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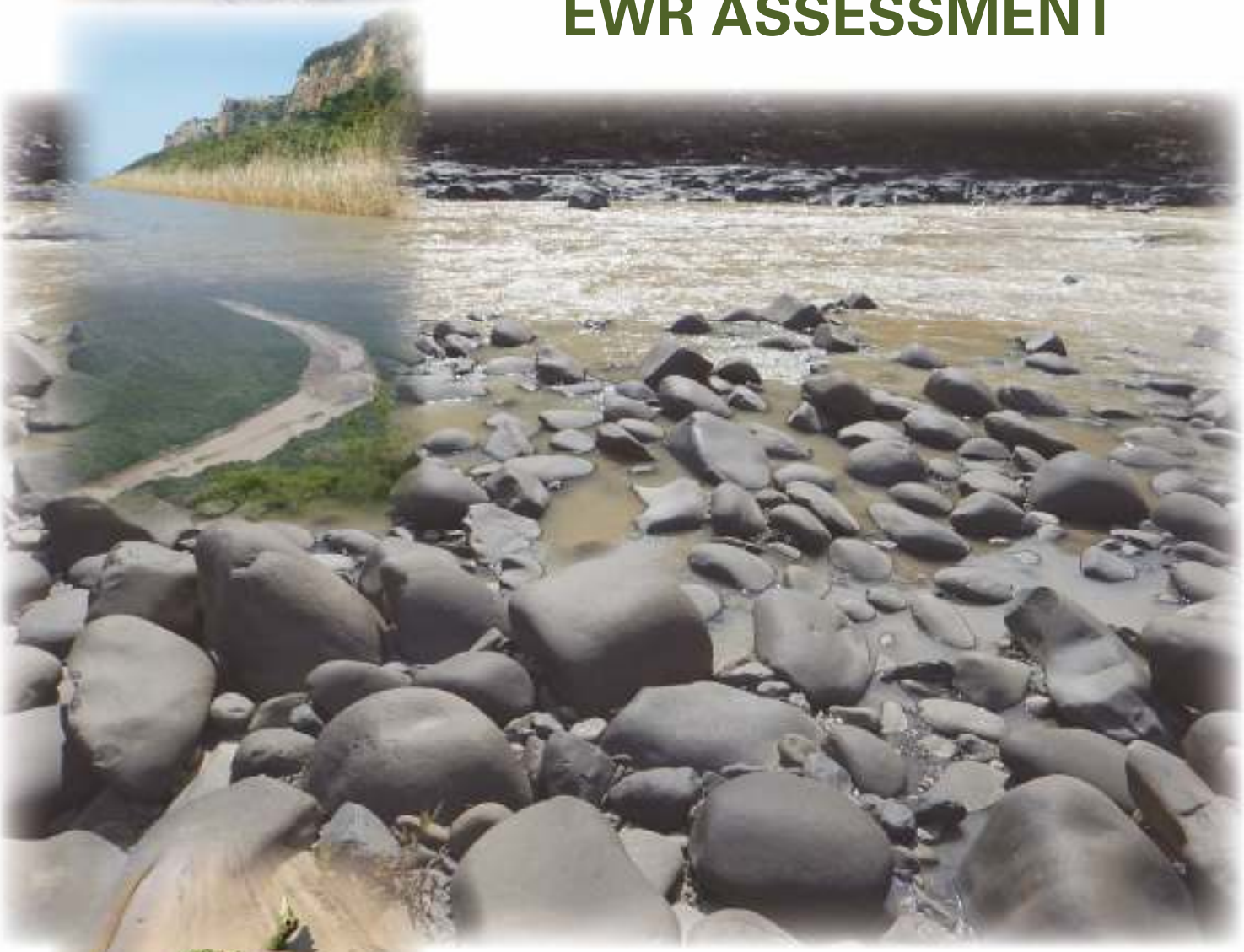
WP 11004

DETERMINATION OF WATER RESOURCE CLASSES AND RESOURCE QUALITY OBJECTIVES FOR THE WATER RESOURCES IN THE MZIMVUBU CATCHMENT

River Desktop EWR and Modelling Report:

VOLUME 2 – DESKTOP EWR ASSESSMENT



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Fax: +27 (12) 323 0321

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Compiled by:
Scherman Colloty & Associates cc
22 Somerset Street
Grahamstown
6139

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Bold indicates this report

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REVIEWERS:	Project Management Team
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Approved for Scherman Colloty & Associates cc:

_____

Dr Patsy Scherman
Study Leader

Supported by:

_____

Mr Lawrence Mulangaphuma
Project Manager

Recommended by:

_____

Ms Lebogang Matlala
Director: Water Resource Classification

Approved for the Department of Water and Sanitation by:

_____

Ms Ndileka Mohapi
Chief Director: Water Ecosystems

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The following persons contributed to this project:

Project Management Team

Matlala, L	DWS: Water Ecosystems; Classification
Mulangaphuma, L	DWS: Water Ecosystems; Classification
Scherman, P-A	Scherman Colloty & Associates cc
Sauer, J	Scherman Colloty & Associates cc
Weni, E	DWS: Eastern Cape Regional Office
Weston, B	DWS: Water Ecosystems; Surface Water Reserves
Neswiswi, T	DWS: Water Ecosystems; Surface Water Reserves
Kganetsi, M	DWS: Resource Protection and Waste
Molokomme, L	DWS: Water Ecosystems; Groundwater Reserves
Muthraparsad, N	DWS: Environment and Recreation
Thompson, I	DWS: Integrated Water Resource Planning
Matume, M	DWS: Stakeholder Engagement and Coordination
Cilliers, G	DWS: Resource Quality Information Services
Majola, S	DWS: Resource Quality Information Services

Consulting Team

The following specialists provided input to the ecological results presented in the report.

Specialist	Company
Kotze, P	Clean Stream Biological Services
Mackenzie, J	MacKenzie Ecological & Development Services cc.
Scherman, P-A	Scherman Colloty & Associates cc.

AUTHORS

The following persons contributed to this report:

Authors	Company
Birkhead, A	Streamflow Solutions cc.
Louw, D	Rivers for Africa eFlows Consulting (Pty) Ltd.

GIS support and mapping was undertaken by Sandra MacFadyen of BioGIS.

REPORT SCHEDULE

Version	Date
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Final report	June 2017

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BHN	Basic Human Needs
BHNR	Basic Human Needs Reserve
CMA	Catchment Management Agency
CSA	Conservation South Africa
DRM	Desktop Reserve Model
DWA	Department of Water Affairs (name change from DWAF after April 2009)
DWS	Department of Water and Sanitation (name change from DWA after May 2014)
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ERS	Environmental and Rural Solutions
ES	Ecological Sensitivity
EWR	Ecological Water Requirements
IFR	Instream Flow Requirements
IUA	Integrated Unit of Assessment
GIS	Global Information System
MRU	Management Resource Unit
NFEPA	National Freshwater Ecosystem Priority Areas
NWRCS	National Water Resources Classification System
PD	Present Day
PES	Present Ecological State
PESEIS	Present Ecological State Ecological Importance and Sensitivity
RDRM	Revised Desktop Reserve Model
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RUs	Resource Units
SQ	Sub-Quaternary
ToR	Terms of Reference
VBA	Visual Basic Application
WMA	Water Management Area
WRCS	Water Resource Classification System
WRSM2000	Water Resources Simulation Model 2000
WWTW	Waste Water Treatment Works

GLOSSARY

Biophysical Node	A point in the river which can be a survey site or a hypothetical point ("site"). Survey sites are EWR sites or Key Biophysical Nodes. Hypothetical points are Desktop Biophysical Nodes.
EcoClassification	EcoClassification (or the Ecological Classification process) refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various physical attributes of rivers relative to the natural reference condition. A range of models are used during EcoClassification, each of which relate to the indicators assessed.
Ecological Importance and Sensitivity (EIS)	Key indicators in the ecological classification of water resources. Ecological importance relates to the presence, representativeness and diversity of species of biota and habitat. Ecological sensitivity relates to the vulnerability of the habitat and biota to modifications that may occur in flows, water levels and physico-chemical conditions.
Ecological Water Requirements (EWR)	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
EWR sites	Specific points on the river as determined through the 'hotspot' and site selection process. An EWR site consists of a length of river which may consist of various cross-sections assessed for both hydraulic and ecological purposes. These sites provide sufficient indicators to assess environmental flows and assess the condition of biophysical components (drivers such as hydrology, geomorphology and physico-chemical conditions) and biological responses (*viz*. fish, macroinvertebrates and riparian vegetation).
Integrated Unit of Analysis (IUAs)	An IUA is a homogeneous area that can be managed as an entity. It is the basic unit of assessment for the Classification of water resources, and is defined by areas that can be managed together in terms of water resource operations, quality, socio-economics and ecosystem services.
Management Resource Units (MRUs)	Resource Units can be further delineated into homogenous river reaches from a biophysical basis under present circumstances. These delineations are referred to as Management Resource Units.
Present Ecological State (PES)	The current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses *viz*. fish, invertebrates, riparian vegetation). The degree to which ecological conditions of an area have been modified from natural (reference) conditions.
Recommended Ecological Category (REC)	The Recommended Ecological Category is the future ecological state (Ecological Categories A to D) that can be recommended for a resource unit depending on the EIS and PES. The REC is determined based on ecological criteria and considers the EIS, the restoration potential of the system and attainability thereof.
Resource Quality Objectives (RQOs)	The RQOs for a water resource are a numerical or descriptive (narrative) statement of the conditions which should be met in the receiving water resource, in terms of resource quality, in order to ensure

	that the water resource is protected. They might describe, amongst others, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota.
Resource Units (RUs)	RUs are delineated during an Ecological Reserve determination study, as each will warrant its own specification of the Reserve, and the geographic boundaries of each must be clearly delineated. These sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach. RUs are nested within IUAs and may contain an Ecological Water Requirement site.
Sub-Quaternary (SQ) catchments	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments), to a Sub-Quaternary or quinary level.
Water Resource Classification System (WRCS)	The Water Resource Classification System is a defined set of guidelines and procedures for determining the different classes of water resources (South African National Water Act (Act 36 of 1998) Chapter 3, Part 1, Section 2(a)). The outcome of the Classification Process will be the setting of the class, Reserve and Resource Quality Objectives by the Minister or delegated authority for every significant water resource (river, estuary, wetland and aquifer) under consideration. This class, which will range from Minimally used to Heavily used, essentially describes the desired condition of the resource, and concomitantly, the degree to which it can be utilised.

1 INTRODUCTION

1.1 BACKGROUND

The Department of Water and Sanitation (DWS) initiated this study to determine Water Resource Classes and associated RQOs for the Mzimvubu catchment in Water Management Area (WMA) 7. The main aims of the project, as defined by the Terms of Reference (ToR), is to undertake the following:

- Coordinate the implementation of the Water Resource Classification System (WRCS) as required in Regulation 810 in Government Gazette 33541 dated 17 September 2010, by classifying all significant water resources in the Mzimvubu catchment;
- determine Resource Quality Objectives (RQOs) using the DWS's procedures to determine and implement RQOs for the defined classes; and
- review work previously done on Ecological Water Requirements (EWRs) and the Basic Human Needs Reserve (BHNR) and assess whether suitable for the purposes of Classification.

This report described the information used and the methodology applied to provide EWR estimates for each Resource Unit (RU) at desktop biophysical nodes in the study area.

1.2 STUDY AREA

The study area is represented by the Mzimvubu catchment which consists of the main Mzimvubu River, with the Tsitsa, Thina, Kinira and Mzintlava rivers as the main tributaries and the estuary at Port St Johns. The river reaches sizeable proportions after the confluence of these four tributaries in the Lower Mzimvubu area, approximately 120 km from its source, where the impressive Tsitsa Falls can be found near Shawbury Mission. The Mzimvubu catchment and river system lies along the northern boundary of the Eastern Cape and extends for over 200 km from its source in the Maloti-Drakensberg watershed on the Lesotho escarpment to the estuary at Port St Johns. The catchment is in Primary T, comprises of T31–36 and stretches from the Mzimkhulu River on the north-eastern side to the Mbashe and Mthatha river catchments in the south. The Mzimvubu River catchment is found in WMA 7, i.e. the Mzimvubu to Tsitsikamma WMA.

The catchment covers more than two million hectares in the Eastern Cape and is comprised of almost 70% communal land. The Mzimvubu River system has been prioritised nationally as being one of the few remaining 'near-natural rivers' (NFEPA (National Freshwater Ecosystem Priority Areas) Assessment; Nel *et al.*, 2011), but the catchment is classified as vulnerable as a result of rapid rates of degradation in the watershed.

The WMA is relatively well endowed with water resources, with most occurring in the eastern part of the area. Of the current usage in the WMA, the most significant by far is agriculture via irrigation. The next largest use is by municipalities. No major instream dams occur along the main rivers, with the only dams of any significant size being the dams of Mountain Lake Dam [Mvenyane River (T31H)], Crystal Springs Dam [Mzintlava River (T32C)], Mountain Dam [Keneka River (T33A)], Belfort Dam [(Mafube River (T33A)] Ntenetyana Dam [Ntenetyana River (T33G)], Ugie Dam [Wildebees River (T35F)], Nquadu Dam (T35K), Majola Dam (T36B), Mount Fletcher Dam (T34C), Maclear Dam (T35D) and Forest Dam (T33H). Some remnant catchment dams exist in the Ongeluksnek valley and on the commercial farms in the margins of the Cedarville flats, but this is

not a common practice in traditional farming systems (ERS/CSA, 2011). However, there are a number of instream abstraction weirs.

1.3 RESOURCE UNITS AND DESKTOP BIOPHYSICAL NODES

The delineation of the Resource Units (RUs) and Management Resource Units (MRUs) are described in the Status quo and Delineation Report for this study (DWS, 2017). Each of the these are represented by biophysical nodes which are either desktop nodes, or EWR sites (**Figure 1.1**). This report focusses on the desktop nodes for which EWRs are estimated through a desktop model.

1.4 EWR ASSESSMENT FOR THE DESKTOP BIOPHYSICAL NODES

Volume 2 (this report) documents the quantification of the Ecological Water Requirements (EWRs) at the desktop biophysical nodes, i.e. sites requiring desktop EWR estimates. There are 82 biophysical nodes in the study area and an EWR is required at most of these nodes. Due to the large size of the study area and therefore large number of nodes, all EWRs cannot be determined at a detailed level. A prioritisation process (DWS, 2017) was followed to identify those nodes or rivers requiring detailed assessments. Prioritisation also provided information regarding the level at which other nodes should be addressed. The biophysical nodes and type of EWR assessments that need to be undertaken at the nodes are provided in **Table 1.1**.

Table 1.1 Biophysical nodes and levels of EWR assessment

Tertiary catchment	Number of IUAs	Number of nodes representing RUs and MRUs	Desktop EWR	New EWR sites as key nodes	Existing EWR sites as key nodes	Extrapolated from EWR sites
T31	1 (IUA T31)	19	16	0	0	3 (DRM)
T32	2 (IUA T32_a, T32_b)	13	11	0	0	2 (DRM)
T33	2 (IUA T33_a, T33_b)	14	10	0	1	2 (DRM), 1 (yield model)
T34	2 (IUA T34_a, T34_b)	14	12	0	1	1 (yield model)
T35	4 (IUA T35_a, T35_b, T35_c, T35_d)	19	17	0	1	1 (yield model)
T36	2 (IUA T36_a & estuary)	3	2	1	0	0
TOTAL		**82**	**68**	**1**	**3**	**10**

DRM: Desktop Reserve Model

The results of the desktop EWR assessments at 75 desktop biophysical nodes are provided in this report. Detailed EWR assessments have been undertaken at four EWR sites which are key biophysical nodes in the study area, as shown on **Figure 1.1**.

The Present Ecological State (PES) for the nodes is available as documented in DWS (2017). During this task the Recommended Ecological Category (REC) had to be determined for the desktop biophysical nodes so that EWRs can be estimated for the REC.

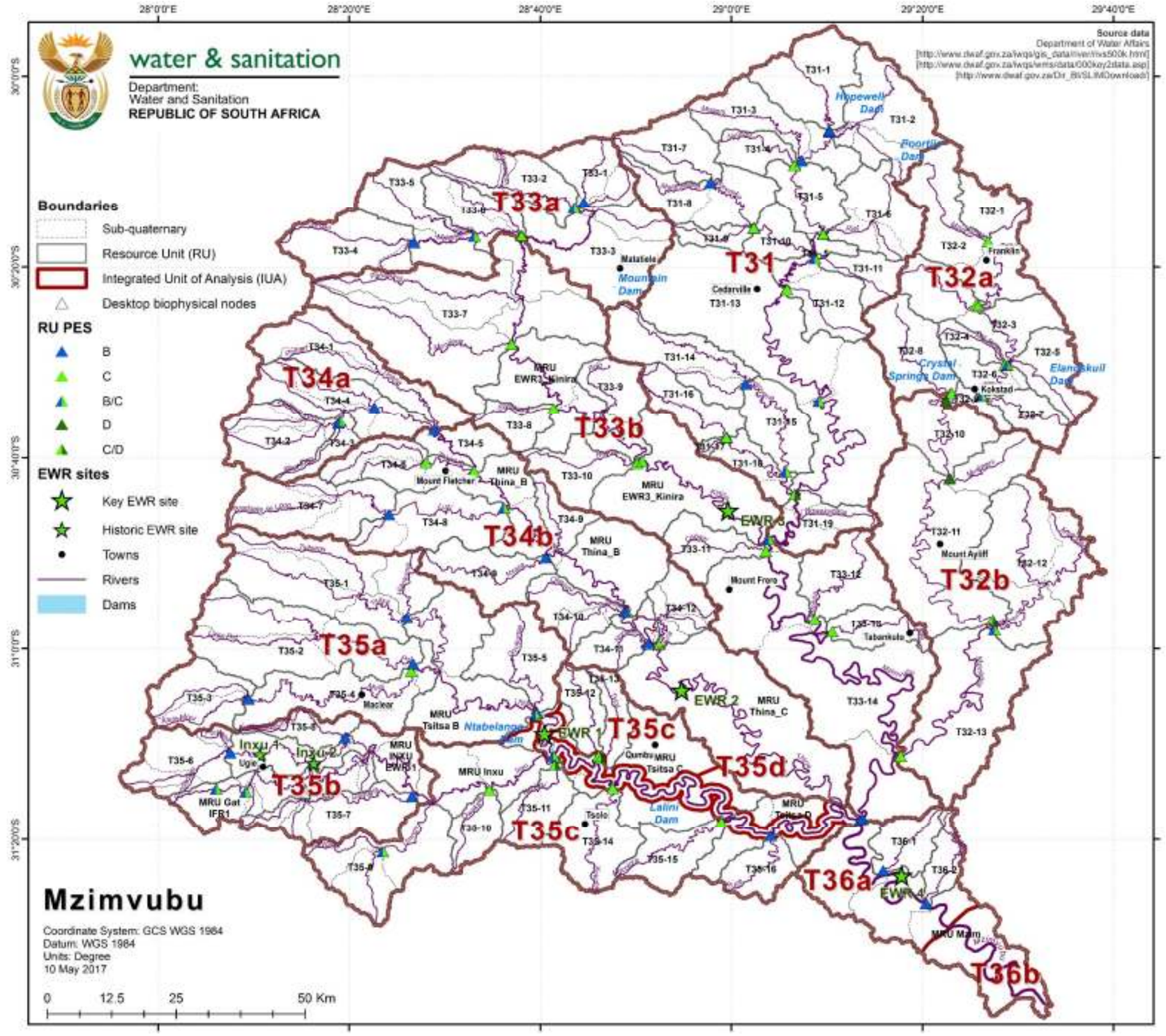

Figure 1.1 Desktop biophysical nodes in Mzimvubu catchment T3

1.5 QUANTIFY EWRs AND BHNR

This study entails Classification and setting of RQOs. Embedded in the National Water Resources Classification System (NWRCS) is the determination of the Reserve. The project plan for this study (**Figure 1.2**) incorporates the EWR and BHNR step.

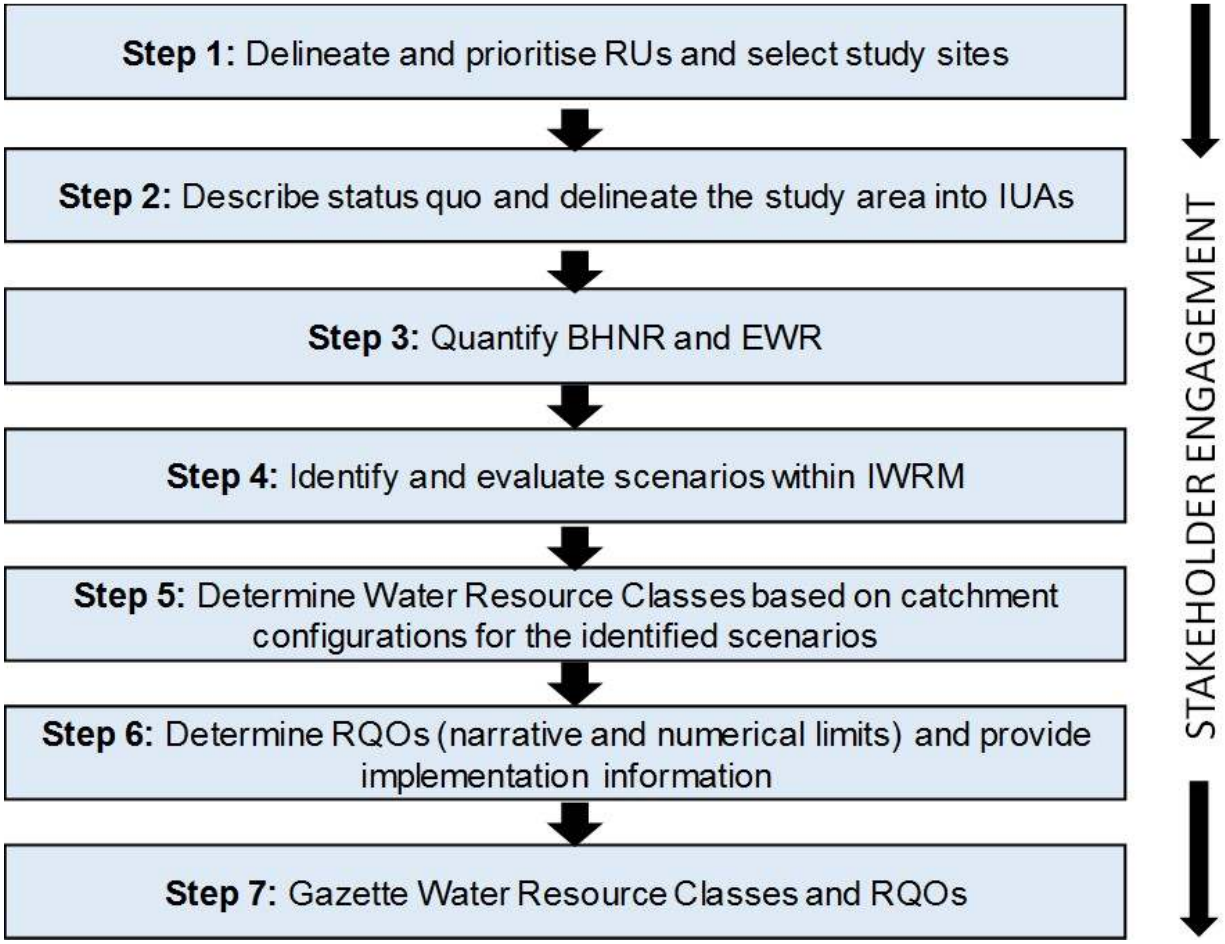

Figure 1.2 Project plan for the Mzimvubu Classification and RQO study

This report forms part of the outcomes of Step 3 for the river component of the study.

1.6 PURPOSE AND OUTLINE OF THIS REPORT

The purpose of the report is to document the process and results followed for the EcoClassification and EWR estimates for the desktop biophysical node. The report structure is as follows:

- **Chapter 1** provides background and the introduction to the report.
- **Chapter 2** lists EcoClassification results for Resource Units of desktop biophysical nodes.
- **Chapter 3** summarises the EWR results of the desktop biophysical nodes.
- **Chapter 4** lists the references for this report.

2 RESOURCE UNITS: ECOCLASSIFICATION

The sub-quaternary (SQ) river reaches as indicated in http://www.dwa.gov.za/iwqs/gis_data /river/rivs500k.html and http://www.dwa.gov.za/iwqs/gis_data/river/River_Report_01.pdf, form the basic delineation unit of the desktop PESEIS assessment undertaken for the DWA and the Water Research Commission (DWA, 2014a) for all WMAs across South Africa. These SQs were combined to form RUs based on similar Ecological Category and similar land use (detail can be seen in DWS (2017)). Each Resource Unit is represented by a biophysical node (see DWAF (2006) for definitions).

EcoClassification consists of three basic steps as follows (Kleynhans and Louw, 2007):

- Determination of Present Ecological State (PES) (DWS, 2017)
- Determination of Ecological Importance and Sensitivity (EIS) (DWS, 2017)
- Deriving the Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) is a recommendation from an ecological viewpoint which is considered within the decision-making process toward defining Water Resource Classes. The REC recommendation is based on either maintenance of the PES or an improvement thereof. Improvements are only considered if the EIS is HIGH or VERY HIGH. The PES is maintained if the EIS is LOW or MODERATE. The guidelines to derive the REC are based on the level of the PES and the EIS as indicated in **Table 2.1** (DWS, 2014b). Note that in all cases the restoration potential and practicalities of ecological attainability of recommendations that require improvements, are considered.

Table 2.1 Guideline for setting RECs

PES	EIS	REC	Comment
A, A/B, B	High or Very High	A, A/B, B	The PES will be maintained as it is already in a good condition that will support the high EIS.
B/C	High or Very High	B	As this condition is close to a B, marginal improvement may be required as a B is sufficient to support the high EIS.
C	High or Very High	B	Attempts should be made to improve by a Category.
C/D	High or Very High	B/C	Attempts should be made to improve by a Category.
D	High or Very High	C	Attempts should be made to improve by a Category.
D/E, E, E/F, F	n/a	D	Any Category below a D should (if restoration potential still exists) be improved to at least a D to ensure a minimum level of sustainability. This is irrespective of the EIS. It is unlikely though that it would be practical to improve an F river to a D without considerable investment, effort and possibly physical rehabilitation of the river.

During the review of the 2014 PESEIS results for the Mzimvubu catchment (DWS, 2014c) (results can be seen in DWS (2017)), a master spreadsheet was developed that includes all the information required to derive the REC based on the guidelines presented in **Table 2.1**. The following steps were followed to determine the REC – all steps are documented in the spreadsheet which is available as part of electronic information, i.e. e-data, for the study. It must be noted that

this process forms part of the desktop level of EcoClassification (Kleynhans and Louw, 2007) and therefore the restoration capability could only be determined based on this level of information.

- Determine the PES and provide an Ecological Category for the EcoStatus.
- Provide the reasons for the PES. Focus on whether the issues are flow or non-flow related. Flow related implies that the direct source and causes of the problem are in flow changes (e.g., decreased flow due to pumping for irrigation) or non-flow related (e.g., presence of alien vegetation).
- Determine the Ecological Importance (EI) and Ecological Sensitivity (ES).
- Adjust **Table 2.1** to address the desktop level available for the EI and the ES. It is important to note that the PESEIS (DWS, 2014b) provides separate results for the EI and ES. It is generally acknowledged that the EI is a better indication of whether improvement is required, however the ES can also be important in certain circumstances (see below). The following rule was therefore developed to integrate the EI and ES into an EIS value:
  - If the EI is high and the PES is lower than a B, then the REC should improve.
  - If the ES is high and the PES is lower than a B and if the required improvement is flow or water quality related, then the REC should improve.
  - If the ES is high the PES is lower than a B and the improvement that would be required is water quality related, then attempt to improve.
  - If the SQ is a verified NFEPA then the EIS is changed to High. This should not influence the REC as verified NFEPAs have to be, amongst others, in a B PES and therefore do not require improvement.

Table 2.2 summarises the results for the desktop biophysical nodes and forms the basis for the EWR estimation (see **Chapter 3**).

The description of the columns is as follows:

- Column 1: RU name.
- Column 2: River name where available.
- Column 3: PES according to the review of the PESEIS study results (DWS, 2017).
- Column 4: Based on the EIS (DWS, 2017) and on the rules provided in this chapter, the necessity for improvement is indicated. If improvement is required (yes) it means that the EIS is high or very high. If improvement is not required (no), the EIS is low or moderate.
- Column 5: Comments provided to indicate what would be required to improve the REC and whether it is attainable as well as information on whether the actions required would need flow- or non-flow-related measures.
- Column 6: A conclusion on whether the improvement is attainable.
- Column 7: REC derived based on previous columns.

Table 2.2 REC results for the desktop biophysical nodes

RU	River	PES	Improve?	REC comment	Improvement attainable?	REC
T31-1	Mzimvubu	B/C	NO			B/C
T31-2	Krom	B	NO			B
T31-3	Mzimvubu	B	NO			B
T31-4	Nyongo	C	NO			C
T31-5	Mzimvubu	B	NO			B
T31-6	Riet	C	NO			C
T31-7	Tswereka	B	NO			B
T31-8	Tswereka	B/C	NO			B/C
T31-9		C	NO			C
T31-10	Tswereka	D	NO			D
T31-11		B/C	NO			B/C
T31-12	Mzimvubu	C	NO			C
T31-13	Mzimvubu	B/C	NO			B/C
T31-14	Mvenyane	B	NO			B
T31-15	Mvenyane	B/C	NO			B/C
T31-16	Mkemane	B	NO			B
T31-17		C	YES	Possible sewage treatment required. Erosion control and improved agricultural practices. Alien vegetation removal.	Difficult	B/C
T31-18	Mkemane	C/D	YES	Water quality improvement required in terms of sedimentation, i.e. erosion control.	Difficult	B/C
T31-19	Mzimvubu	B/C	NO			B/C
T32-1	Mzintlava	C	YES	Flow only needs to improve as it relates to sensitivity. Control and management of dams.		B/C
T32-2	Mzintlava	C	NO			C
T32-3		C	YES	Flow only needs to improve as it relates to sensitivity. Control of, amongst others, pivot irrigation, to supply EWR.		B/C
T32-4	Mill Stream	C	YES	Combination of flow and non-flows impacts.		B/C
T32-5	aManzamnyama	B/C	NO			B/C
T32-6	Mzintlava	B	NO			B
T32-7		B/C	NO			B/C
T32-8	Droewig	C	NO			C
T32-9	Mzintlava	D	NO			D
T32-10	Mzintlava	D	NO			D
T32-11	Mzintlava	C/D	YES	Erosion control and improved agricultural practices. Alien vegetation removal.	Difficult	C
T32-12	Mzintlavana	B/C	YES	Erosion control. Alien vegetation removal.	Difficult	B
T32-13	Mzintlava	C	YES	Improve riparian continuity by improving riparian buffer zone (floodplain agriculture).		B
T33-1	Mafube	B	NO			B
T33-2	Kinira	B/C	NO			B/C

RU	River	PES	Improve?	REC comment	Improvement attainable?	REC
T33-3		C	NO			C
T33-4	Jordan	B	NO			B
T33-5	Seeta	B/C	NO			B/C
T33-6	Mosenene	C	NO			C
T33-7	Kinira	C	NO			C
T33-8	Somabadi	C	NO			C
T33-9	Kinira	C	NO	Water quality improvement required in terms of sedimentation, i.e. erosion control.	Difficult	C
T33-10	Ncome	C	NO			C
T33-11	Cabazi	C	NO			C
T33-12	Mnceba	C	NO			C
T33-13	Caba	C	YES	Improvement of WWTW discharge quality, Erosion prevention, riparian buffer protection.		B
T33-14	Mzimvubu	Extrapolate from MzimEWR4 by means of the yield model.				
T34-1	Phinari	B	NO			B
T34-2	Thina	B	NO			B
T34-3	Thina	B/C	NO			B/C
T34-4	Phiri-e-ntso	B	NO			B
T34-5	Thina	C	YES	Supply the EWR from the dam. Improve the WWTW discharge quality.		B/C
T34-6	Tokwana	C	NO			C
T34-7	Luzi	B	NO			B
T34-8	Luzi	B/C	NO			B/C
T34-9	Nxaxa	B	NO			B
T34-10	Tsilithwa	B	NO			B
T34-11	Ngcothi	B	NO			B
T34-12	Ngcibira	C	NO			C
T35-1	Tsitsa	B	NO			B
T35-2	Pot	B	NO			B
T35-3	Klein-Mooi	B	NO			B
T35-4	Mooi	C	NO			C
T35-5	Gqukunqa	B	NO			B
T35-6	Inxu	B	NO			B
T35-7	Gqaqala	B	NO			B
T35-8	Kuntombizininzi	B	NO			B
MRU Inxu EWR 1	Inxu	B/C	NO			B/C
MRU Gat IFR1	Gatberg	B/C	YES	Flow modification can only improve if dams are managed to ensure EWR.	Difficult	B
MRU Inxu	Inxu	Extrapolate from MzimEWR4 by means of the yield model.				
T35-9	KuNgindi	B/C	NO			B/C
T35-10	Qwakele	C	YES	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	Difficult	B/C

RU	River	PES	Improve?	REC comment	Improvement attainable?	REC
T35-11	Ncolosi	C/D	YES	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	Difficult	C
T35-12	Culunca	C	YES	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	Difficult	B/C
T35-13	Tyira	C/D	NO			C/D
T35-14	Xokonxa	C	NO			C
T35-15	Ngcolora	C	NO			C
T35-16	Ruze	B	NO			B
T36-1	Mzintshana	B	NO			B
T36-2	Mkata	B	NO			B

The REC is used for the category for which the EWR is estimated (**Chapter 3**). However, in the cases where the REC is an improvement of the PES, an assessment must be made whether that improvement can be achieved by means of increasing the flow. If the improvement requires *non-flow related* measures, e.g. vegetation removal or improvement of Waste Water Treatment Works (WWTW) operation, the EWRs are estimated for the PES. In the cases where improvement is required, the EC for which the EWRs must be estimated is provided in the last column of **Table 2.3**. The table is therefore limited to instances where the PES and REC are not the same, and where improvement is required.

Table 2.3 EC for which the EWRs must be estimated

RU	River	PES	REC comment	REC	EC for EWR estimation
T31-17		C	Possible sewage treatment required. Erosion control and improved agricultural practices. Alien vegetation removal.	B/C	C
T31-18	Mkemane	C/D	Water quality improvement required in terms of sedimentation, i.e. erosion control.	B/C	C/D
T32-1	Mzintlava	C	Flow only needs to improve as it relates to sensitivity. Control and management of dams.	B/C	B/C
T32-3		C	Flow only needs to improve as it relates to sensitivity. Control of, amongst others, pivot cultivation to supply EWR.	B/C	B/C
T32-4	Mill Stream	C	Combination of flow and non-flows impacts.	B/C	B/C
T32-11	Mzintlava	C/D	Erosion control and improved agricultural practices. Alien vegetation removal.	C	C/D
T32-12	Mzintlavana	B/C	Erosion control. Alien vegetation removal.	B	B/C
T32-13	Mzintlava	C	Improve riparian continuity by improving riparian buffer zone (floodplain agriculture).	B	C
T33-13	Caba	C	Improvement of WWTW discharge quality, erosion prevention, riparian buffer protection.	B	C
T34-5	Thina	C	Supply the EWR from the dam. Improve	B/C	C

RU	River	PES	REC comment	REC	EC for EWR estimation
			the WWTW discharge quality.		
MRU Gat IFR1	Gatberg	B/C	Flow modification can only improve if dams are managed to ensure EWR.	B	B
T35-10	Qwakele	C	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	B/C	C
T35-11	Ncolosi	C/D	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	C	C/D
T35-12	Culunca	C	Improve the riparian zone condition (erosion control and limit cultivation in zone) to improve water quality.	B/C	C

3 RUs: EWR ESTIMATION AND RESULTS

3.1 BACKGROUND

The Desktop Reserve Model (DRM) of Hughes and Hannart (2003) has been extensively used over the last decade for estimating EWRs in this and other countries. The DRM was applied in this study, rather than the revised version, i.e. the Revised DRM (or RDRM), which has been described by Hughes *et al.* (2012) and Hughes *et al.* (2014). The reason for choosing the 'original' version of the DRM is that the RDRM is currently being refined and extended under the auspices of a joint Water Research Commission/DWS project. The approaches (or 'rules') for estimating both low flow and high flow (desktop) EWRs in the RDRM are being reassessed, and the refinements being made are quite substantial. It was initially anticipated that the RDRM could be used in this desktop EWR study, with the existing and somewhat coarse (default) rules being better informed by the results from the detailed surveys of the four main-stem EWR sites on the Tsitsa, Thina, Kinira and Mzimvubu rivers (**Figure 1.1**). Further consideration, however, led to the conclusion that it would be preferable to apply the original DRM in this study, rather than the existing RDRM which has limitations that are presently being addressed.

3.2 APPROACH

3.2.1 Biophysical nodes, information provided and DRM set-up in SPATSIM

Biophysical nodes are located within RU catchments, generally at their outlets, and were labelled sequentially according to their secondary catchments. Naturalised and Present Day (PD) hydrological monthly time series for the period 1920 to 2004 were provided by WRP Consulting Engineers, the yield modellers for the study.

For some nodes (which represent ecological conditions at the RU scale), an improvement in the ecological category is recommended, relative to the PES (refer to **Table 2.3**). For these nodes, the time series of EWR flows were not constrained to be equivalent-to, or less-than, PD flows. For the remaining nodes, the EWR flows are constrained by the PD hydrology.

The DRM was set-up in SPATSIM (Spatial and Time Series Information Modelling framework) for the 76 (biophysical) nodes. SPATSIM was used to export the EWR flow assurance rules (low and high flows) and the total EWR time series. As the DRM does not possess the ability to constrain EWR rules and flows to PD hydrology, this was performed externally (to SPATSIM/DRM) using VBA (Visual Basic Application) script. Flow-assurance tables were then recalculated from the constrained (to PD) total EWR time series.

3.2.2 Desktop extrapolation using EWR sites

For seven of the nodes along main-stem channels (refer to **Table 3.1**), EWRs were extrapolated from the results determined for an EWR site (by adjusting parameter values in the DRM). This is considered more accurate than the (default) desktop application, and yielded results higher than desktop values by approximately 4.5% of the naturalised MAR (2% and 2.5% for the low and high flow EWRs, respectively).

3.2.3 Existing (historic) EWR results from sites in sub-catchment T36

Historic EWRs exist for sites on the Gatberg and Wildebees (Inxu) rivers in headwaters of sub-catchment T36, having been completed in 2000 and 2011, respectively. The naturalised (modelled) hydrology for the Gatberg River sites has changed substantially, rendering the EWR results of 17 years ago unusable for this study. For the Wildebees (Inxu) River, however, the EWR results of 2011 (refer to Scherman *et al.*, 2011) were used to inform the desktop analysis in this study, and default parameters in the DRM were modified accordingly.

3.3 RESULTS

A summary of the total long-term (i.e. 1920 to 2004) EWR total flow requirements for the REC, including naturalised and PD Mean Annual Runoff, are provided in **Table 3.1**. Shaded nodes indicate those extrapolated from EWR sites. These are also indicated in the footnote to the table.

The desktop EWR results are also provided in the following formats as text files named according to the nodes:

- Time series of average monthly total (i.e., low plus high flows) EWR flow requirements (in 10^6 m^3) for the period 1920 to 2004.
- Assurance rules for EWR total flows (in 10^6 m^3 and m^3/s); and naturalised and PD flow-duration tables are also included in the .rul text files. An example of an EWR flow-assurance file, generated by the VBA script, is illustrated in **Table 3.2**.

Results for all nodes are available as part of the electronic data (e-data) for the study.

Table 3.1 Summary of desktop EWRs for the biophysical nodes in the Mzimvubu catchment

RU node	Mean Annual Runoff (10^6 m^3)		REC	Long-term EWR requirements	
	Natural	PD		(10^6 m^3)	% Natural
T31-1	32.73	31.25	B/C	7.67	23.4
T31-2	31.33	29.95	B/C	7.41	23.6
T31-3	87.01	83.51	B	24.09	27.7
T31-4	8.92	8.83	C	1.92	21.5
T31-5	104.92	100.32	B	28.87	27.5
T31-6	13.98	11.93	C	2.72	19.4
T31-7	12.78	12.71	B	3.70	29.0
T31-8	29.55	27.73	B/C	7.42	25.1
T31-9	4.00	3.97	C	0.87	21.8
T31-11	3.71	3.42	B/C	0.89	24.1
T31-12[1]	190.45	178.26	C	50.19	26.4
T31-13[1]	217.82	204.88	B/C	63.20	29.0
T31-14	23.98	21.44	B	6.61	27.6
T31-15	40.83	37.95	B/C	9.85	24.1
T31-16	13.61	13.48	B	3.77	27.7
T31-17	1.30	1.30	C	0.28	21.7
T31-18	64.81	61.80	C/D	12.03	18.6

RU node	Mean Annual Runoff (10^6 m^3)		REC	Long-term EWR requirements	
	Natural	PD		(10^6 m^3)	% Natural
T31-19[1]	335.66	316.55	B/C	96.49	28.7
T32-1	9.46	8.78	B/C	2.27	24.0
T32-2	37.60	31.93	C	6.61	17.6
T32-3	11.08	10.74	B/C	2.66	24.0
T32-4	4.26	4.12	B/C	1.04	24.3
T32-5	13.86	13.14	B/C	3.35	24.2
T32-6	86.17	75.38	B	22.54	26.2
T32-7	8.53	8.18	B/C	2.06	24.2
T32-8	18.43	16.63	C	3.75	20.3
T32-9	98.14	88.08	D	15.86	16.2
T32-10	134.49	120.44	D	21.34	15.9
T32-11[1]	223.24	205.32	C/D	52.72	23.6
T32-12	57.16	55.41	B/C	13.11	22.9
T32-13[1]	348.86	326.94	C	86.05	24.7
T33-1	20.45	19.60	B	5.62	27.5
T33-2	26.29	26.16	B/C	6.28	23.9
T33-3	97.37	94.75	C	19.96	20.5
T33-4	33.94	33.87	B	9.13	26.9
T33-5	69.76	69.37	B/C	16.27	23.3
T33-6	94.27	93.66	C	18.83	20.0
T33-7[1]	302.96	296.36	C	74.52	24.6
T33-8	6.17	6.13	C	1.27	20.7
T33-9[1]	368.32	360.77	C	91.80	24.9
T33-10	15.58	15.15	C	3.17	20.3
T33-11	14.01	12.06	C	2.82	20.1
T33-12	17.05	16.89	C	3.37	19.8
T33-13	9.22	8.63	C	1.82	19.8
T34-1	33.59	33.45	B	8.92	26.6
T34-2	32.91	32.64	B	8.68	26.4
T34-3	41.14	40.89	B/C	9.42	22.9
T34-4	68.08	67.39	B	17.98	26.4
T34-5	123.48	120.06	C	24.30	19.7
T34-6	20.35	20.21	C	4.10	20.2
T34-7	45.20	44.38	B	11.98	26.5
T34-8	84.70	83.32	B/C	19.65	23.2
T34-9	27.13	22.55	B	7.38	27.2
T34-10	20.07	18.96	B	5.47	27.2
T34-11	11.86	11.30	B	3.23	27.2
T34-12	18.25	17.13	C	3.70	20.3
T35-1	101.14	97.60	B	28.25	27.9
T35-2	79.71	78.37	B	22.17	27.8
T35-3	63.69	61.52	B	17.16	26.9

RU node	Mean Annual Runoff (10^6 m^3)		REC	Long-term EWR requirements	
	Natural	PD		(10^6 m^3)	% Natural
T35-4	127.57	111.92	C	25.89	20.3
T35-5	46.09	43.90	B	12.63	27.4
T35-6	37.64	33.71	B	10.38	27.6
T35-7	26.15	24.02	B	7.31	28.0
T35-8	14.29	9.68	B	3.75	26.3
T35-9	35.07	34.43	B/C	8.42	24.0
T35-10	19.87	19.72	C	4.10	20.7
T35-11	29.76	29.18	C/D	5.55	18.6
T35-12	18.12	17.58	C	3.74	20.6
T35-13	14.72	14.25	C/D	2.74	18.6
T35-14	36.24	33.38	C	7.47	20.6
T35-15	10.19	10.07	C	1.93	18.9
T35-16	13.52	13.52	B	3.56	26.3
Inxu1[2]	44.38	39.42	B/C	7.93	17.9
Gat2[2]	10.90	8.15	B	3.06	27.7
T36-1	14.34	14.25	B	3.75	28.1
T36-2	9.78	9.72	B	2.56	26.1

[1] EWRs extrapolated from EWR sites

[2] Note that the node names of the EWR sites differ from the RU name, which in this case represents the MRU

Table 3.2 Example of an EWR flow-assurance rule file: T31-1.rul

Node: T31-1
FDCs (Nat & PD) and EWR assurance rules for REC B/C (EWR reference = naturalised, constrained to PD)
Date & time generated: 27/02/2017 12:52

Units: million cubic metres (MCM)
Naturalised (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	13.290	13.290	3.224	1.786	1.061	0.876	0.692	0.520	0.430	0.390	0.328	0.290	0.250	0.240	0.220	0.150	0.150
Nov	16.790	16.790	10.546	5.776	3.501	1.984	1.096	0.798	0.640	0.580	0.490	0.394	0.339	0.276	0.233	0.180	0.180
Dec	18.330	18.330	15.485	13.030	10.205	8.330	5.028	2.314	0.940	0.788	0.598	0.494	0.397	0.278	0.230	0.210	0.210
Jan	26.220	26.220	17.647	14.788	12.732	10.488	7.882	4.954	3.340	2.652	1.968	1.022	0.816	0.602	0.440	0.230	0.230
Feb	27.730	27.730	20.402	16.568	12.975	11.308	9.510	7.550	5.730	4.158	3.370	1.560	0.824	0.710	0.600	0.230	0.230
Mar	34.630	34.630	19.676	14.750	13.344	11.176	8.062	5.328	4.550	3.730	2.740	1.606	1.096	0.878	0.735	0.290	0.290
Apr	12.170	12.170	7.148	5.402	4.794	4.226	2.928	2.122	1.490	1.144	0.950	0.792	0.730	0.648	0.473	0.290	0.290
May	22.390	22.390	2.140	1.406	1.182	1.028	0.730	0.670	0.600	0.528	0.488	0.422	0.400	0.380	0.353	0.260	0.260
Jun	7.950	7.950	2.126	0.990	0.731	0.626	0.544	0.466	0.420	0.390	0.358	0.340	0.320	0.310	0.276	0.180	0.180
Jul	3.290	3.290	1.224	0.854	0.690	0.636	0.546	0.420	0.370	0.340	0.310	0.282	0.279	0.270	0.243	0.210	0.210
Aug	3.770	3.770	1.339	0.760	0.660	0.608	0.480	0.390	0.350	0.294	0.278	0.260	0.250	0.240	0.213	0.190	0.190
Sep	29.860	29.860	2.123	0.892	0.683	0.546	0.434	0.380	0.340	0.310	0.268	0.250	0.239	0.210	0.163	0.130	0.130

Present Day (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	12.790	12.790	3.076	1.690	0.980	0.826	0.580	0.386	0.290	0.244	0.148	0.072	0.040	0.040	0.030	0.020	0.020
Nov	16.320	16.320	10.273	5.606	3.390	1.940	1.106	0.808	0.660	0.578	0.460	0.324	0.259	0.174	0.043	0.040	0.040
Dec	18.000	18.000	15.219	12.762	9.980	8.058	4.850	2.274	0.940	0.798	0.618	0.462	0.354	0.236	0.116	0.040	0.040
Jan	26.310	26.310	17.611	14.638	12.625	10.470	7.690	4.872	3.360	2.598	1.868	1.006	0.739	0.560	0.373	0.080	0.080
Feb	27.930	27.930	20.315	16.652	13.076	11.318	9.522	7.602	5.610	4.246	3.440	1.732	0.951	0.736	0.541	0.050	0.050
Mar	34.890	34.890	19.867	14.944	13.358	11.322	8.106	5.414	4.660	3.758	2.782	1.770	1.190	1.052	0.778	0.320	0.320
Apr	12.100	12.100	7.099	5.294	4.744	4.130	2.810	2.042	1.440	1.054	0.898	0.710	0.658	0.566	0.372	0.200	0.200
May	22.260	22.260	1.970	1.344	1.024	0.936	0.568	0.506	0.410	0.378	0.300	0.250	0.220	0.210	0.166	0.050	0.050
Jun	7.580	7.580	1.983	0.780	0.502	0.456	0.292	0.206	0.170	0.130	0.098	0.072	0.050	0.050	0.043	0.030	0.030
Jul	2.960	2.960	1.012	0.704	0.551	0.430	0.302	0.172	0.120	0.080	0.058	0.040	0.040	0.040	0.040	0.030	0.030
Aug	3.560	3.560	1.124	0.500	0.460	0.320	0.234	0.142	0.070	0.040	0.040	0.040	0.040	0.036	0.030	0.020	0.020
Sep	29.480	29.480	1.891	0.694	0.520	0.300	0.190	0.106	0.050	0.040	0.040	0.030	0.030	0.030	0.030	0.020	0.020

Reserve (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	0.377	0.377	0.377	0.376	0.374	0.372	0.362	0.343	0.285	0.244	0.148	0.072	0.040	0.040	0.030	0.020	0.020
Nov	0.607	0.607	0.607	0.606	0.604	0.599	0.584	0.543	0.497	0.400	0.315	0.212	0.179	0.152	0.043	0.040	0.040
Dec	1.214	1.214	1.214	1.214	1.210	1.203	1.181	1.129	0.940	0.788	0.598	0.454	0.335	0.236	0.116	0.040	0.040
Jan	1.784	1.784	1.784	1.784	1.699	1.620	1.480	1.332	1.100	0.938	0.765	0.544	0.439	0.353	0.288	0.080	0.080
Feb	4.051	4.051	4.051	4.050	3.794	3.545	3.148	2.744	2.098	1.741	1.407	0.898	0.629	0.570	0.429	0.050	0.050
Mar	2.116	2.116	2.116	2.114	2.008	1.904	1.731	1.535	1.247	1.024	0.787	0.524	0.456	0.391	0.355	0.290	0.290
Apr	0.966	0.966	0.966	0.965	0.960	0.953	0.929	0.874	0.790	0.658	0.509	0.360	0.311	0.263	0.239	0.200	0.200
May	0.444	0.444	0.444	0.443	0.442	0.439	0.428	0.406	0.369	0.301	0.247	0.181	0.164	0.146	0.134	0.050	0.050
Jun	0.330	0.330	0.330	0.329	0.328	0.325	0.292	0.206	0.170	0.130	0.098	0.072	0.050	0.050	0.043	0.030	0.030

Jul	0.282	0.282	0.282	0.281	0.280	0.277	0.268	0.172	0.120	0.080	0.058	0.040	0.040	0.040	0.040	0.030	0.030
Aug	0.255	0.255	0.255	0.254	0.253	0.251	0.232	0.142	0.070	0.040	0.040	0.040	0.040	0.036	0.030	0.020	0.020
Sep	0.347	0.347	0.347	0.347	0.345	0.300	0.190	0.106	0.050	0.040	0.040	0.030	0.030	0.030	0.030	0.020	0.020

Units: cubic metres/second (m^3/s)

Naturalised (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	4.962	4.962	1.204	0.667	0.396	0.327	0.258	0.194	0.161	0.146	0.122	0.108	0.093	0.090	0.082	0.056	0.056
Nov	6.478	6.478	4.069	2.228	1.351	0.765	0.423	0.308	0.247	0.224	0.189	0.152	0.131	0.106	0.090	0.069	0.069
Dec	6.844	6.844	5.781	4.865	3.810	3.110	1.877	0.864	0.351	0.294	0.223	0.184	0.148	0.104	0.086	0.078	0.078
Jan	9.789	9.789	6.589	5.521	4.754	3.916	2.943	1.850	1.247	0.990	0.735	0.382	0.305	0.225	0.164	0.086	0.086
Feb	11.361	11.361	8.359	6.788	5.316	4.633	3.896	3.093	2.348	1.704	1.381	0.639	0.338	0.291	0.246	0.094	0.094
Mar	12.929	12.929	7.346	5.507	4.982	4.173	3.010	1.989	1.699	1.393	1.023	0.600	0.409	0.328	0.274	0.108	0.108
Apr	4.695	4.695	2.758	2.084	1.850	1.630	1.130	0.819	0.575	0.441	0.367	0.306	0.282	0.250	0.182	0.112	0.112
May	8.359	8.359	0.799	0.525	0.441	0.384	0.273	0.250	0.224	0.197	0.182	0.158	0.149	0.142	0.132	0.097	0.097
Jun	3.067	3.067	0.820	0.382	0.282	0.242	0.210	0.180	0.162	0.150	0.138	0.131	0.123	0.120	0.106	0.069	0.069
Jul	1.228	1.228	0.457	0.319	0.258	0.237	0.204	0.157	0.138	0.127	0.116	0.105	0.104	0.101	0.091	0.078	0.078
Aug	1.408	1.408	0.500	0.284	0.246	0.227	0.179	0.146	0.131	0.110	0.104	0.097	0.093	0.090	0.080	0.071	0.071
Sep	11.520	11.520	0.819	0.344	0.264	0.211	0.167	0.147	0.131	0.120	0.103	0.096	0.092	0.081	0.063	0.050	0.050

Present Day (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	4.775	4.775	1.148	0.631	0.366	0.308	0.217	0.144	0.108	0.091	0.055	0.027	0.015	0.015	0.011	0.007	0.007
Nov	6.296	6.296	3.963	2.163	1.308	0.748	0.427	0.312	0.255	0.223	0.177	0.125	0.100	0.067	0.017	0.015	0.015
Dec	6.720	6.720	5.682	4.765	3.726	3.009	1.811	0.849	0.351	0.298	0.231	0.172	0.132	0.088	0.043	0.015	0.015
Jan	9.823	9.823	6.575	5.465	4.714	3.909	2.871	1.819	1.254	0.970	0.697	0.376	0.276	0.209	0.139	0.030	0.030
Feb	11.443	11.443	8.323	6.822	5.357	4.637	3.901	3.115	2.298	1.740	1.409	0.710	0.390	0.302	0.222	0.020	0.020
Mar	13.026	13.026	7.417	5.579	4.987	4.227	3.026	2.021	1.740	1.403	1.039	0.661	0.444	0.393	0.290	0.119	0.119
Apr	4.668	4.668	2.739	2.042	1.830	1.593	1.084	0.788	0.556	0.407	0.346	0.274	0.254	0.218	0.144	0.077	0.077
May	8.311	8.311	0.736	0.502	0.382	0.349	0.212	0.189	0.153	0.141	0.112	0.093	0.082	0.078	0.062	0.019	0.019
Jun	2.924	2.924	0.765	0.301	0.194	0.176	0.113	0.079	0.066	0.050	0.038	0.028	0.019	0.019	0.017	0.012	0.012
Jul	1.105	1.105	0.378	0.263	0.206	0.161	0.113	0.064	0.045	0.030	0.022	0.015	0.015	0.015	0.015	0.011	0.011
Aug	1.329	1.329	0.420	0.187	0.172	0.119	0.087	0.053	0.026	0.015	0.015	0.015	0.015	0.013	0.011	0.007	0.007
Sep	11.373	11.373	0.730	0.268	0.201	0.116	0.073	0.041	0.019	0.015	0.015	0.012	0.012	0.012	0.012	0.008	0.008

Reserve (total)

	0.1	1.0	5.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	85.0	90.0	95.0	99.0	99.9
Oct	0.141	0.141	0.141	0.140	0.140	0.139	0.135	0.128	0.106	0.091	0.055	0.027	0.015	0.015	0.011	0.007	0.007
Nov	0.234	0.234	0.234	0.234	0.233	0.231	0.225	0.210	0.192	0.154	0.122	0.082	0.069	0.059	0.017	0.015	0.015
Dec	0.453	0.453	0.453	0.453	0.452	0.449	0.441	0.421	0.351	0.294	0.223	0.170	0.125	0.088	0.043	0.015	0.015
Jan	0.666	0.666	0.666	0.666	0.634	0.605	0.552	0.497	0.411	0.350	0.285	0.203	0.164	0.132	0.108	0.030	0.030
Feb	1.660	1.660	1.660	1.659	1.554	1.452	1.290	1.124	0.860	0.713	0.576	0.368	0.258	0.234	0.176	0.020	0.020
Mar	0.790	0.790	0.790	0.789	0.750	0.711	0.646	0.573	0.466	0.382	0.294	0.196	0.170	0.146	0.132	0.108	0.108
Apr	0.373	0.373	0.373	0.372	0.370	0.368	0.358	0.337	0.305	0.254	0.196	0.139	0.120	0.102	0.092	0.077	0.077
May	0.166	0.166	0.166	0.166	0.165	0.164	0.160	0.152	0.138	0.113	0.092	0.067	0.061	0.055	0.050	0.019	0.019
Jun	0.127	0.127	0.127	0.127	0.127	0.125	0.113	0.079	0.066	0.050	0.038	0.028	0.019	0.019	0.017	0.012	0.012
Jul	0.105	0.105	0.105	0.105	0.105	0.103	0.100	0.064	0.045	0.030	0.022	0.015	0.015	0.015	0.015	0.011	0.011
Aug	0.095	0.095	0.095	0.095	0.094	0.094	0.087	0.053	0.026	0.015	0.015	0.015	0.015	0.013	0.011	0.007	0.007
Sep	0.134	0.134	0.134	0.134	0.133	0.116	0.073	0.041	0.019	0.015	0.015	0.012	0.012	0.012	0.012	0.008	0.008

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APPENDIX A: COMMENTS REPORT

Page / Section	Report statement	Comments	Changes made?	Author comment
DWS Project Management Committee – 10 April 2017				
Report		Editorial comments	Yes	Addressed throughout.
Pg 1-1		Replace heading General with Background	Yes	
Pg 1-4, Fig 1.2	Project plan for the Mzimvubu Classification/RQO study	Please remove forward slash and name the figure as follow: Project plan for the Mzimvubu Classification and RQO study.	Yes	
Pg 1-2		Check Grammar under Heading: RESOURCE UNITS AND DESKTOP BIOPHYSICAL NODES	Yes	
Pg 1-2		EWR Prioritisation process is not explained in the report.	No	EWR prioritisation is covered in the Status Quo and (RUs and IUA) Delineation Report, i.e. report number WE/WMA7/00/CO N/CLA/0316.
Fig 1.1		The study area map should include the departmental logo and not SC&A	Yes	
Pg 3-2		Map is not visible.	Yes	The map has been removed as the quality cannot be improved as it is a screenshot.
		The approach of determining Desktop EWR report is not in line with the WRCS guidelines (vol: 1, 2, 3), (Overview and the 7-step classification procedure; and Ecological, hydrological and water quality guidelines for the 7-step classification procedure) (DWA, February 2007a and 2007b).	No	Below a quote from Vol 1 of the Classification Guidelines: *"…nodes that are not suitable for extrapolation from sites with high-confidence Reserve data; the EWR quantification for those nodes should be based on a desktop model (e.g. Hughes and Hannart, 2003)."* Note that the term *for example* is used as the classification guidelines do not prescribe which models to use. The Desktop model has however been in place and extensively used in RDM for the last 20 years and is an accepted tool.

Page / Section	Report statement	Comments	Changes made?	Author comment
Pg 2-3		REC results for the desktop biophysical nodes does not show EIS as per the guideline for setting REC.	Yes	In Table 2 Column 4 indicates that if improvement is required, then this is dictated by the EIS. The explanation (see below) has been made more explicit so as to avoid adding a column that results in duplication. The section in bold shows the addition. Column 4: Based on the EIS (DWS, 2017) and on the rules provided in this chapter, the necessity for improvement is indicated. **If improvement is required (yes) it means that the EIS is high or very high. If improvement is not required (no), the EIS is low or moderate.**
Pg 1-3		The Map (Desktop biophysical nodes in Mzimvubu catchment T3) should include location of IUA not only RU.	Yes	The map has been updated.

Page / Section	Report statement	Comments	Changes made?	Author comment
		The report does not provide information on the development of the rule curves, summary tables and modified time series at each hydro node for use in the Water Resources Yield Model during the scenario analysis.	No	This comment is not clear. The model provides the rule curves and time series at each node, which is the standard output of the model and the standard input in the yield model. This output is the result of populating the model with the correct hydrological and ecological information. The workings of this model is described in various papers and Water Research Commission reports and as with all other models used in DWS applications, the intricacies of the model design is not explained in a report. There is no development of curves as it is built into the model. All this information is provided electronically and it is referred to as such in the document: The desktop EWR results are also provided in the following formats as text files named according to the nodes: ▪ Time series of average monthly total (i.e. low plus high flows) EWR flow requirements (in 10^6 m^3) for the period 1920 to 2004. ▪ Assurance rules for EWR total flows (in 10^6 m^3 and m^3/s); and naturalised and PD flow-duration tables are also included in the .rul text files. An example of an EWR flow-assurance file, generated by the VBA script, is illustrated in Table 3.2.