti and Mkomazi is highlighted by the difference in employment per mm^3; 117 for the Mvoti and 81 for the Mkomazi.

The forestry in the Lovu catchment is included, because the operational scenarios mentioned a possible reduction in forestry areas, which will be a disbenefit in the CBA model.

The differences in the industry multipliers indicate very clearly the difference in the make-up of the various industries in the four catchments. The Mkomazi GDP multiplier of R154.56 per m^3 shows the typical low value of a "wet" industry, while the Lovu value of R 2.275.39 per m^3 the value of a "dry" industry. The employment multipliers show the same characteristics.

The same urban domestic multipliers were used for all three the catchment areas.

3.4.3 Cost Calculations

The capital costs of the different dams and waste water projects were updated to 2013 values in cases where it was not available. The implementation period was based on the best available data varying from 2 to 4 years and the operational and maintenance (O&M) cost is calculated as a percentage of the capital costs (Table 3.3).

Table 3.3 Capital, operational and maintenance costs used in the CBA model

Project	Catchment	Capital costs	Annual O&M costs	Implementation period- years
Smithfield Dam	*Mkomazi*	*R2 018 million*	*R15.14 million*	*6*
Smithfield Dam	*uMngeni*	*R16 399 million*	*R41.99 million*	*6*
Isithundu Dam	*Mvoti*	*R1442.97 million*	*R21.35 million*	*6*
Darvill WWTW[1]	*uMngeni*	*R120.7 million*	*R1.00 million*	*2*
eThekwini WWTW	*uMngeni*	*R143.6 million*	*R1.2 million*	*2*

1 Waste Water Treatment Works

The construction capital cost for the construction of the Smithfield Dam was provided by WRP Consulting Engineers (Pty) Ltd., the allocation to the Mkomazi is only the estimated costs of the dam wall. The operational cost is based on the 0.75% cost per annum.

The Isithundu Dam capital cost was inflated by Conningarth from the 2009 figures and the O&M costs are calculated using 0.75%.

The Waste Water Treatment capital costs is based on the costs per m^3 and estimated by Conningarth.

3.4.4 Benefits

The benefits are calculated by multiplying the appropriate annual increase in water with the appropriate activity multiplier; GDP and Employment. Table 3.4 provides an indication of the different compounded growth rates over time.

Table 3.4 Projected Future Growth per Sector

Year	Growth rate	1	2	3	10	20	30	40
Population	*1.08%*	*2.17%*	*3.28%*	*4.39%*	*11.34%*	*23.97%*	*38.02%*	*53.68%*
Water	*1.436%*	*1.436%*	*2.89%*	*4.37%*	*15.32%*	*33.00%*	*53.38%*	*76.88%*
Economy	*6%*	*6.0%*	*12.36%*	*19.10%*	*79.08%*	*220.71%*	*474.35%*	*928.57%*

As it is always very difficult to do a forecast using the current historical available data as a base, the above figures must be treated with caution. It is good practice to update the different growth values every 5 to 10 years.

The population can increase by 54% over the next 40 years and the water demand by 77%. Currently the official unemployment rate for the metropolitan area is around 30%, which is a very high figure and one of the motivating factors for the National Development Plan (NDP) aiming for a 6% annual growth rate. Whether it is attainable, is not part of this project.

In the different catchments the current water usage is applied as the base value and the growth starts from this base value. The annual increase in volume is obtained by subtracting the current year volume from the previous year. The annual additional volume is then multiplied with the respective GDP and Employment multipliers for the different activities.

3.4.5 Water Allocation

The additional water allocation from catchment to catchment differs and is presented in the Table 3.5.

Table 3.5 Additional water allocation per activity

Activity	Mvoti	uMngeni	Lovu	Mkomazi
Domestic	*15%*	*69%*	*69%*	*3.1%*
Industrial	*35%*	*31%*	*31%*	*56.6%*
Irrigation	*50%*	*No allocation*	*No allocation*	*40.3%*
Source	*Historical use*	*Calculated without irrigation*	*Calculated without irrigation*	*Historical use*

4 RESULTS

The results of the different operational scenarios for each of the catchments are presented in terms of the total discounted GDP, employment values and the URV values. It is important to remember that in the evaluation process the results can only be compared in a specific catchment but not across the catchments.

4.1 MVOTI CATCHMENT

Table 4.1 presents the results of the different operational scenarios for the Mvoti catchment.

Table 4.1 Results of the operational scenarios in the Mvoti Catchment

Sc	Projected GDP growth (R million)	Projected additional labour	URV (R/m^3)	URV (Number/mm^3)
MV3	*R 39 637.65*	*21 661*	*R140.30*	*749*
MV41	*R 15 808.43*	*6 427*	*R180.00*	*967*
MV42	*R 25 713.48*	*11 360*	*R170.75*	*899*
MV43	*R 23 996.70*	*10 412*	*R173.02*	*913*

Table 4.2 presents the results in terms of economic preference.

Table 4.2 Ranked Mvoti results

Position	Total values	URV values
1	*MV3*	*MV41*
2	*MV42*	*MV43*
3	*MV43*	*MV42*
4	*MV41*	*MV3*

Table 4.2 indicates that, depending on the terms of methodology applied, the economic preferences differ; in this case the "Total Value" approach is preferable as it projects the largest economic impact. The URV value presents the most efficient answer without considering the total economic impact. From an economic perspective the MV3 scenario is the preferable option with MV41 the worst case.

4.2 uMNGENI CATCHMENT

Table 4.3 presents the results of the different operational scenarios for the uMngeni catchment.

Table 4.3 Results of the operational scenarios in the uMngeni Catchment

Sc	Additional allocation (million m^3/a)	Projected GDP growth (R million)	Projected additional labour	URV (R/m^3)	URV (Number/mm^3)
UM41	*142.2*	*R 13 927*	*208 611*	*R15.95*	*239*
UM51	*205*	*R 11 942*	*232 725*	*R10.73*	*209*

Both methodology approaches favour UM41 as the preferable option when compared to UM52.

4.3 LOVU CATCHMENT

Table 4.4 presents the results of the different operational scenarios for the Lovu catchment.

Table 4.4 Results of the operational scenarios in the Lovu Catchment

Sc	Additional allocation (mm^3/a)	Projected GDP growth (R million)	Projected additional labour	URV GDP (R/m^3)	URV Labour ($Number/mm^3$)
LO3	*2.65*	*R15 429*	*78 524*	*R737*	*3 752*
LO4	*5.30*	*R23 864*	*120 476*	*R732*	*3 695*

From Table 4.4 the Total Results differ from the URV approach. Overall the Total Value approach is the preferable approach with LO4 the best from an economic perspective.

4.4 MKOMAZI CATCHMENT

Table 4.5 presents the results of the different operational scenarios for the Mkomazi catchment. The results represent not only the possible impact in the Mkomazi but also the impact of the different volumes that can be transferred.

Table 4.5 Results of the operational scenarios in the Mkomazi Catchment

Sc	Smithfield HFY	Ngwadini HFY	Projected GDP growth (R million)	Projected additional labour	URV GDP (R/m^3)	URV Labour ($Number/mm^3$)
MK2	*196.00*	*11.99*	*R 386 158*	*402 685*	*R 649*	*3 668*
MK21	*142.20*	*8.03*	*R 348 392*	*342 577*	*R 656*	*3 783*
MK22	*150.60*	*8.03*	*R 354 093*	*353 837*	*R 661*	*3 806*
MK23	*150.60*	*8.03*	*R 354 093*	*353 837*	*R 661*	*3 806*
MK31	*150.10*	*5.98*	*R 351 204*	*351 777*	*R 686*	*3 948*
MK32	*161.00*	*6.63*	*R 358 397*	*365 594*	*R 682*	*3 925*
MK33	*161.00*	*6.63*	*R 358 397*	*365 594*	*R 682*	*3 925*
MK4	*142.50*	*54.80*	*R 357 056*	*346 582*	*R 584*	*3 378*
MK41	*84.10*	*54.80*	*R 290 228*	*243 680*	*R 535*	*3 130*
MK42	*92.50*	*54.80*	*R 303 646*	*261 266*	*R 545*	*3 180*

Table 4.6 presents the results in terms of economic preference.

Table 4.6 Ranked Mkomazi results

Position	Total Values	URV values
1	*MK2*	*MK 31*
2	*MK 32 and MK 33*	*MK 32 and MK 33*
3	*MK 4*	*MK 22 and MK 33*
4	*MK 22 and MK 33*	*MK21*
5	*MK 31*	*MK 2*
6	*MK 21*	*MK 4*
7	*MK 42*	*MK 42*
8	*MK 41*	*MK 41*

Again the two approaches provide different rankings and the "Total Value Approach" is the more acceptable in terms of economic variables with MK2 the preferable option followed by Mk32 and 33 with MK41 the worst case.

4.5 CONCLUSION

The various operational scenarios all present positive answers and should all make a positive contribution to the economic growth and employment creation in the four catchments. The final preferable option will depend on the interaction between the economic values, the goods and services and the environmental impacts.

5 REFERENCES

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6 APPENDIX A: REPORT COMMENTS

Page / Section	Report statement	Comments	Changes made?	Author comment
Table 2.4	The formulated scenarios use the Darvill and eThekwini re –use in scenarios UM51 and UM52	Certainly Table 6 of the Summarized results of this report needs further discussion as it is incorrect / incomplete, (and the associated use of data referring to "re-use" in the Economic report needs review	None	As the scenario includes the specific option it can only be changed if the scenario is changed.
Paragraph 2.3	The socio-economic impact is based on the water in the river and the water removed from the river. The economic evaluation is based on the water that are removed from a certain river and applied in the same catchment or another catchment	The presentation at the 4th PSC meeting made clear that these indicators were based on 'water that was taken out of the river.', whereas the 'ecological goods and services' considered water remaining in the river. The consequence of this approach is that a catchment without dams for abstraction would have no 'macro-economic ' impacts (which would distort the " multi criteria balance matrix for that water resource) and thus ignores the economic (and social) benefits of the Municipality's existing and proposed residential and economic development in the catchment.	Section clarified.	The statement is not factually correct, the fact is that if water is removed from a specific catchment and made available in another catchment the economic impact of that volume of water is measured in the "new" receiving catchment.
Paragraph 3.1.2	The reference is to the implementing authority that will take a balanced decision.	The Economic Report also states that the report does not address issues around affordability, tariffs and funding but rather that these would form part of the Multi Criteria decision making process.	Short section added.	The MCDA referred to is not the one developed for the classification project but a decision to be taken by the local or regional implementing authority.
Table 3.4		Certain assumptions have been made in respect of population growth (and water demand) and it is not clear whether the Municipality's IDP / SDF (vision) was considered at all in the 30 to 40 year projections	No change	It has been considered and applied
Page iii	What does URV stand for?	Terminology and Acronyms	No change	It is in the Acronym list and in the main report explained
Page iii	UM51?	Scenario evaluation	Corrected	It has been considered and corrected
Table 3-1	Column Identification		Corrected	It has been considered and corrected