DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE UPPER VAAL WATER MANAGEMENT AREA (WMA8)

WP10533

RESOURCE UNIT PRIORITISATION REPORT

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Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8) - WP10533

Resource Unit Prioritisation Report

Executive Summary

The Resource Quality Objectives (RQOs) determination procedures for the Upper Vaal Water Management Area (WMA) involved the application of the seven step framework established by the Department of Water Affairs in 2011 (DWA, 2011). Although the procedures involve defining the resource, setting a vision, determination of RQOs and Numerical Limits (NLs), gazetting this and then moving to implementation, monitoring and review before starting the process all over again, some of these steps were achieved in the Water Resource Classification (WRC) Study and not repeated in this study. The procedural steps established for this case study to determine RQOs for rivers, groundwater, dams and wetland resources in the WMA include:

- Step 1. Delineate the Integrated Units of Analyses (IUAs) and Resource Units (RUs).
- Step 2. Establish a vision for the catchment and key elements for the IUAs.
- Step 3. Prioritise and select RUs and ecosystems for RQO determination.
- Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change.
- Step 5. Develop draft RQOs and NLs.
- Step 6. Agree Resource Units, RQOs and Numerical Limits with stakeholders.
- Step 7. Finalise and Gazette RQOs.

Components of steps 1 and 2 were available from the WRC study to which this RQO determination process was aligned. This report documents the prioritisation and selection of RUs and ecosystems for RQO determination in the Upper Vaal WMA (Step 3).

The prioritisation process resulted in the selection of the number of resources as indicated in Table 1, for each IUA, for which sub-components and indicators would be selected in Step 4:

Table 1: Summary of results of the prioritisation process for the Upper Vaal WMA

IUA	Rivers	Wetlands	Dams	Groundwater
Total	27	20	18	
UA	2	4	2	
UB	3	2	1	
UC1	1	5	1	
UC2	3	1	4	
UC3	1			
UD	2	0	3	
UE	3			30
UG	1			
UH	1	0	1	
UI	5	4		
UJ	1			
UK	1	1		
UL	2	3	4	
UM	1		2	

Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8) - WP10533

Inception Report

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ABBREVIATIONS

Acronym	Meaning
Al	Aluminium
As	Arsenic
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
Chl-a	Chlorophyll a
Cl	Chlorine
Cr(VI)	Hexavalent chromium
Cu	Copper
DOC	Dissolved organic carbon
DRM	Desktop Reserve Model
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
F	Fluorine
FEPA	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
GIS	Geographical Information Science
Hg	Mercury
□g/l	Micrograms per litre
IBA	Important Bird Areas
IRHI	Index of Reservoir Habitat Impairment
IUA	Integrated Unit of Analysis
IWRM	Integrated Water Resource Management
IWRMP	Integrated Water Resources Management Plan
KNP	Kruger National Park
m^3/s	Cubic meters per meter (cumecs)
MAR	Mean Annual Runoff
MC	Management Class
mg/l	Milligrams per litre
MIRAI	Macroinvertebrate Response Assessment Index
Mn	Manganese
NFEPA	National Freshwater Ecosystem Priority Areas
NL	Numerical Limit
NO_2	Nitrite
NO_3	Nitrate
NTU	Turbidity
NWA	National Water Act
NWRS	National Water Resource Strategy

O_2	Oxygen
Pb	Lead
PES	Present Ecological State
pH	power of hydrogen
PO_4	Phosphate
RDM	Resource Directed Measures
REC	Recommended Ecological Category
REC	Recommended ecological category
RHAM	Rapid Habitat Assessment Method
RHP	River Health Programme
RO	Regional Office
RQOs	Resource Quality Objectives
RR	Reporting rates
RU / RUs	Resource Unit/s
RUET	Resource Unit Evaluation Tool
RUPT	Resource Unit Prioritisation Tool
SASS5	South African Scoring System version 5
Se	Selenium
SPI	Specific Pollution sensitivity Index
TDS	Total Dissolved Solids
TIN	Total Inorganic Nitrogen
TPC	Threshold of Probable Concern
VEGRAI	Vegetation Response Assessment Index
VMAR	Virgin Mean Annual Runoff
WE	Water Ecosystems
WMA	Water Management Area
WRC	Water Resource Classification
WWTW	Waste Water Treatment Works
Zn	Zinc

DEFINITION OF PROJECT SPECIFIC ACRONYMS:

EWR – Ecological Water Requirements is synonymous with the ecological component of the Reserve as defined in the Water Act (1998).

IUA – Integrated Unit of Analysis or spatial units that will be defined as significant resources (as prescribed by the NWA).They are finer-scale units aligned to watershed boundaries, in which socio-economic activities are likely to be similar.

MC – The Management Class is set by the WRC and describes the degree of alteration that resources may be subjected to.

REC – Recommended Ecological Category – this is a recommendation purely from the ecological perspective designed to meet a possible future state.

RU – Resource Unit is a stretch of river that is sufficiently ecologically distinct to warrant its own specification of Ecological Water Requirements

WRC – Water Resources Classification is a procedure required by the Water Act 1998 that produces a MC per IUA for all water resources.

Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8) - WP10533

Resource Unit Prioritisation Report

1 INTRODUCTION

The rationale for requiring RQOs, their components, their applicability and implementation procedures emanate from the National Water Act of South Africa (NWA, 1998). The Water Act (1998) requires that all water resources are protected in order to secure their future and sustainable use. It lays out a plan where each significant water resources (surface water, wetlands, groundwater and estuaries) are classified according to a WRC System. In the process, the Reserve is also determined for the water resource, i.e. the amount of water, and the quality of water, that is required to sustain both the ecosystem and provide for basic human needs. This Reserve then contributes to the Classification of the resource. This classification results in a Management Class and associated RQOs for water resources, which then gives direction for future management activities in the WMA. According to the Water Act (NWA, 1998), the purpose of RQOs are to establish clear goals relating to the quality of the relevant water resources and stipulates that in determining RQOs a balance must be sought between the need to protect and sustain water resources and the need to use them (sensu DWA, 2011). Thus the "working part" of the Classification of water resources, is the RQOs that are produced. These are numerical and narrative descriptors of conditions that need to be met in order to achieve the required management scenario as provided during the resource classification. Such descriptors relate to the:

(a) quantity, pattern, timing, water level and assurance of instream flow
(b) water quality including the physical, chemical, and biological characteristics of the water
(c) character and condition of the instream and riparian habitat; and
(d) characteristics, condition and distribution of the aquatic biota (DWA, 2011).

This section of the RQO determination procedure includes the prioritisation and selection of RUs and ecosystems RQO determination in the Upper Vaal WMA (Step 3; DWA, 2011). The Water Resource Classification System proposes that RQOs are set for each RU. In reality however, this may not be practical as there may be a large number of RUs within a selected catchment. A rationalisation process is necessary to prioritise and select the most useful RUs for RQO determination. The objective of Step 3 is therefore to prioritise and select preliminary RUs which will then be discussed and agreed with stakeholders during Step 6.

2 SCOPE OF THE STUDY

The study entails the determination of Resource Quality Objectives (RQOs) for all significant water resources (rivers, wetlands, dams (or lakes) and groundwater ecosystems) in the Upper Vaal Water Management Area (WMA). The RQO determination procedure established by DWA (2011) has been implemented to determine RQOs in this case study. The RQO determination procedure is based on a seven step framework including (DWA, 2011; Figure 1):

- Step 1. Delineate the Integrated Units of Analysis (IUAs) and define the Resource Units (RUs)
- Step 2. Establish a vision for the catchment and key elements for the IUAs
- Step 3. Prioritise and select preliminary Resource Units for RQO determination
- Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change
- Step 5. Develop draft RQOs and Numerical Limits
- Step 6. Agree Resource Units, RQOs and Numerical Limits with stakeholders
- Step 7. Finalise and Gazette RQOs

In 2013 the Department of Water Affairs completed the Water Resource Classification (WRC) study for the Upper Vaal WMA which included the delineation IUAs and established a vision for the catchment and key elements for the IUAs (DWA, 2013). This resulted in the determination of Management Classes for each IUA and Recommended Ecological Categories for biophysical nodes selected to represent the riverine ecosystem in the WMA. These outcomes met the IUA delineation requirements for the study and provided the vision information, including Management Classes for the study. As such this study did not duplicate these components but rather adopted the outcomes from the WRC study (DWA, 2013). Apart from these components that were obtained from the WRC study, some developments/adaptations were made to the DWA (2011) RQO determination procedure to the groundwater, wetland and dam components of the study in particular. This report documents the approach adopted and the outcomes of the implementation of Step 3 of the RQO determination procedure (DWA, 2011).

3 METHODOLOGY

3.1 RESOURCE QUALITY OBJECTIVES METHODOLOGY OVERVIEW

The Resource Quality Objectives determination procedures established by DWA (2011) were implemented in this study. This included the implementation of the seven-step procedural framework which is repeatable and as such allows for an adaptive management cycle with additional steps (Figure 1). Overall the procedure involved defining the resource, setting a vision, determining RQOs and Numerical Limits (NLs), gazetting the RQOs and NLs and then moving to implementation, monitoring and review of these RQOs and NLs before starting the process all over again. A summary of the procedural steps established for this case study, with some adaptations that were required to include groundwater, dams and wetland resources include:

- **Step 1. Delineate the IUAs and RUs:** In this case study IUAs were obtained from the Water Resource Classification (WRC) study (DWA, 2012) and applied to all water resources considered in the study (rivers, wetlands, dams and groundwater ecosystems). Three spatial levels for resources were considered for RQO determination in this case study:
    - Regional (IUA) scale assessments were considered for rivers, wetlands and groundwater resources in the study.
    - Resource Unit scale assessments that were aligned to biophysical nodes obtained from the WRC study (DWA, 2012) were considered for river and groundwater resources alone.
    - Ecosystem scale assessments were considered for wetland and dam ecosystems/resources in the study.

  The RU delineation procedure initially involved the identification of sub-quaternary reaches of rivers in the WMA for each biophysical node obtained from the WRC study. The RU delineation process then involved amalgamating the upstream associated sub-quaternary reaches of riverine ecosystems, and their associated catchment areas. As a result, the number of RUs selected for the study was identical to and could later be aligned to the information associated with the biophysical nodes from the WRC study. The delineation procedure for ecosystem scale resource assessment involved the use of Geographical Information System (GIS) spatial ecosystem data.
- **Step 2. Establish a vision for the catchment and key elements for the IUAs:** The stakeholder requirements and their associated outcomes, which include the Management Classes for IUAs and RECs for RUs from the WRC study, were adopted as the vision for this study (DWA, 2012). No further visioning process was appropriate as this could have conflicted with the WRC process. The WRC outcomes were skewed towards river resources in the WMA which necessitated obtaining additional information for the other resources considered in the study (i.e. wetlands, dams and groundwater ecosystems). This additional information is highlighted in the applicable reports.
- **Step 3. Prioritise and select RUs and ecosystems for RQO determination:** This step involved the use of existing ecological specifications (EcoSpecs) and user specifications (UserSpecs) information from the Upper Vaal Reserve and WRC studies. This information was used to implement the RU Prioritisation Tool for rivers (DWA, 2011) and the new RU Prioritisation Tools developed for groundwater RUs as part of this study. Wetland ecosystem prioritisation involved the implementation of a new GIS based prioritisation approach developed for the study and dam ecosystem prioritisation was based on a desktop assessment of available user- and eco-spec information. During this step, RU and ecosystem prioritisation stakeholder participation workshops were carried out during which available information was discussed and amended according to available local information regarding the protection and use requirements for the WMA. During these RU and ecosystem prioritisation stakeholder workshops, consensus was reached to select the final lists of prioritised RUs and ecosystems for the RQO determination process.
- **Step 4. Prioritise sub-components for RQO determination, select indicators for monitoring and propose the direction of change:** This step included the hosting of a range of specialist workshops for rivers, dams, wetlands and groundwater resources where RU Evaluation Tools were used to select sub-components for RQO determination, select indicators and propose the direction of change. The RU Evaluation Tools used for wetlands, dams and groundwater were developed for the study. This information was then used to develop draft RQOs and Numerical Limits in the next step. The relevant activities of this step were:

4.1 Identify and assess the impact of current and anticipated future use on water resource components
4.2 Identify requirements of important user groups
4.3 Selection of sub-components for RQO determination
4.4 Establish the desired direction of change for selected sub-components
4.5 Complete the information sheet for the Resource Unit Evaluation Tool

- **Step 5. Develop draft RQOs and Numerical Limits**: This step was based on the outcomes of the RU and ecosystem prioritisation step (Step 4). From the outcomes of the RU and ecosystem prioritisation step, draft RQOs were established and provided to recognised specialists to establish NLs that were generally quantitative descriptors of the different components of the resource (such as the water quantity, quality, habitat and biota). These descriptors were designed to give a quantitative measures of the RQOs (DWA, 2011). Although the NLs may have had some uncertainty associated with them and were not originally intended for gazetting (DWA, 2011), they were considered for gazetting in the study at the request of the Department of Water and Sanitation (DWS) Chief Directorate: Legal Services. Refer to the RQO and NL reports for more information (REF). The relevant activities of this step were:
    5.1 Carry over sub-component and indicator information from the Resource Unit Evaluation Tool
    5.2 Extract available data to determine the present state for selected sub-components and indicators
    5.3 Assess the suitability of the data
    5.4 Where necessary, collect data to determine the Present State for selected indicators
    5.5 Determine the level at which to set RQOs
    5.6 Set appropriate draft RQOs
    5.7 Set appropriate draft Numerical Limits in line with the draft RQO
    5.8 Determine confidence in the RQOs and process
- **Step 6. Agree on Resource Units, RQOs and Numerical Limits with stakeholders:** This component included the consideration of RQO and NL outcomes with stakeholders prior to the initiation of the gazetting process. The relevant activities of this step were:
    6.1 Notify stakeholders and plan the workshop
    6.2 Present and refine the Resource Unit selection with stakeholders
    6.3 Present the sub-components and indicators selected for the RQO determination
    6.4 Present the proposed direction of change and associated rationale
    6.5 Present and revise RQOs and Numerical Limits
- **Step 7. Finalise and Gazette RQOs:** This component of the RQO determination process is still to be carried out. A Legal Notice was developed as a part of this study for submission to Chief Directorate: Legal Services of the DWS for gazetting.

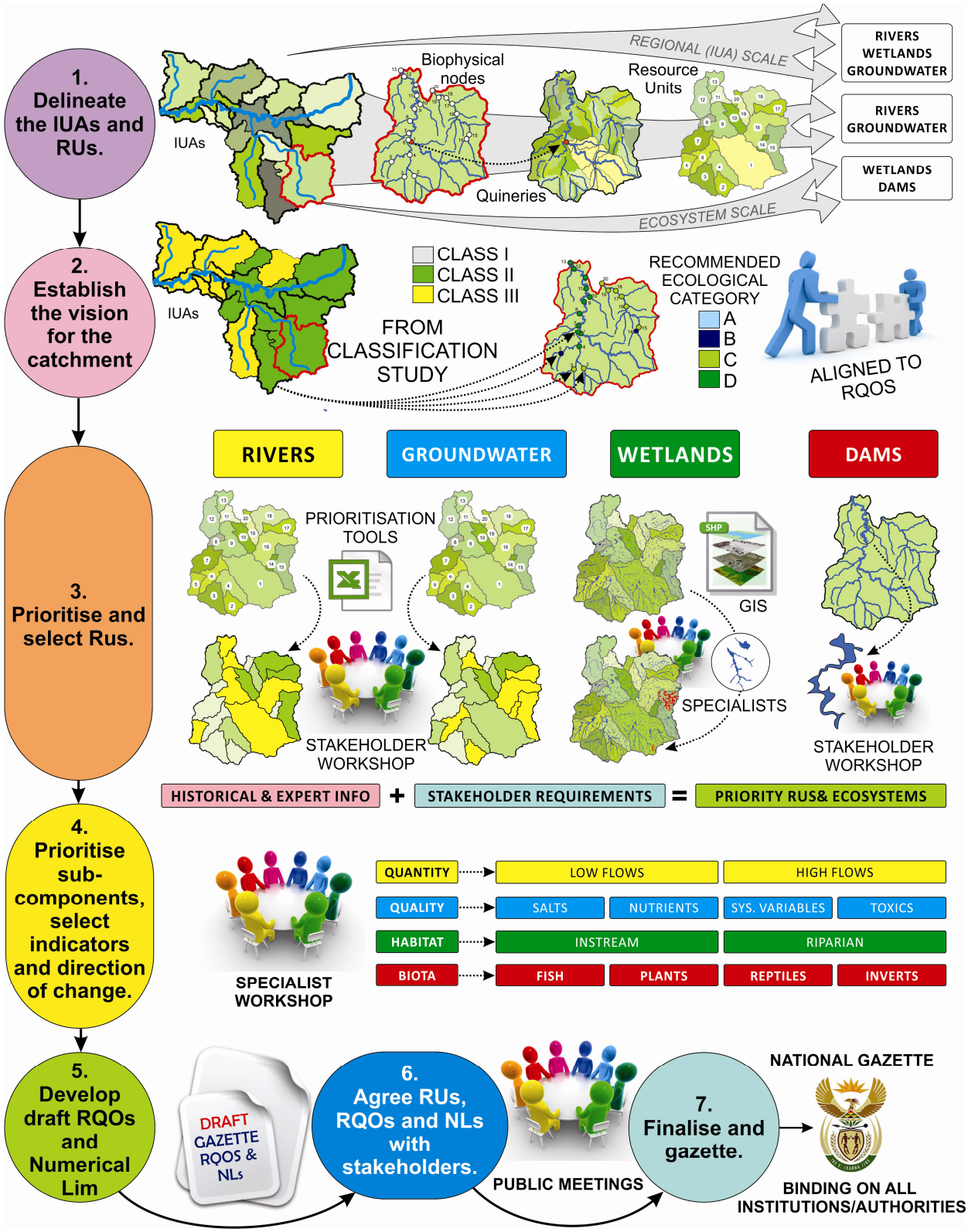


Figure 1: Schematic summary of the RQO determination procedure (adapted from DWA, 2011) which was implemented in this study.

3.2 RESOURCE UNIT PRIORITISATION OVERVIEW AND GAPS

The Water Resource Classification System proposes that RQOs are set for each RU. In reality however, this is not practical as there are a large number of RUs within the WMA and it would be expensive to set RQOs to monitor them all. A rationalisation process is therefore necessary to prioritise and select the most useful RUs for RQO determination. The objective of Step 3 was therefore to prioritise and select preliminary RUs which were discussed and agreed with stakeholders. Different approaches were used to prioritise the river, wetland, groundwater and dam resources within the Upper Vaal WMA. Each of these respective approaches is discussed below.

3.3 STAKEHOLDER WORKSHOPS

A stakeholder engagement workshop to contribute to the prioritisation of RUs for Rivers, Groundwater and dams in the Upper Vaal WMA study was held from 24-26 July 2013 (held from 24-26 July at Thornbirds, Johannesburg, APPENDIX I) stakeholders with local knowledge of the use and protection scenarios of the study area were invited to comment and if needed amend the desktop score .

3.4 STEP 3: RIVER RESOURCE UNIT PRIORITISATION FOR UPPER VAAL WMA

The RQO methodology provides a decision support tool, the Resource Unit Prioritisation Tool (RUPT), to guide the selection process (DWA, 2011). This tool was used to determining the relative importance of monitoring each RU in the Upper Vaal WMA as part of management operations. All of the RUs are ranked in order, from highly important to not important.

3.4.1 SCORING OF CRITERIA AND SUB-CRITERIA IN THE RUPT

The RUPT assesses a range of criteria and sub-criteria including the following:

- Position of the RU within the IUA
- Importance of each RU to users and level of threat posed to water resource quality for users
- Importance of each RU to ecological components and level of threat posed to water resource quality for the environment
- Resource Units for which management action should be prioritised
- Practical considerations associated with RQO determination for each RU

The information used to evaluate each of these criteria was gathered from a range of sources including the Water Resource Classification, Stats SA Census 2011 and the PES-EIS study. The method of data processing and scoring of each of criterion and sub-criterion is detailed in Appendix A1. The actual scores assigned to each RU for each sub-criterion are detailed in Appendix A2.

3.4.2 EVALUATION OF THE RELATIVE RANKING AND WEIGHTING OF EACH CRITERION AND SUB-CRITERION

The RUPT assigns standard ranks and relative weights to each criterion and sub-criterion. These ranks and relative weights remained unchanged for all criteria and sub-criteria with the exception of the Ecological Importance sub-criteria. The ranks and weights of these sub-criteria were adjusted as the data included in the provincial biodiversity aquatic plans incorporated the NFEPA data which had already been assessed as a separate sub-criterion. The initial and adjusted ranks and weights for each of these sub-criteria are detailed in Table 2.

Table 2: Initial and adjusted ranks and weights for the Ecological Importance sub-criteria in the RUPT

Criterion	Sub-criteria	Initial rank	Initial weight	Altered rank	Altered weight
Ecological importance	Resource units with a high or very high EIS category	3	80	3	80
	Resource units which have an A/B NEC and / or PES	2	90	2	90
	Resource units identified as National Freshwater Ecosystem Priority Areas	1	100	1	100
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	1	100	4	70

3.4.3 SELECTION OF PRELIMINARY RESOURCE UNITS FOR RQO DETERMINATION

The RUPT provides summary prioritisation scores for each RU. These integrated scores are calculated on the weighted individual scores applied to each RU. The prioritisation scores for each RU based on the desktop application of the RUPT are provided in Table 3. These scores provide an indication of which RUs should be selected for RQO determination.

Table 3: RUs and associated prioritisation scores generated through desktop application of the RUPT and presented to stakeholders. A high score represents the most important RU.

RU	Prioritisation score	RU	Prioritisation score	RU	Prioritisation score
RU 75	0.79	RU 13	0.36	RU 39	0.22
RU 65	0.71	RU 29	0.35	RU 3	0.21
RU 50	0.62	RU 53	0.35	RU 15	0.21
RU 45	0.60	RU 62	0.35	RU 10	0.20
RU 68	0.60	RU 56	0.32	RU 54	0.19
RU 73	0.59	RU 33	0.32	RU 49	0.19
RU 8	0.51	RU 41	0.32	RU 20	0.19
RU 64	0.51	RU 43	0.31	RU 24	0.19
RU 74	0.51	RU 11	0.31	RU 26	0.19
RU 63	0.50	RU 14	0.31	RU 48	0.19
RU 67	0.48	RU 18	0.31	RU 6	0.19
RU 58	0.47	RU 35	0.31	RU 61	0.19
RU 60	0.46	RU 34	0.31	RU 55	0.18
RU 71	0.46	RU 70	0.30	RU 51	0.18
RU 52	0.45	RU 59	0.29	RU 57	0.17
RU 28	0.44	RU 69	0.28	RU 17	0.17
RU 40	0.44	RU 22	0.26	RU 38	0.17
RU 72	0.43	RU 4	0.25	RU 30	0.16
RU 66	0.43	RU 2	0.22	RU 32	0.16
RU 47	0.39	RU 5	0.22	RU 42	0.16
RU 21	0.38	RU 7	0.22	RU 23	0.15
RU 36	0.38	RU 9	0.22	RU 12	0.12
RU 46	0.37	RU 19	0.22	RU 25	0.07
RU 1	0.37	RU 27	0.22	RU 16	0.04
RU 44	0.36	RU 37	0.22	RU 31	0.03

3.4.4 PRESENTATION AND revision OF RUPT AND PRIORITISED RESOURCE UNITS WITH STAKEHOLDERS

The populated RUPT and associated prioritised RUs were presented to stakeholders at a workshop on 24 - 26 July 2013. This provided an opportunity for stakeholders to interrogate the scores, ranks and weights for each of the criteria and sub-criteria.

3.4.5 AMENDMENT OF DESKTOP SCORES WITH STAKEHOLDERS

The scores for each criterion were mapped and presented in a graphical format for discussion. Each score was interrogated and where necessary amended. The amended criteria are detailed in Table 4 and the actual change in each score and the associated justification is included in Appendix A3.

Table 4: Overview of amendments by stakeholders to each criterion and sub-criterion

Criterion	Sub-criterion	Proposed amendments by stakeholders
Position of resource unit within IUA		A number of scores were adjusted as in some cases there were more than one RU at the base of the IUA.
Importance for users (Current & anticipated future use)	Resource units which provide important cultural services to society	A number of scores were adjusted based on local knowledge.
	Resource units which are important in supporting livelihoods of significant vulnerable communities	These scores were not altered during the stakeholder workshop
	Resource units which are important in meeting strategic requirements and international obligations	Scores for three RUs were adjusted to account for the Ramsar and world heritage site status.
	Resource units that provide supporting and regulating services	A number of scores were adjusted based on local knowledge.
	Resource units most important in supporting activities contributing to the economy (GDP & job creation) in the catchment (e.g. commercial agriculture, industrial abstractions and bulk abstractions by water authorities)	A number of scores were adjusted based on local knowledge.
Threat posed to users	Level of threat posed to users	A number of scores were adjusted based on local knowledge.
Ecological Importance	Resource units with a high or very high EIS category	Scores for five RUs were adjusted based on local knowledge.
	Resource units which have an A/B NEC and / or PES	Scores for three RUs were increased based on local knowledge.
	Resource units identified as National Freshwater Ecosystem Priority Areas	These scores were not altered during the stakeholder workshop.
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	During the stakeholder engagement workshop, local knowledge facilitated the identification of additional areas that were being protected. This new data was

Criterion	Sub-criterion	Proposed amendments by stakeholders
		incorporated into the amended RU Prioritisation Tool.
Threat faced by ecological component of the RU	Level of threat posed to ecological components of the resource unit	A number of scores were adjusted by stakeholders.
Management Considerations	Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)	The scores for some RUs were altered based on information from the PES-EIS study.
Practical Considerations	Availability of EWR site data or other monitoring data (RHP, DWAF gauging weirs etc.) located within reach?	Some scores were adjusted as some additional water quality monitoring is being undertaken in some RUs (e.g. by Rand Water)
	Accessibility of resource unit for monitoring	These scores were not altered during the stakeholder workshop.
	Safety risk associated with monitoring resource units.	These scores were not altered during the stakeholder workshop.

3.4.6 ADJUSTMENT OF RELATIVE RANKINGS AND WEIGHTINGS OF CRITERIA AND SUB-CRITERIA WITH STAKEHOLDERS

Workshop participants also evaluated the relative ranks and weights allocated to each of the criteria and sub-criteria. No changes were made to the standard ranks and weights included in the RUPT.

3.4.7 SELECTION OF FINAL PRIORITY RESOURCE UNITS

A final priority map was produced where RUs with high scores were initially prioritised on a catchment scale. Thereafter additional RUs for IUAs that did not contain any priority RUs were identified and added to the priority list. Stakeholders then reviewed this list and replaced some of the proposed priority RUs with other RUs which they felt were more important. The rationale for the selection of these RUs by stakeholders is provided in Table 5. A total of 27 RUs were prioritised for the Upper Vaal WMA (Table 5). These comprised 21 Resource Units which had the highest scores in the tool as well as an additional six which stakeholders felt were important.

Table 5: Rationale for selection of priority River Resource Units

RU	Score from tool	Reason for selection by stakeholders	Selected based on score from RUPT or by stakeholders?
RU 75	0.89	N/A	RUPT
RU 73	0.72		
RU 65	0.71		
RU 66	0.7		
RU 45	0.68		
RU 50	0.62		
RU 8	0.59		
RU 58	0.58		
RU 68	0.54		
RU 60	0.53		

RU 35	0.52		
RU 47	0.51		
RU 62	0.51		
RU 64	0.51	*These RUs were removed during the sub-component phase with stakeholder approval during the public meeting phase and were not ultimately selected for RQO determination.*	
RU 46	0.5		
RU 63	0.5		
RU 10	0.49	N/A	
RU 43	0.48		
RU 67	0.48		
RU 40	0.47		
RU 71	0.46		
RU 34	0.44	This RU is positioned in the upper Wilge River Catchment (IUA UC2) below the Sterkfontien Dam. This RU was initially prioritised during the Prioritisation workshop by stakeholders to regulate the effects of the dam on the river ecosystems in the study are. *This RU was later removed during the sub-component phase with stakeholder approval during the public meeting phase and was not ultimately selected from RQO determination.*	Stakeholders
RU 36	0.38	This RU is positioned in the Rus se Spruit in the Wilge River Catchment (IUA UC2) and was initially prioritised during the Prioritisation workshop by stakeholders to address the EcoSpecs within the RU. *This RU was later removed during the sub-component phase with stakeholder approval during the public meeting phase and was not ultimately selected from RQO determination.*	
RU 26	0.38	This RU is located on the Dwaalspruit in IUA UC1 within the Wilge Catchment. This RU was prioritised to ensure the use of the river in the upper Wilge River catchment was regulated to address the important EcoSpecs primarily and some UserSpecs.	
RU 14	0.32	These RUs were both selected for RQO determination within the upper Klip River catchment (IUA UB) to ensure that the important EcoSpecs from the area were managed.	
RU 13	0.32		
RU 21	0.32	This RU which is located in the lower Klip River (IUA UB) and was prioritised for RQO determination to ensure that the use of the riverine ecosystem in the Klip River RU is regulated.	

RU 22	NA	This RU was included for RQO determination during the sub-component phase with stakeholder approval during the public meeting phase to regulate riverine ecosystem use in IUA UC1 based on important EcoSpecs in the upper reaches of the of the Wilge River and its tributaries in the RU.	
RU 52	NA	This RU was included for RQO determination during the sub-component phase with stakeholder approval during the public meeting phase to allow riverine ecosystem use in IUA UF to be regulated due to existing EcoSpecs and UserSpecs requirements.	

3.5 WETLAND ECOSYSTEM PRIORITISATION FOR THE UPPER VAAL WMA

Selection of wetland ecosystems is important as monitoring of these wetlands over the long-terms is intended to provide an indication as to how well wetlands in the catchment are being managed and how they are responding to water resource management at both a catchment and IUA level[1]. A three-pronged approach was used to help prioritize wetland ecosystems for RQO determination in the Upper Vaal catchment, which included:

- A desktop based prioritization process aimed at flagging priorities based on available spatial datasets;
- A comparison of the desktop findings with the findings from a wetland prioritization undertaken for the comprehensive reserve determination study of the integrated Vaal River System (DWA, 2010). This report identified possible priority wetlands within the Upper Vaal catchment according to broad conservation importance, social importance, and/or threats from proposed developments; and
- Engagement with key stakeholders to identify potential priority wetlands based on local knowledge of the study area. The final set of wetlands selected was then reviewed and finalised with stakeholders as part of Step 6 of the RQO process.

While prioritizing individual wetland ecosystems for RQO determination is regarded as useful, it is important to note that wetlands are highly variable systems and are not linearly connected in the same manner that rivers are. As such monitoring of a sub-set of wetlands is likely to provide very little information on how other wetlands within the catchment are responding to site and catchment-level activities. As such, a decision was taken to also set regional-scale RQOs which are designed to provide general resource quality objectives for all wetlands in the Upper Vaal catchment. This also allows for monitoring to be undertaken at a broader level which can be used to obtain a more holistic picture of wetland management. The approach and process followed in setting regional-scale RQOs is outlined in the RQO Subcomponent and subsequent reports.

The approach developed to prioritize wetlands for RQO determination in the Upper Vaal catchment, included:

- Developing a consolidated wetland map for the catchment;
- Consolidation and formatting of datasets to inform wetland prioritization;
- Developing a structured hierarchy and assigning weightings to input datasets; and
- Undertaking a formal GIS analysis to integrate information into desktop wetland prioritization layers for ‘users’ and ‘protection’ purposes.

[1] Bredin *et al*., in prep. Upper Vaal case study: selecting wetland ecosystems for long-term monitoring to provide an indication as to how well wetlands in the catchment are being managed and how they are responding to water resource management at both a catchment and IUA level.

3.5.1 DEVELOPMENT OF A CONSOLIDATED WETLAND MAP

The National Freshwater Ecosystem Priority Areas (NFEPA) wetland coverage, which included WETFEPA and FEPA cluster layers (Figure 2), was used as the primary basis for delineating wetlands RUs in the catchment. This wetland coverage comprises both mapped and modelled wetlands, and is thus only a broad indicator of wetland distribution throughout the catchment.

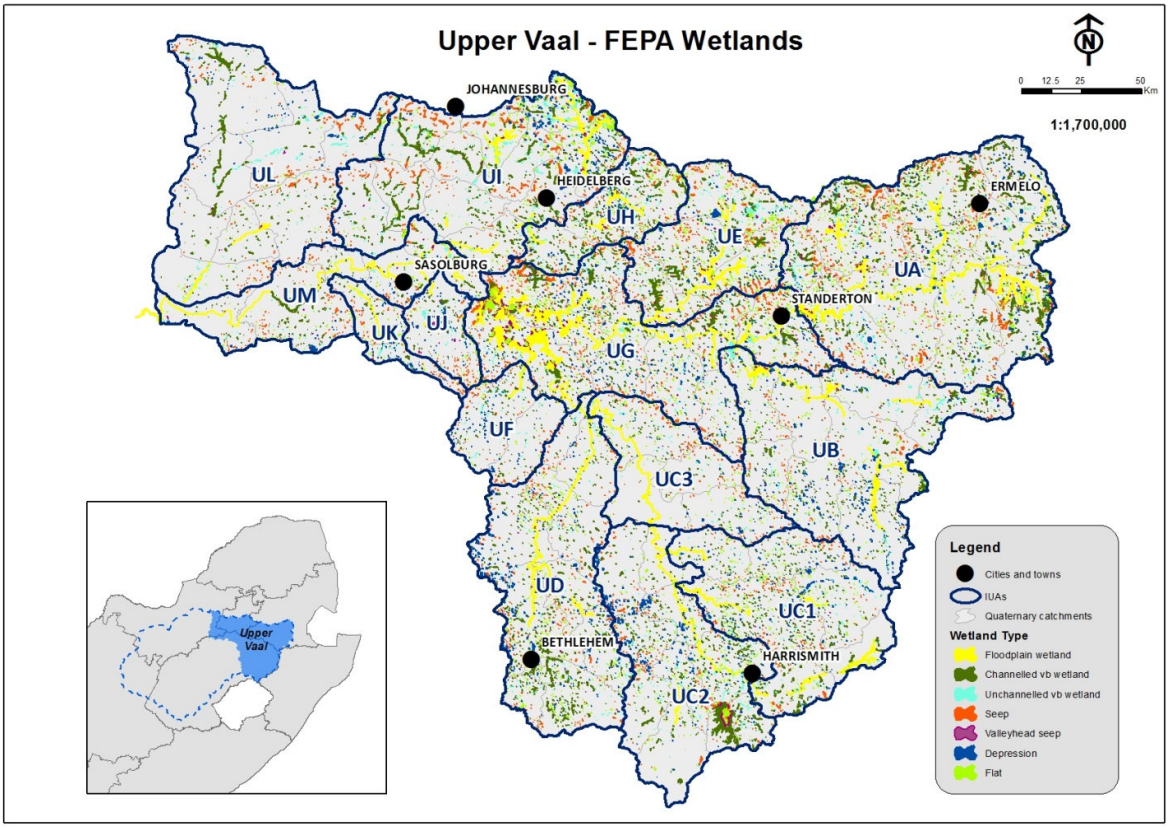


Figure 2: FEPA wetland types throughout the Upper Vaal catchment

3.5.2 CONSOLIDATION AND FORMATTING OF DATASETS

Prior to undertaking the prioritization process, it was important to collate available spatial datasets for wetlands in the focus area. The selection of datasets was informed largely by the prioritization criteria identified in the resource unit prioritization tool (DWA, 2011). Scores (ratings) were then applied to each dataset by considering the relative importance of features identified. In order to prevent scoring biases, these scores ranged from 0-1 with scores of 1 indicating features with the highest importance. The datasets used in the prioritization process are described below.

3.5.3 IMPORTANT WETLANDS FOR USERS IN THE UPPER VAAL CATCHMENT

The importance of wetlands from a user perspective is based on the joint-consideration of the importance of wetlands in supporting user requirements and the threat posed to such resources. The rationale is therefore that those wetlands which are important and under threat should be targeted for RQO determination. The criteria used to determine each of these GIS layers is described in the following subsections. Weightings applied to each layer are provided in Appendix B. Criteria selected to prioritize wetlands from a user perspective are indicated in Figure 3

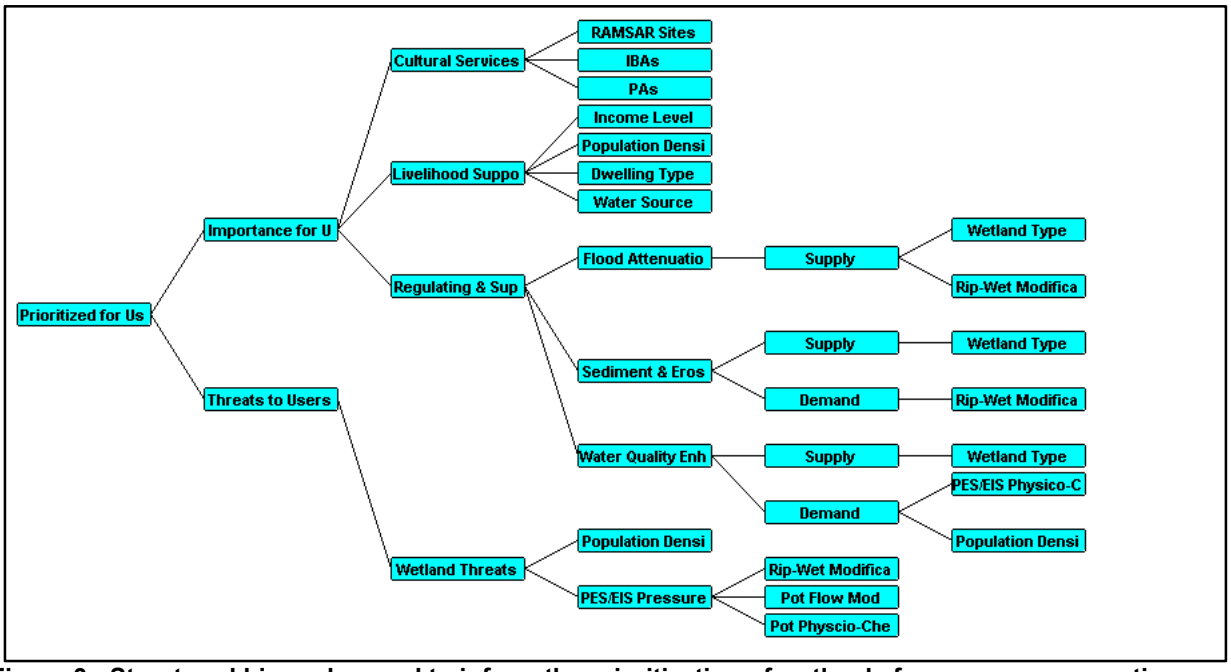


Figure 3: Structured hierarchy used to inform the prioritization of wetlands from a user perspective

Potential important wetlands from a user perspective (Figure 4) were identified through assessing wetlands that provide the following services:

- Cultural services;
- Livelihood support; and
- Regulating and supporting services.

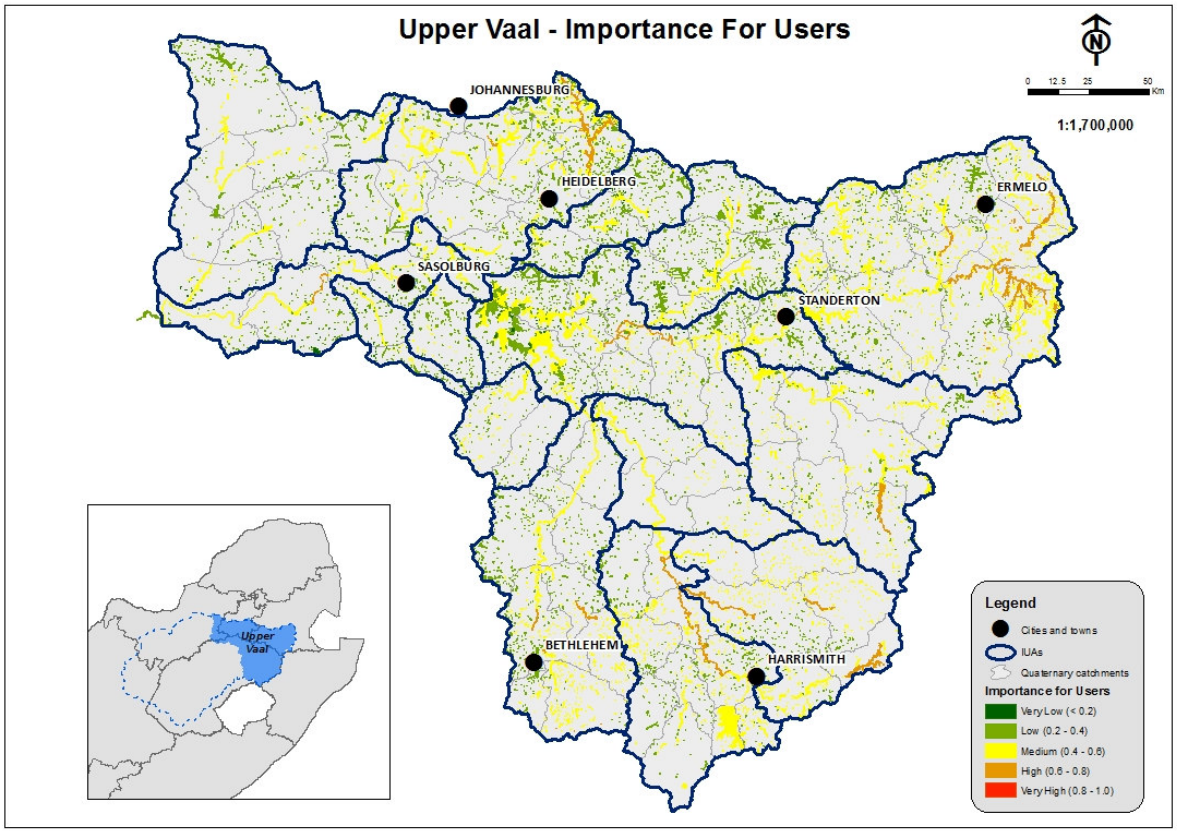


Figure 4: Important wetlands from a user perspective

3.5.3.1 Cultural services

Cultural services are less tangible than material services but are still valued by society. Examples of benefits include recreational use, tourism or scientific benefits, and aesthetic, cultural or spiritual values. Wetlands that provide these benefits should be protected as they contribute to the wellbeing of society. User groups for which this service is likely to be particularly important include subsistence users, recreation and tourism and real estate and property owners/developers. The following datasets were used to obtain an indication of the potential importance of wetlands in providing cultural services:

- **Important Bird Areas (IBA):** The purpose of the IBA Programme is to identify and protect a network of sites, at a biogeographical scale, critical for the long-term viability of naturally-occurring bird populations. Such sites are targeted for research and birding activities.
- **Ramsar sites:** Ramsar sites have been identified based on unique site attributes that emphasise their conservation value at both a National and International level.
- **Formally Protected Areas:** Formal conservation areas are also typically the focus of tourism, research and education activities. Wetlands within these areas are therefore likely to contribute towards these cultural values.

It is important to note that wetlands that are likely to be important from a cultural perspective for subsistence users were not specifically identified. Such wetlands are however likely to be linked with vulnerable communities and would therefore be covered under the livelihood support section.

The layers for the above criteria were intersected with the wetland RU layer to determine those wetlands with value from a cultural services perspective (Figure 5). The scoring and weighting applied to the criteria are provided in Appendix C.

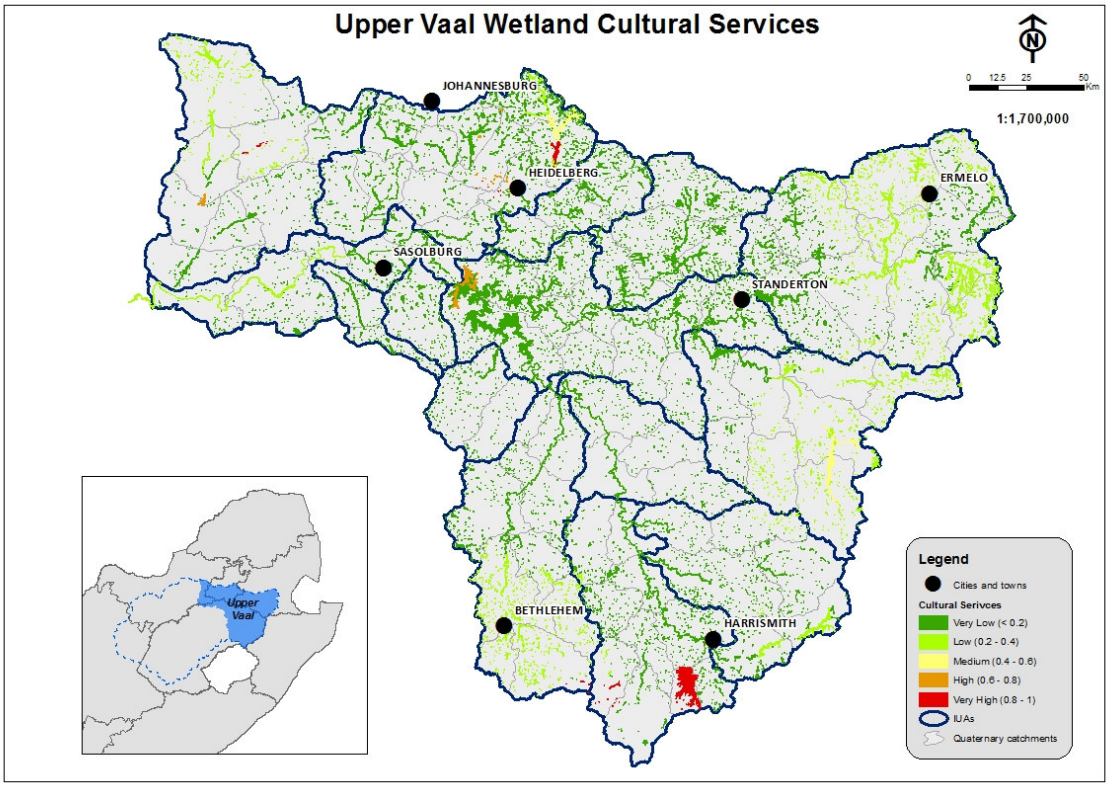


Figure 5: Wetland cultural services

3.5.3.2 Wetlands that support the livelihoods of vulnerable communities

Many poor communities are directly reliant on wetlands for domestic water use, food, grazing, medicinal plants, and building materials. Poor communities are particularly vulnerable to wetland degradation as these changes affect their livelihoods directly. The level of vulnerability determines the degree of impact caused by changes in the level of service provision. Resource units which support significant vulnerable communities should therefore be prioritised. The following Statistics South Africa Census Data was used:

- **Income level**: Income levels provide a useful indicator of areas in which reliance on natural resources (including those available from wetlands) is likely to be higher.
- **Population density:** Population density is also a useful indicator, with higher levels of reliance anticipated in areas with higher population densities.
- **Dwelling type:** Dwelling type also provides useful information and can be used to differentiate between rural communities (e.g. living in huts) and more formal housing which would suggest more affluent communities.
- **Water source:** Water source (e.g. dams/pools, rivers, springs, rainfall tanks) provides an indication of which communities are more likely to be reliant on wetlands.

The layers for the above criteria were intersected with the wetland RU layer to determine those wetlands with value from a livelihood support perspective (Figure 6). The scoring and weighting applied to the criteria are provided in Appendix C.

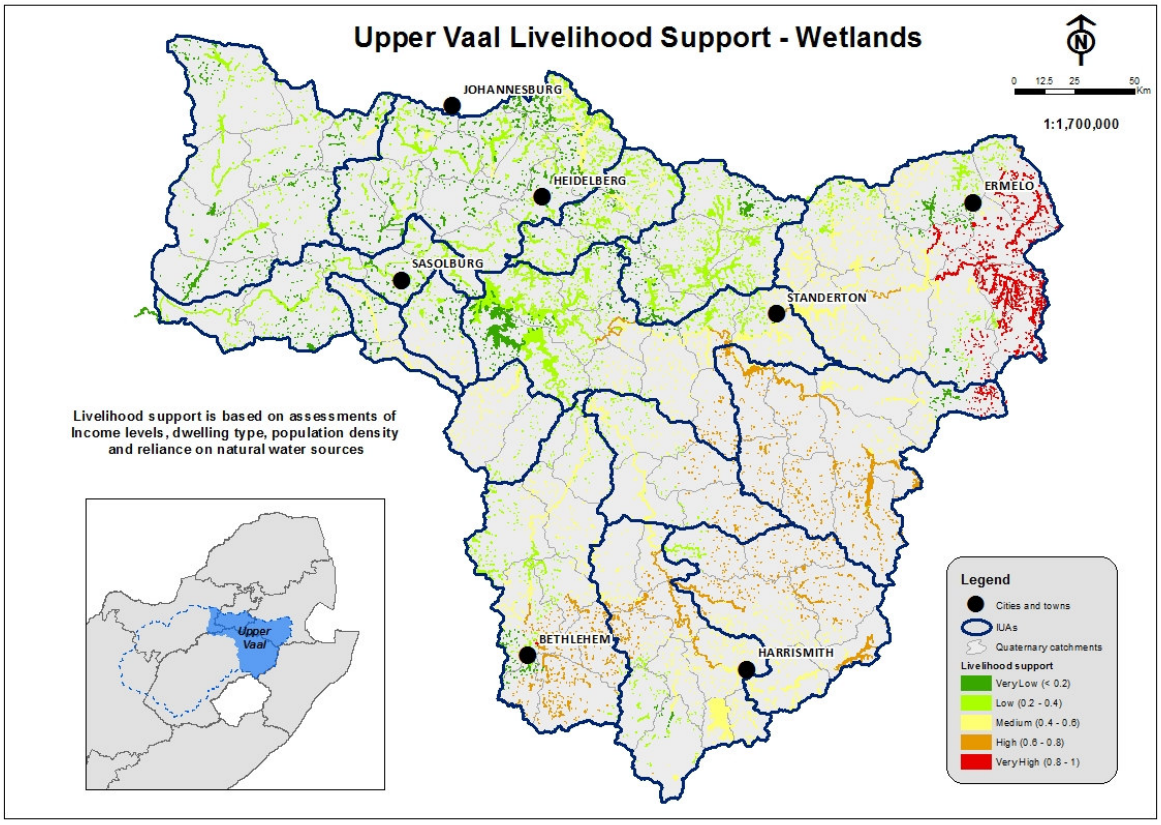


Figure 6: Livelihood support

3.5.3.3 Supporting and regulating services

Regulating and supporting services provided by wetlands include flood attenuation, stream flow regulation, sediment trapping, erosion control, water quality enhancement and carbon storage. Assessing the relative importance of wetlands in providing these services is not easily achieved at a desktop level and is influenced by the ability of the wetland to supply these services (determined by wetland attributes) and the demand for these services (determined by catchment context and surrounding landuse). An attempt has been made to rate the potential importance of wetlands in providing a sub-set of these regulating and supporting services using available GIS datasets as outlined below:

- **Flood attenuation:** Wetland type provides a broad surrogate for the ability of different wetlands to supply a flood attenuation function. Ranking of types was informed by WET-Ecoservices (Kotze *et. al.*, 2007). Riparian – wetland zone modification data from the PES/EIS project (DWA, 2012) was used as surrogate data to provide an indication of current pressures on the wetlands. It was assumed that modified wetlands will provide less of a flood attenuating function than unmodified wetlands.
- **Sediment trapping and erosion control:** Wetland type provides a broad surrogate for the ability of different wetlands to provide a sediment trapping and erosion control function. Ranking of types was informed by WET-Ecoservices (Kotze *et. al.*, 2007). PES/EIS riparian – wetland zone modification data (DWA, 2012), was used as surrogate data to indicate the possible demand for sediment trapping and erosion control services.
- **Water quality enhancement:** Wetland type provided a broad surrogate for the ability of different wetlands to supply a water quality enhancement function. Ranking of types is informed by WET-Ecoservices (Kotze *et. al.*, 2007). The following surrogate data was used to indicate the possible demand for water quality enhancement services:
    - PES/EIS potential physico-chemical modification data (DWA, 2012), which provided a useful indicator of potential water quality impacts.
    - Population density, which provided a surrogate for pressure on the environment and potential negative impacts on water quality. Water resources in catchments characterised by high population densities are therefore likely to be more impacted than those located in less populated landscapes.

The layers for the above criteria were intersected with the wetland RU layer to determine those wetlands with value from a regulating and supporting services perspective (Figure 7). The scoring and weighting applied to the criteria are provided in Appendix C.

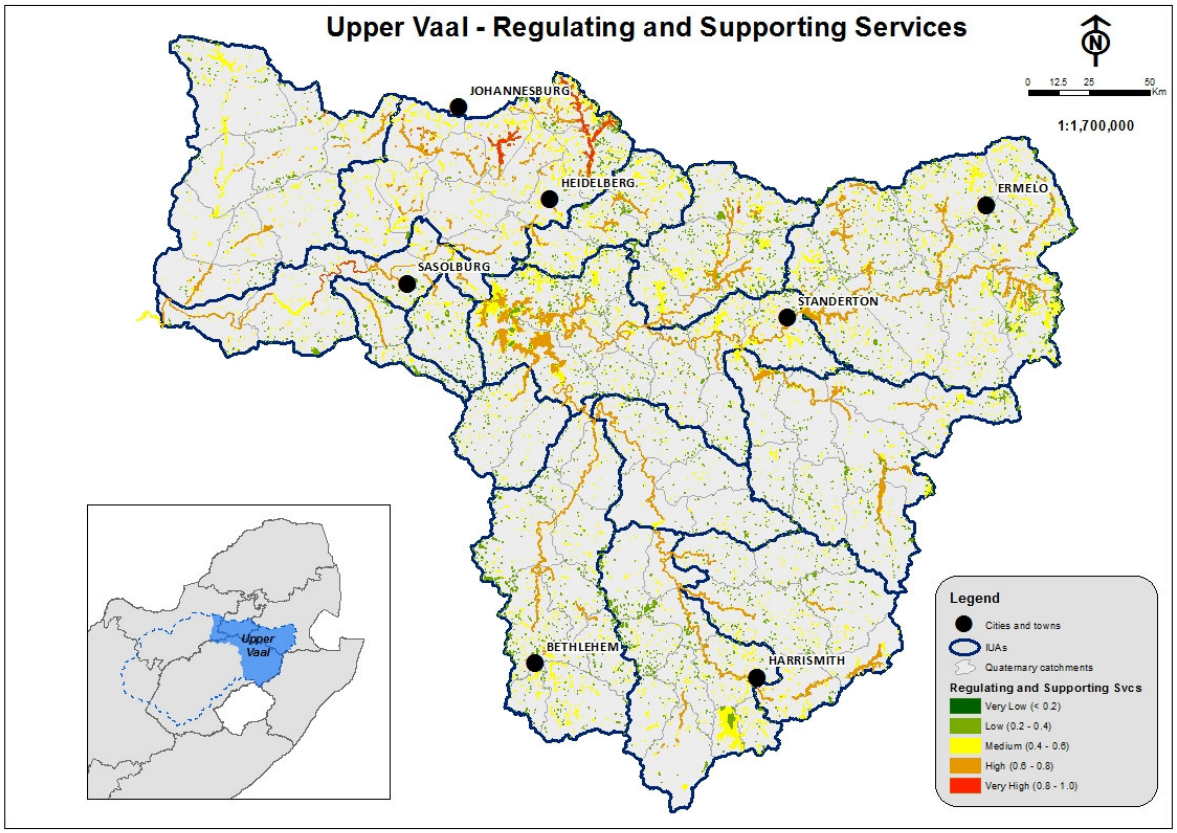


Figure 7: Regulating and supporting services

3.5.3.4 Threat to wetlands from a user perspective

Resource units which are threatened or are likely to be threatened by current or planned future activities (e.g. mines, towns, industries, dams, intensive agriculture) need to be taken into consideration for prioritizing wetlands for monitoring purposes.

The PES/EIS project (DWA 2012) provides ratings for a suite of criteria that provides an indication of current pressures on aquatic resources. The following datasets were used as surrogates to indicate likely threats to wetlands:

- Riparian – wetland zone modification;
- Potential flow modification; and
- Potential physico-chemical modifying activities.

Population density was also used as a surrogate for pressure on the environment. Wetlands in catchments characterised by high population densities were assumed to be more under threat than those located in less populated landscapes.

These threat scores will be integrated to provide a surrogate measure of threats to wetlands (Figure 8). The scoring and weighting applied to the criteria are provided in Appendix C.

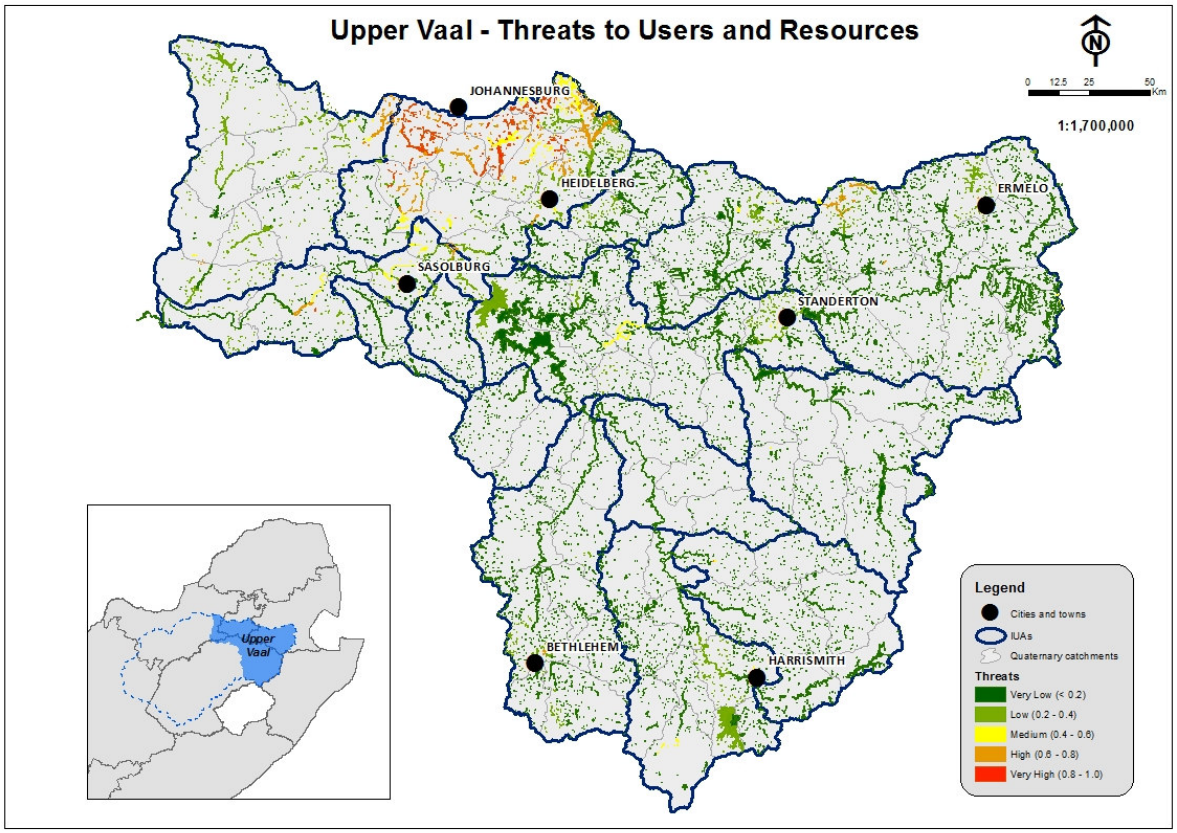


Figure 8: Threats to wetlands

3.5.4 IMPORTANT WETLANDS FOR PROTECTION IN THE UPPER VAAL CATCHMENT

The importance of wetlands from a conservation perspective is based on the joint-consideration of the ecological importance and sensitivity of wetlands and the threat posed to such resources. The rationale is therefore that those wetland that are highly important and under threat should be targeted for RQO determination above other wetland units.

Criteria selected to prioritize wetlands from a protection perspective are indicated in Figure 9 below.

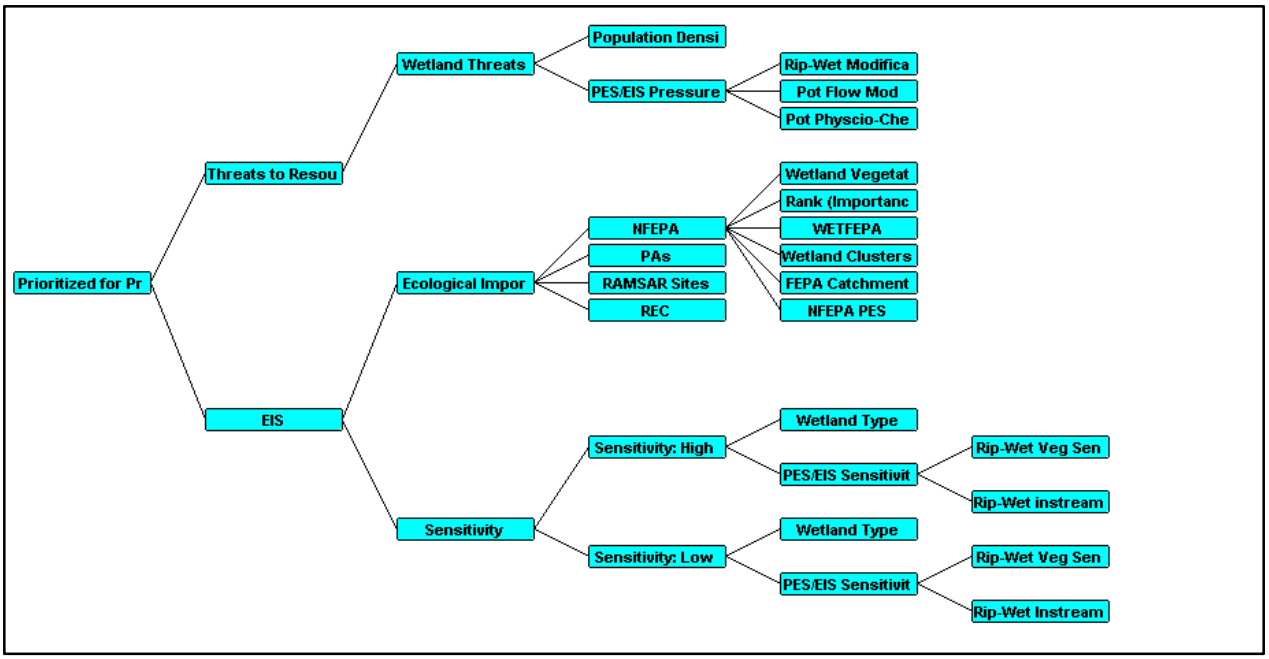


Figure 9: Structured hierarchy used to inform the prioritization of wetlands from a protection perspective

In order to help highlight wetlands that are important from an ecological perspective, the following sub-criteria were taken into consideration:

- Ecological Importance, which included:
  - Protected areas;
  - Ramsar sites;
  - National Freshwater Ecosystem Priority Areas (NFEPA); and
  - Required Ecological Category (REC).
- Ecological Sensitivity, which included:
  - High flow sensitivity; and
  - Low flow sensitivity.

Available datasets for the above criteria were used to develop a suite of GIS layers indicating the importance of wetlands from an ecological perspective. Weightings applied to each layer are provided in Appendix C.

3.5.4.1 Ecological importance and sensitivity

Wetland RUs with Ecological Importance and Sensitivity (EIS) categories of 'Medium' or higher require special attention to prevent deterioration of these resource units. These areas are considered vital for protecting important or sensitive species and maintaining aquatic biodiversity (Figure 10).

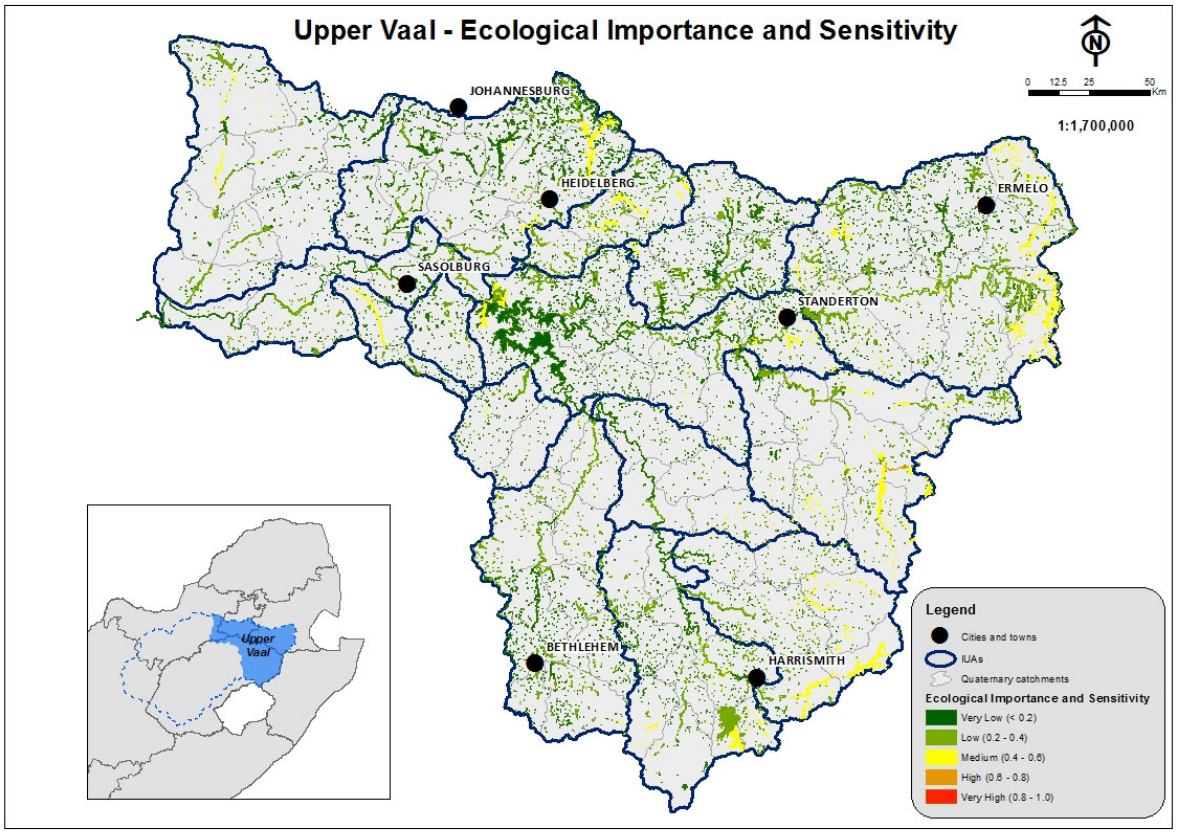


Figure 10: Wetlands ecological importance and sensitivity

An assessment of the ecological importance and sensitivity of wetlands was informed by assessing the sub-criteria ecological importance and ecological sensitivity, which are discussed below.

3.5.4.2 Ecological importance

- **Protection status of the wetland**: Wetlands falling within protected areas (including Ramsar sites) contribute towards the long-term protection of ecosystems and species.
- **Wetland FEPA datasets:** A range of important data is available from this coverage, which was used to select priority wetlands for protection. For the purposes of this assessment, the following attributes were regarded as important:
  - Rank: Wetlands were ranked (1=most important to 6=least important) in terms of their importance. This provided a useful basis for comparing the relative importance of wetlands in contributing towards biodiversity objectives.
  - WETFEPA: Priority wetlands selected to meet national wetland conservation targets.
  - Wetland clusters: Wetland clusters are groups of wetlands within 1 km of each other and embedded in a relatively natural landscape. This allows for important ecological processes such as migration of frogs and insects between wetlands.
  - FEPA Catchments: FEPAs support the biodiversity sector's input into the development of Catchment Management Strategies and into the Water Resource Classification process. This database including FEPAs, RehabFEPAs, Fish Support Areas and Upstream management areas and therefore highlights catchments where water resource management (including wetland management) is important to meet biodiversity targets.
  - Threat status of the wetland vegetation group: Threat status of wetland vegetation groups have been determined as part of the NFEPA project. The threat status of the wetland vegetation group is based on levels of transformation and protection of wetland ecosystems with similar characteristics.

Wetlands occurring within a threatened wetland vegetation group are regarded as having a greater ecological importance than those occurring within wetland vegetation groups of lower threat status.

- **Resource Units which have an A/B REC and /or PES:** Resource Units with an A/B PES or an agreed A/B REC (in the case where Water Resource Classification has been undertaken) need to be carefully managed to prevent deterioration of these reaches. This is particularly relevant given the poor state of South Africa's rivers and the need to protect aquatic biodiversity. PES was based on information available in the Wetland FEPA coverage.

The layers for the above criteria were intersected with the wetland RU layer to determine wetlands of ecological importance (Figure 11). The scoring and weighting applied to the criteria are provided in Appendix C.

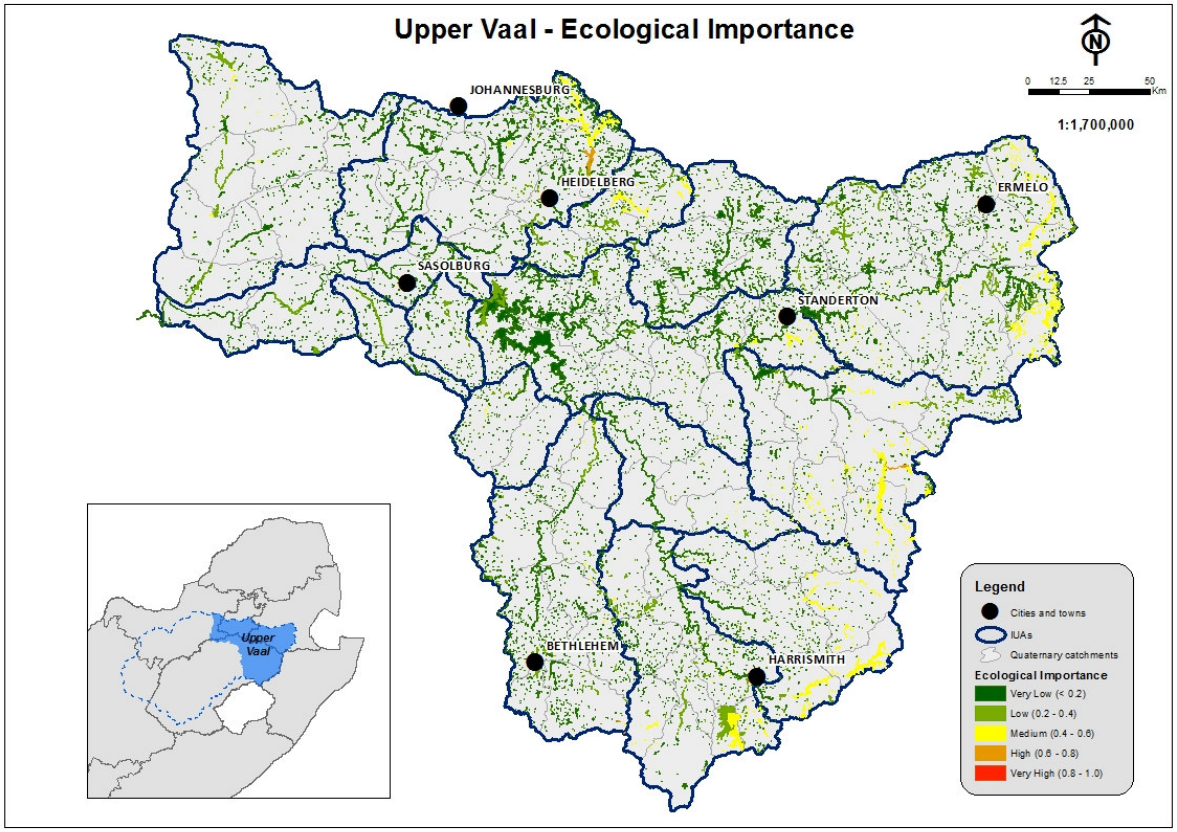


Figure 11: Wetlands of ecological importance

3.5.4.3 Ecological sensitivity

- **Sensitivity to changes in floods**: Floodplains are regarded as most sensitive, followed by valley bottoms, seeps and pans. This was therefore evaluating by linking sensitivity to wetland type information.
- **Sensitivity to changes in low flows / dry season**: Unchannelled valley bottom wetlands are regarded as most sensitive, followed by seeps and other wetland types. This was therefore evaluating by linking sensitivity to wetland type information.
- **PES/EIS Sensitivity:** Two data layers from the PES/EIS project data (DWA 2012) were used as surrogates to further establish the high and low flow sensitivity layers. These included:
  - Riparian-wetland instream vertebrates (excluding fish) intolerance to water level / flow changes; and
  - Riparian-wetland vegetation sensitivity to water level changes.

The layers for the above criteria were intersected with the wetland RU layer to determine wetlands of ecological importance (Figure 12). The scoring and weighting applied to the criteria are provided in Appendix C.

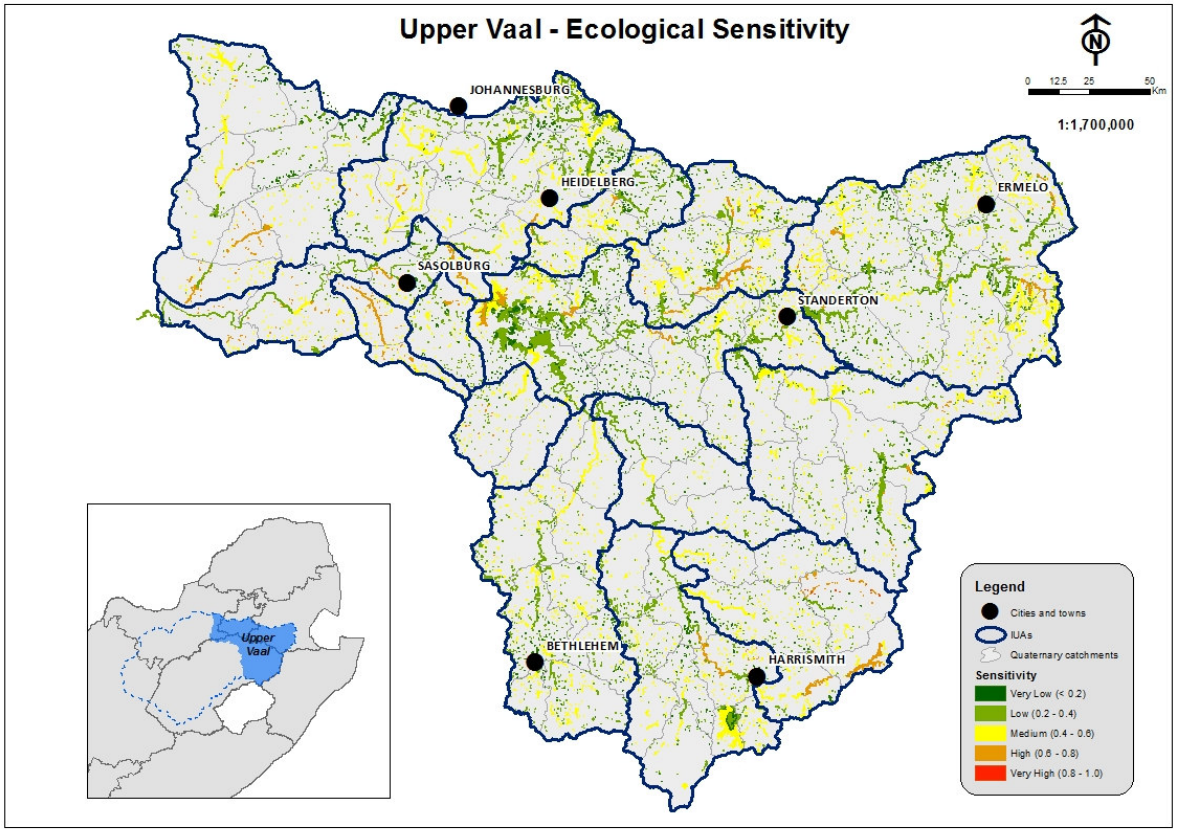


Figure 12: Wetlands of ecological sensitivity

3.5.4.4 Threats to wetlands from a protection perspective

Wetland RUs which are threatened or are likely to be threatened by current or planned future upstream activities need to be taken into consideration for the setting of RQOs, as they will require monitoring due to the potential risks. Refer to *Section 3.5.3.4* for threats to wetlands from a user perspective. These threats were also taken into consideration for the prioritization of wetlands from a protection perspective.

3.6 DAMS ECOSYSTEM PRIORITISATION FOR THE UPPER VAAL WMA

Step 4 of the RQO determination procedure uses the information that was gathered during the previous steps, especially step 3 to determine those priority areas or resource units where RQOs should be determined for the protection of the resource quality. The purpose of the development of RQOs for dams is to ensure adequate releases from the priority dams to provide the quantity and quality of water required for the protection of the aquatic ecosystems downstream of the dams.

The dams that were identified from the various sources of information (DWA database, Water Situation Assessment Model (WSAM) database, Internal Strategic Perspective (ISP) documents, reconciliation strategy documents and any other relevant studies' reports) were used and the following criteria was used to select the final priority dams:

- All dams from the DWA Hydrological Information System (HIS) database
- Additional dams identified through any other study or by stakeholders
- Other dams constructed with the specific purpose to provide water for urban and/or rural water use

- Where a dam was specifically built for irrigation water supply (mainly some of the smaller dams).

3.7 GROUNDWATER RESOURCE UNIT AND ECOSYSTEM PRIORITISATION FOR THE UPPER VAAL WMA

The framework selected for the purpose of groundwater RU prioritisation, was based on the RQO determination procedures for river RUs (DWA, 2011). The approach requires a set of criteria and sub-criteria to be weighted and rated to calculate a priority rating which is then normalised.

The set of criteria and sub-criteria that were selected for the groundwater prioritisation process was largely dictated by available datasets as well as input from the public participation process. The resultant table with the selected criteria as and the relative weights applied is shown in Table 6.

Table 6: Groundwater prioritisation criteria

Criterion	Relative weighting	Sub-criteria	Relative weighting
Importance for users (Current & anticipated future use)	30	Water character of a high quality	30
		Major aquifers	40
		Activities that contribute to economy	30
Threat posed to users	30	Aquifers which are highly stressed	40
		Water quality is currently threatened	40
		Vulnerable aquifers	20
Ecological Importance	30	Groundwater importance to wetlands	45
		Ground-surface water interactions	50
		Important groundwater fauna	5
Management Considerations	10	Management plans already exist	100

Sub-criteria can have a spatial variability across the resource unit extent, but any sub-criteria can only have one rating in the proposed prioritisation model. To address this constraint the following rule set was applied:

a) The sub-criteria category which covers the largest part of the resource unit is assigned.
b) Rule (a) can be overridden through public participation if consensus was reached among the relevant role players.

3.7.1 IMPORTANCE FOR USERS

The sections that follow discuss the sub-criteria linked to the importance for users and the rating guideline that applies to each of the sub-criteria.

3.7.1.1 Water character of high quality

All available water quality data was obtained from the NGA for each of the RU's and the water quality data for these sites were used in generating an expanded Durov diagram which utilises the major anions and cations to produce a plot that characterises water in nine different regions. The plotting procedure of the expanded Durov diagram is available in Appendix E. A water quality score was assigned (Figure 13) to each of the nine regions to assist in evaluating the status of each RU. Since a Durov diagram only gives information about the character

of the water, the EC parameter was also displayed to give an indication of the salinity of the water in question. The average values for the Upper Vaal sites are displayed in Figure 14 and were evaluated against the SANS 241:2005 drinking water guidelines.

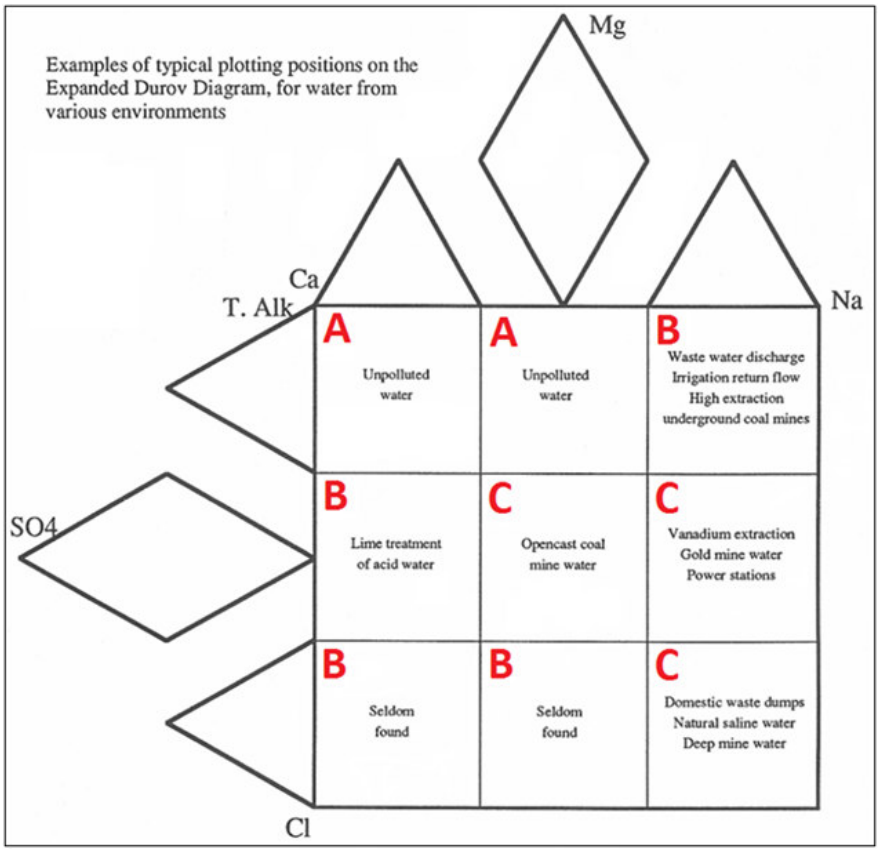


Figure 13: Class assignment of expanded Durov diagram

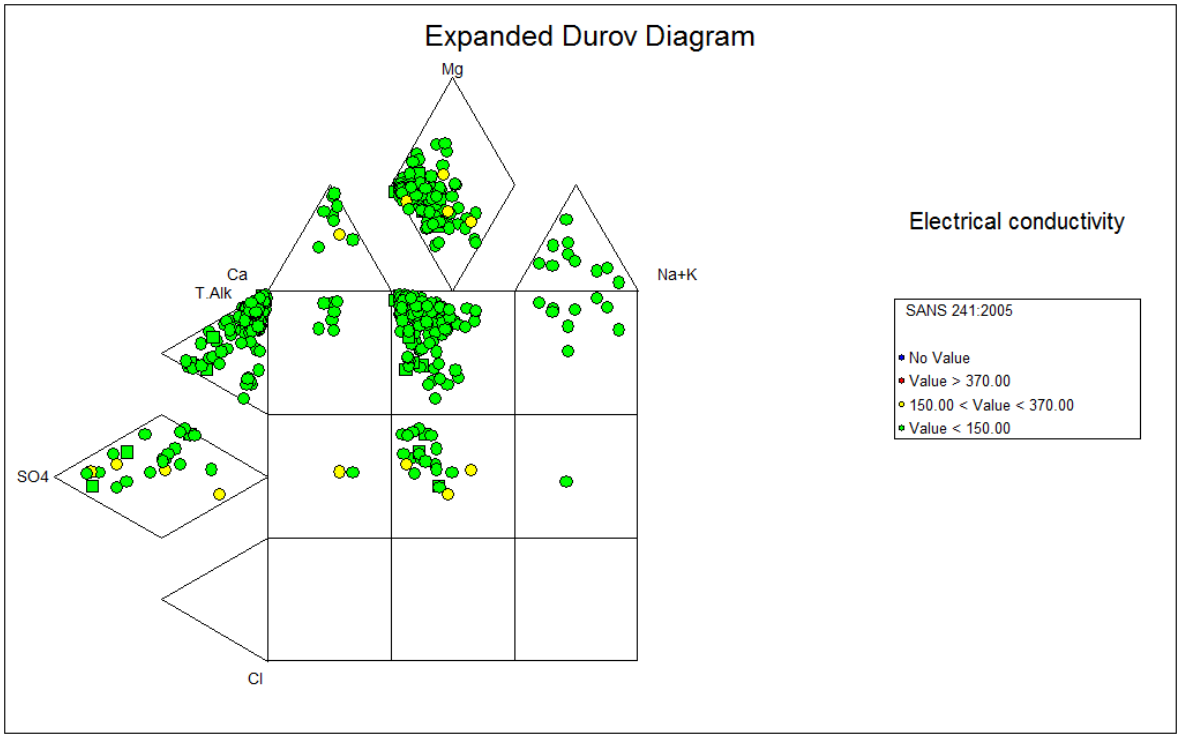


Figure 14: Expanded Durov diagram with evaluation of EC

It should be noted that the chemistry data used, span over the entire time line available in the database. Applied date filters resulted in little or no data for various areas.

The rating guideline applied to each RU for evaluating the water character is presented in Table 7 and the spatial distribution of the final ratings is shown in Figure 15.

Table 7: Water character rating guideline

Rating	Guideline
0.0	RU's which contain a C water quality score
0.5	RU's which contain a B water quality score
1.0	RU's which contain an A water quality score

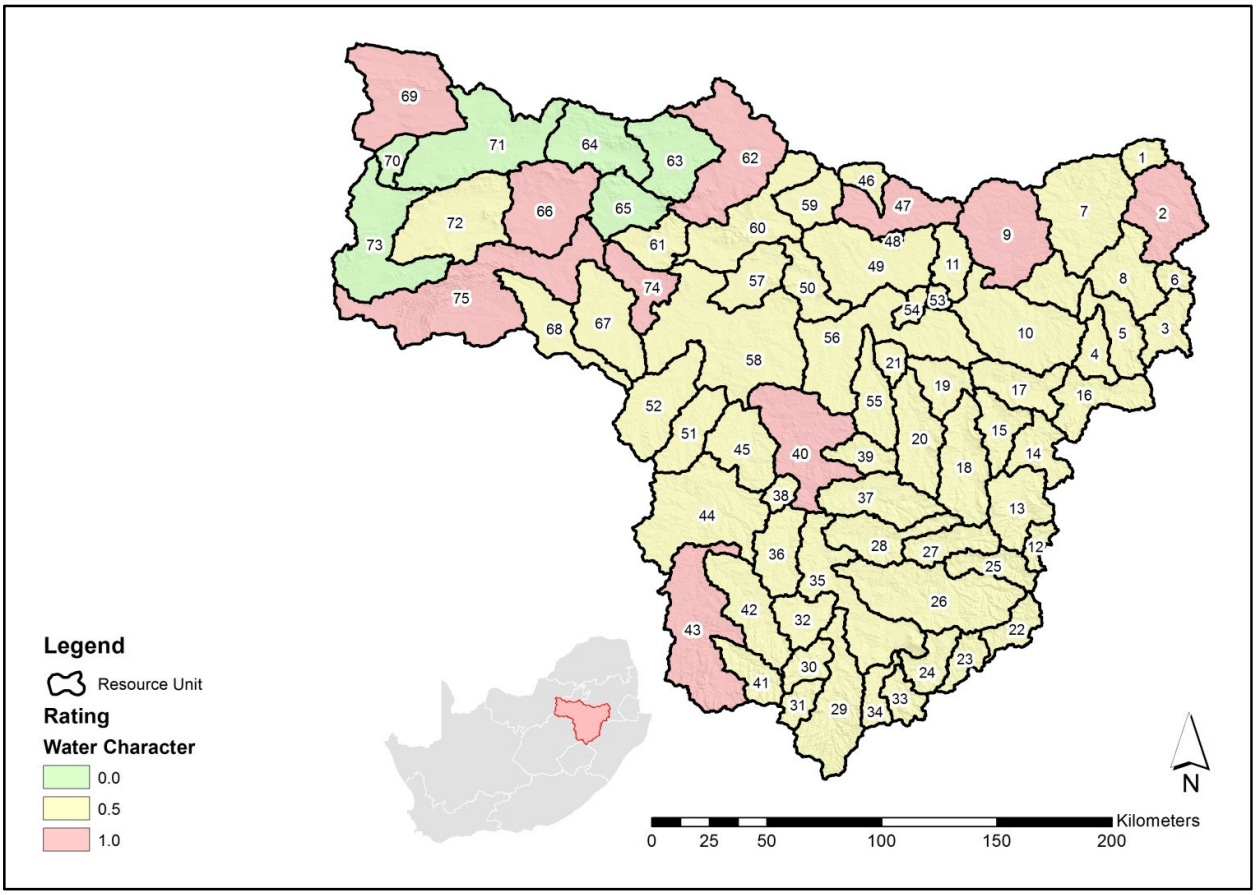


Figure 15: Spatial distribution of water character rating

3.7.1.2 Major aquifers

Groundwater occurrence was identified using the Geohydrological Yield map (DWAF, 2009) obtained from DWS. Three aquifer yield classes were defined as high, medium and low irrespective of the aquifer type as shown in Table 8. The resultant yield classification map is shown in Figure 16.

Table 8: Aquifer yield class

Aquifer Yield Class	Aquifer Yield Range
High	2.0 – 5.0 L/s
Medium	0.5 – 2.0 L/s
Low	0.0 – 0.5 L/s

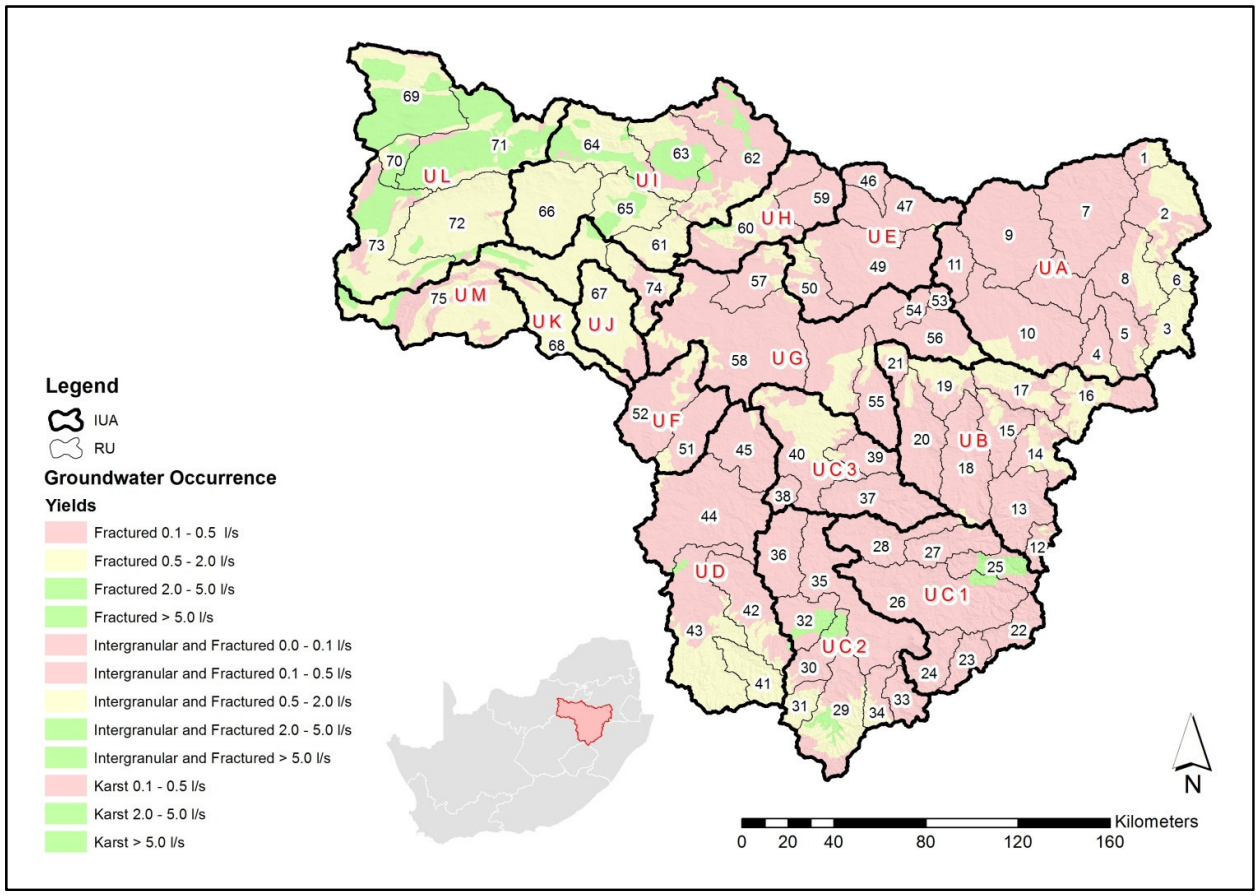


Figure 16: Major aquifer classification map

The rating guideline applied to each RU for evaluating major aquifers are presented in Table 9 and the spatial distribution of the final ratings is shown in Figure 17.

Table 9: Major aquifer rating guideline

Rating	Guideline
0.0	RU's which contain or are dominated by poor aquifers (< 0.5 L/s)
0.5	RU's which contain or are dominated by minor aquifers (0.5 - 2 L/s)
1.0	RU's which contain or are dominated by major aquifers (> 2L/s)

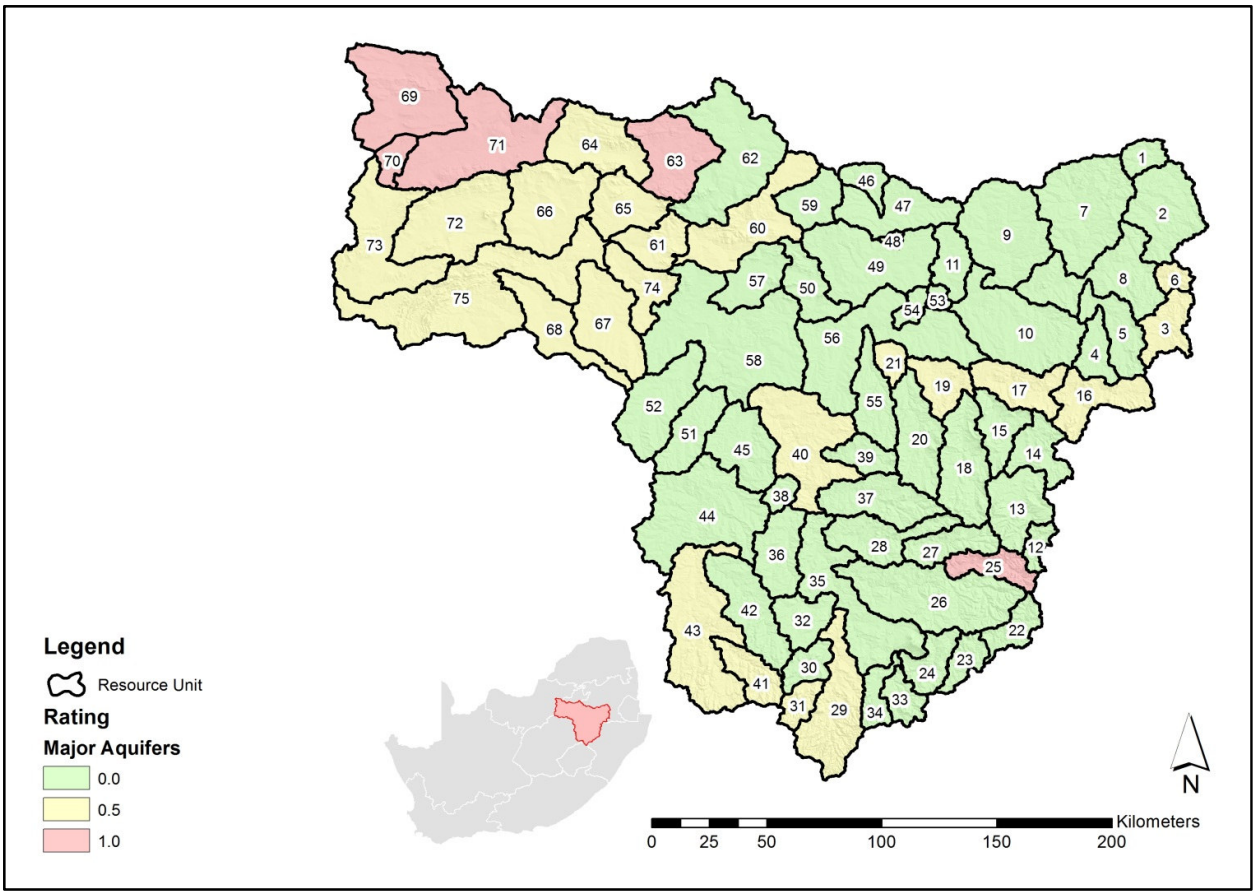


Figure 17: Spatial distribution of major aquifers rating

3.7.1.3 Activities that contribute to the economy

Activities that contribute to the economy that could be dependent on groundwater were identified as farming, parks and mines. The datasets used to depict the aforementioned activities is as follows:

- Protected Areas (DWAF Groundwater Resource Assessment Phase 2, 2006)
- Cultivated Lands (SANBI Land Cover, 2009)
- Registered Groundwater Use (WARMS Data, 2013)
- High Yielding Aquifers as discussed in previous section

The resulting map of the aforementioned covers is shown in Figure 18. The mining activities are not explicitly shown due to the fact that if they utilise groundwater it should be included in the registered use as obtained from the WARMS database.

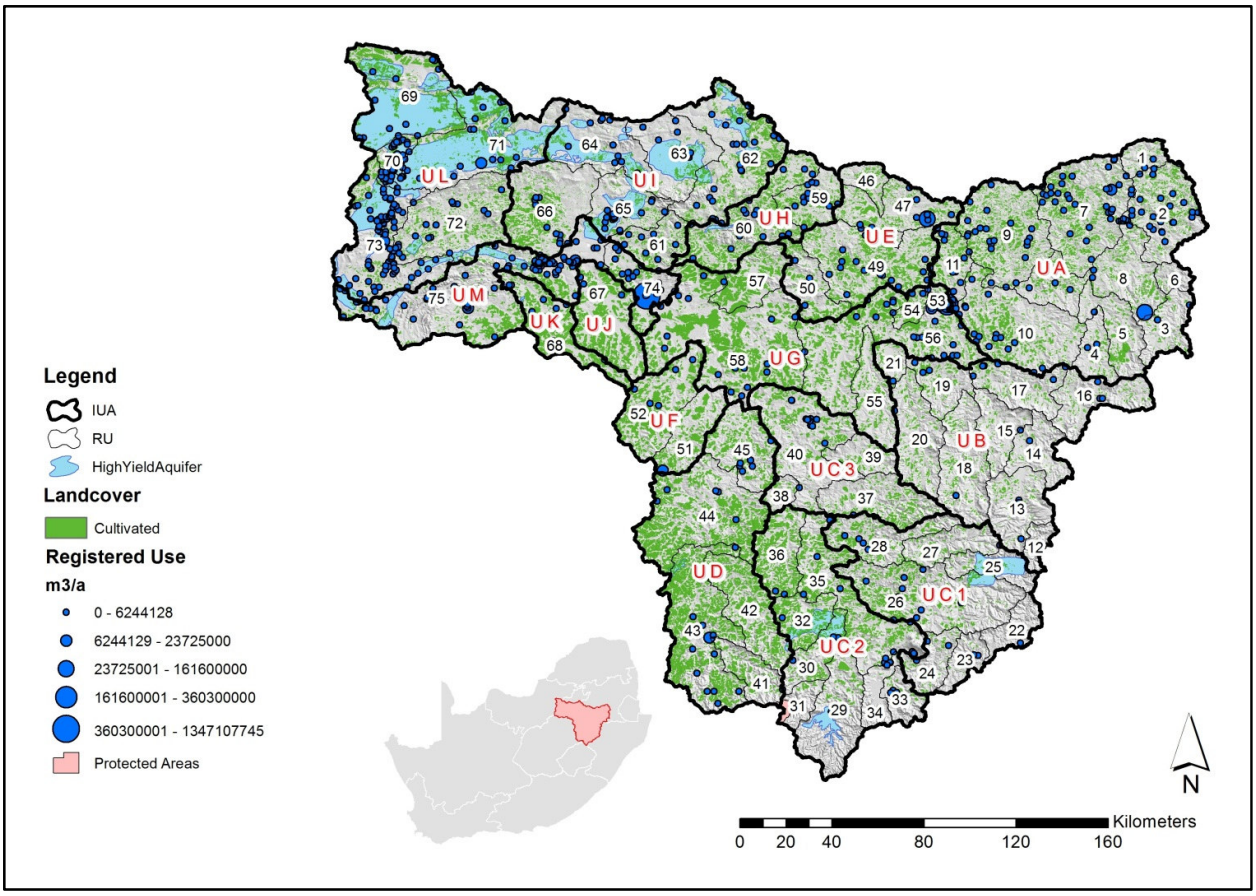


Figure 18: Activities that contribute to the economy

The rating guideline applied to each RU for evaluating the activities that contribute to the economy is presented in Table 10 and the spatial distribution of the final ratings is shown in Figure 19.

Table 10: Contribution to economy rating guideline

Rating	Guideline
0.0	RU's which do not directly support any activities which contribute to the economy
0.5	RU's which support activities which provide a moderate contribution to the economy
1.0	RU's which support activities which contribute significantly to the economy

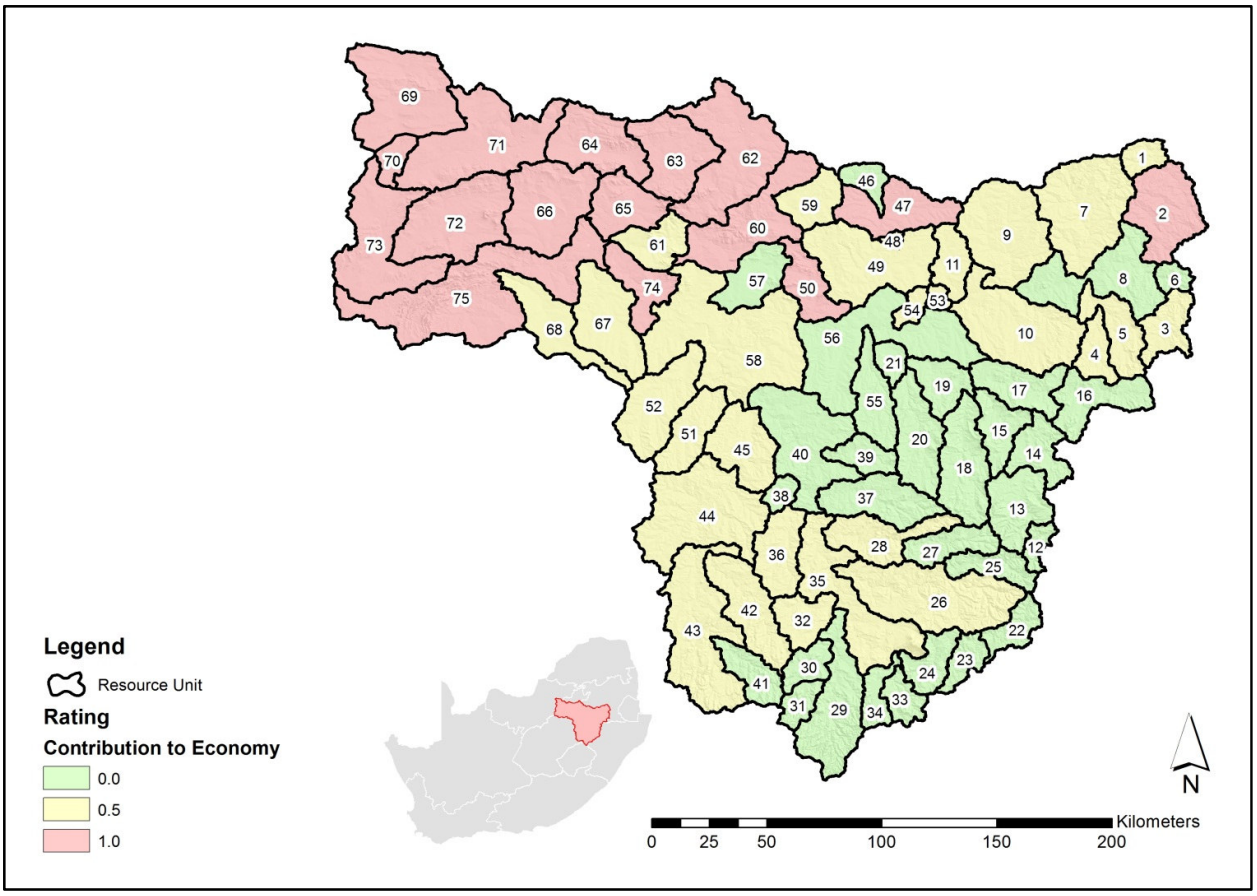


Figure 19: Spatial distribution of contribution to the economy rating

3.7.2 THREAT POSED TO USERS

The sections that follow discuss the sub-criteria linked to the threat posed to users and the rating guideline that applies to each of the sub-criteria.

3.7.2.1 Aquifers which are highly stressed (relative aquifer stress)

The AFYM (Murray *et al*, 2011) was used to calculate the aquifer firm yield per quaternary catchment that comprises the various RU's. The existing use was expressed as a percentage of the firm yield to calculate a stress index. It is important to note that the firm yield model is very conservative. The default values for the quaternaries were used that was supplied with the model, which was sourced through the GRAII project. The stress indices were classified as high, medium and low and the class breaks were chosen by selecting the highest and lowest stress index and assigning the high class low class respectively. The remainder of the remainder of the indices were scaled accordingly.

The rationale behind the approach outlined above is to highlight quaternaries that are more stressed than others, even though they may not currently be stressed. There is a huge uncertainty in the current groundwater use figures and therefore it is not possible to calculate high confidence stress indices. The purpose of the prioritisation tool is only to highlight differences between RU's to assist in the prioritisation process and the relative stress index calculation allows for the generation of contrasts between the RU's.

The resulting aquifer stresses are shown in Figure 20.

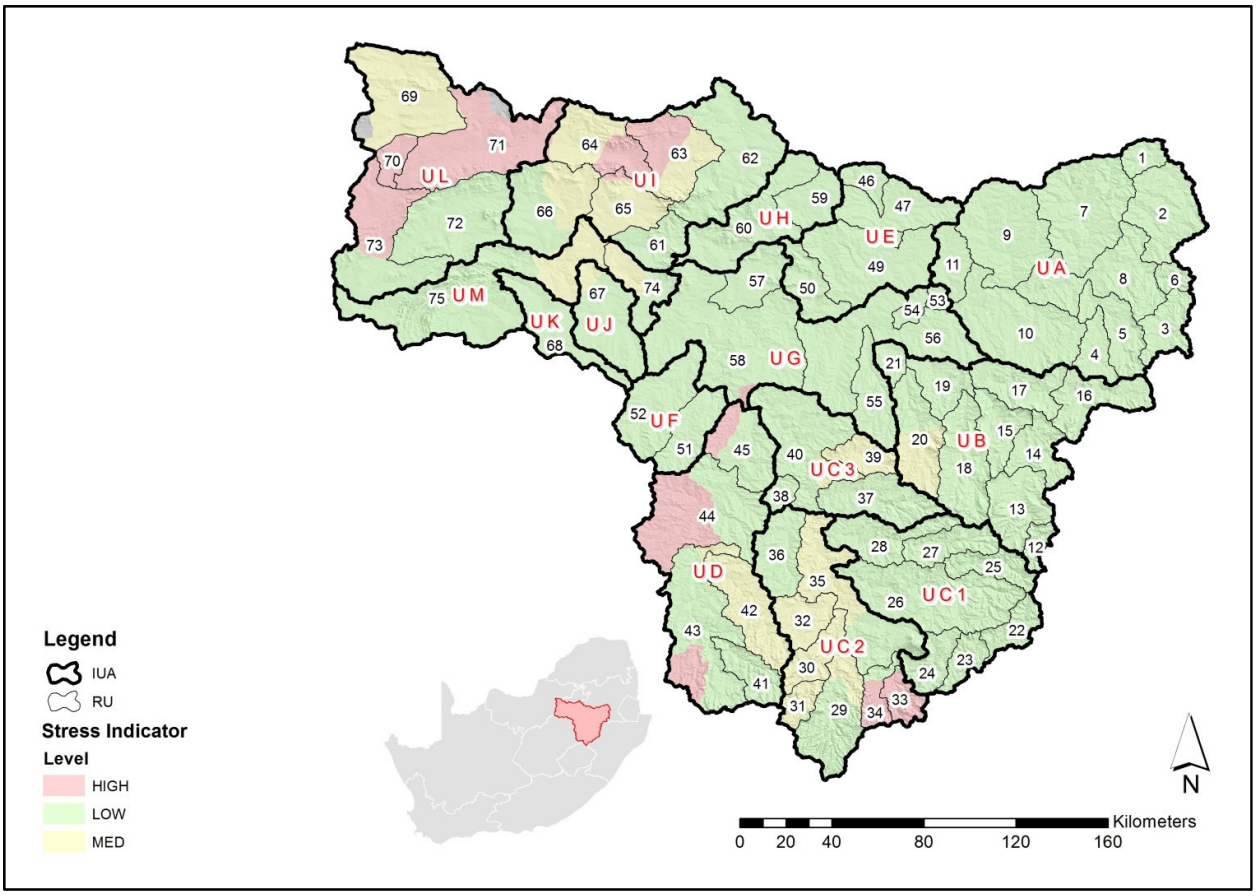


Figure 20: Relative aquifer stress

The rating guideline applied to each RU for evaluating the relative aquifer stress is presented in Table 11 and the spatial distribution of the final ratings is shown in Figure 21.

Table 11: Relative aquifer stress rating guideline

Rating	Guideline
0.0	RU's which contain or are dominated by aquifers which are not stressed
0.5	RU's which contain or are dominated by aquifers which are moderately stressed
1.0	RU's which contain aquifers which are highly stressed

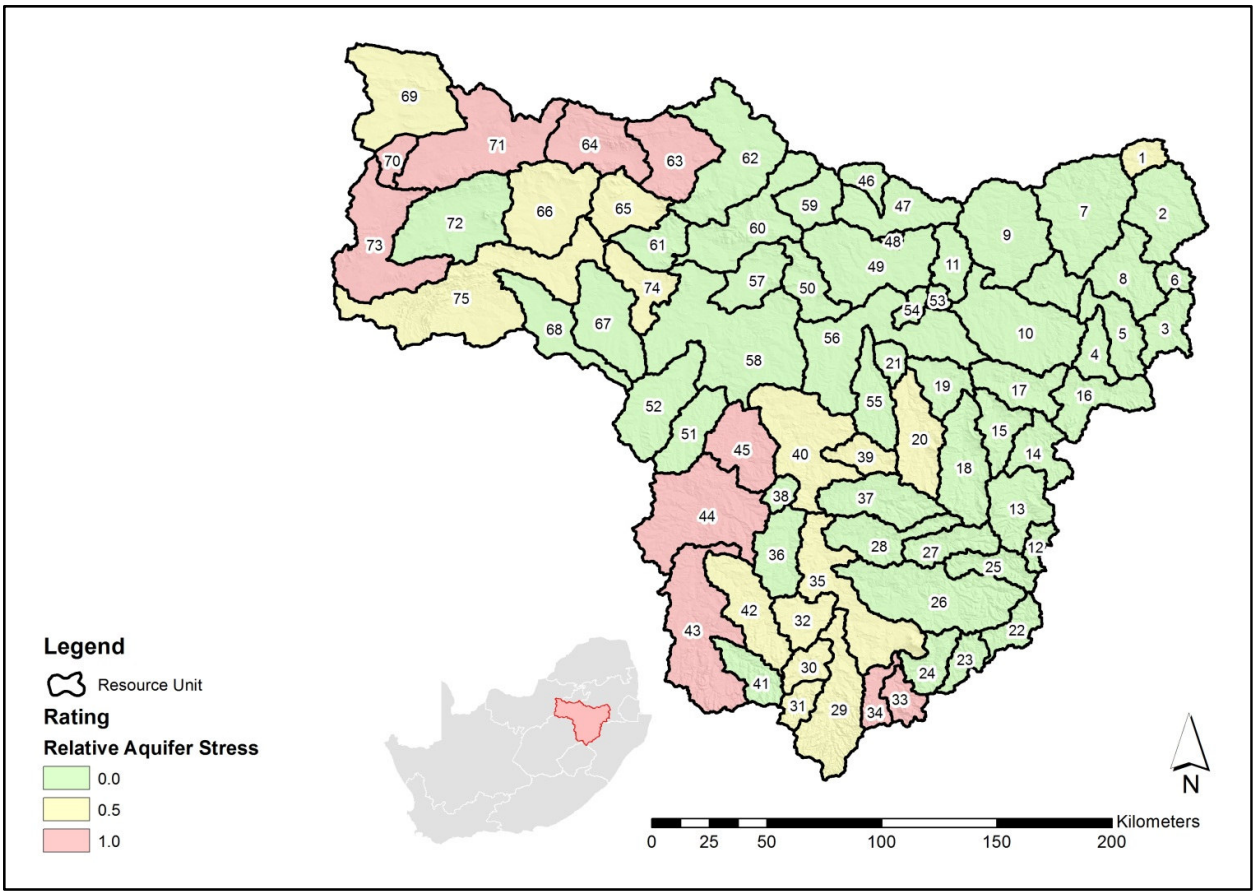


Figure 21: Spatial distribution of relative aquifer stress rating

3.7.2.2 Water quality currently threatened

There is not enough historic data available with good distribution across the study area to allow for the generation of a detailed groundwater quality map. The datasets used to visually show the current water quality across the area are:

- The TDS map to give indication of the regional groundwater salinity levels (DWAF Vegter Map, 1995)
- Current and Abandoned Mines (NWU Geography Department, author unknown)

Background groundwater quality is inherently related to the host geology and can be spatially highly variable depending on the geological and physical setting. Although mining operations can be indicative of potential groundwater quality issues, the evaluation of this sub-criterion relies heavily on the public participation process. The resultant map produced is shown in Figure 22.

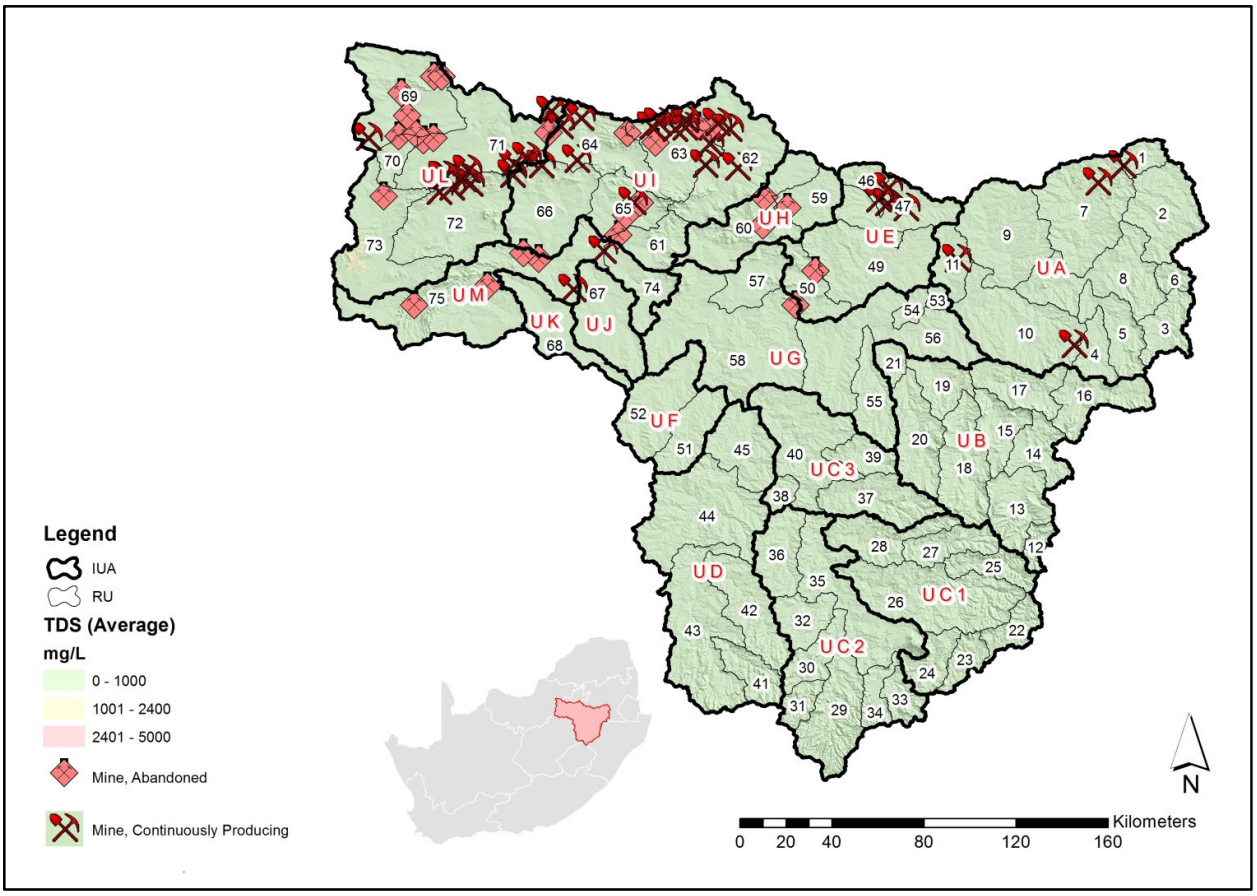


Figure 22: Groundwater quality distribution map

The rating guideline applied to each RU for evaluating water qualities that are currently threatened is shown in Table 12 and the spatial distribution of the final ratings is shown in Figure 23.

Table 12: Water quality that is threatened rating guideline

Rating	Guideline
0.0	RU's where potential threat to water quality is low
0.5	RU's where potential threat to water quality is moderate
1.0	RU's where potential threat to water quality is high

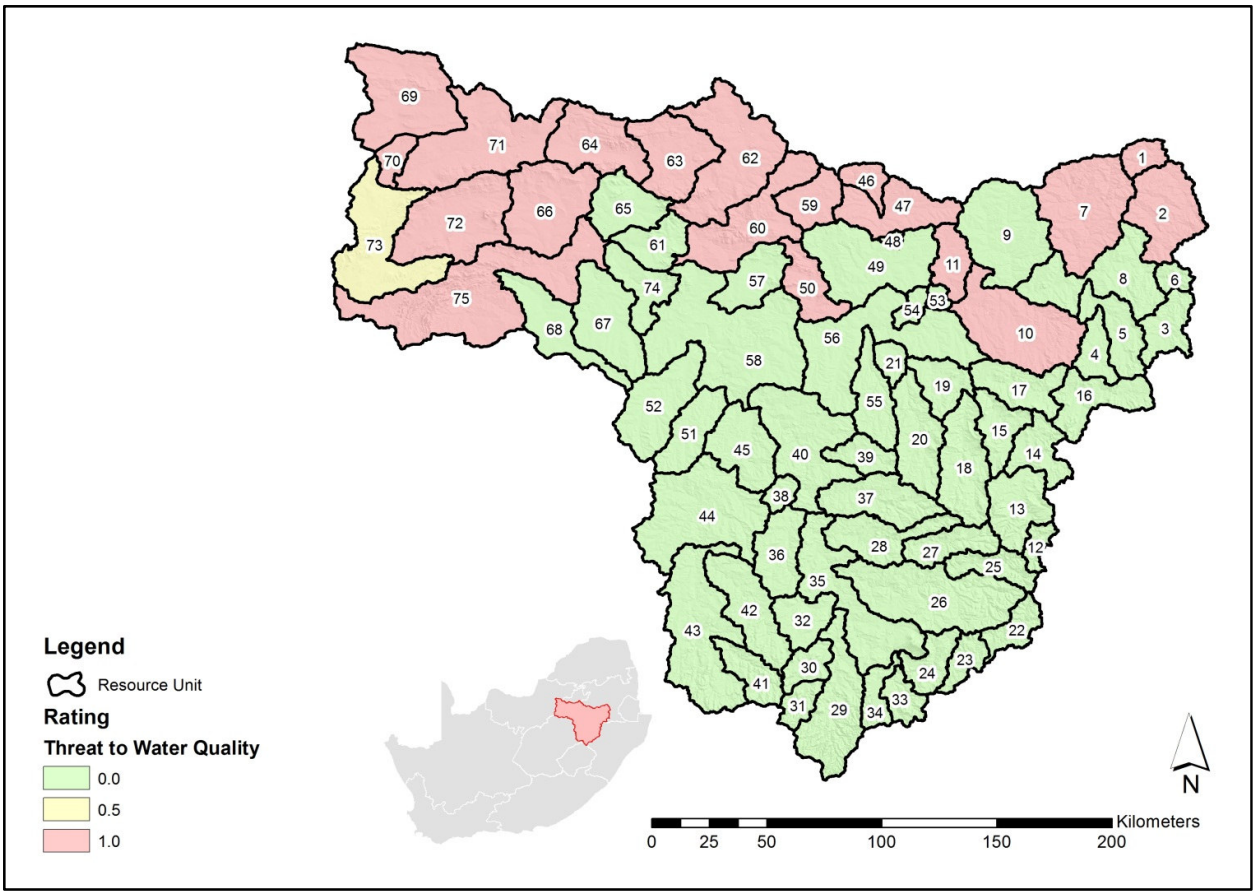


Figure 23: Spatial distribution of threat to water quality rating

3.7.2.3 Vulnerable aquifers

Aquifer vulnerability is addressed through the DRASTIC map (DWAF, 2011). The map comprise of the following parameters:

Table 13: DRASTIC Parameters

Parameter	Input dataset
Depth to water table (D)	126 263 groundwater levels from the NGDB (for 4 280 of these, the mean groundwater level was calculated from time-series data) were interpolated to a groundwater level grid.
Recharge (R)	Recharge calculated as part of GRAII-3 project.
Aquifer material (A)	1:1 million Geology from CGS
Soils (S)	WR90 soils data set
Topography and slope (T)	DWAF 20m DTM resampled to 1X1km
Impact of the vadose (unsaturated) zone (I)	1:1 million Geology from CGS
Hydraulic conductivity (C)	1:1 million Geology from CGS

The DRASTIC index has a maximum index of 200 which represents the highest aquifer vulnerability with respect to pollution. For the purpose of the prioritisation tool the following classes of DRASTIC index were adopted based on the index range for the study area:

- High Vulnerability (122-178)
- Medium Vulnerability (90-121)
- Low Vulnerability (60-89)

The resulting map is shown in Figure 24.

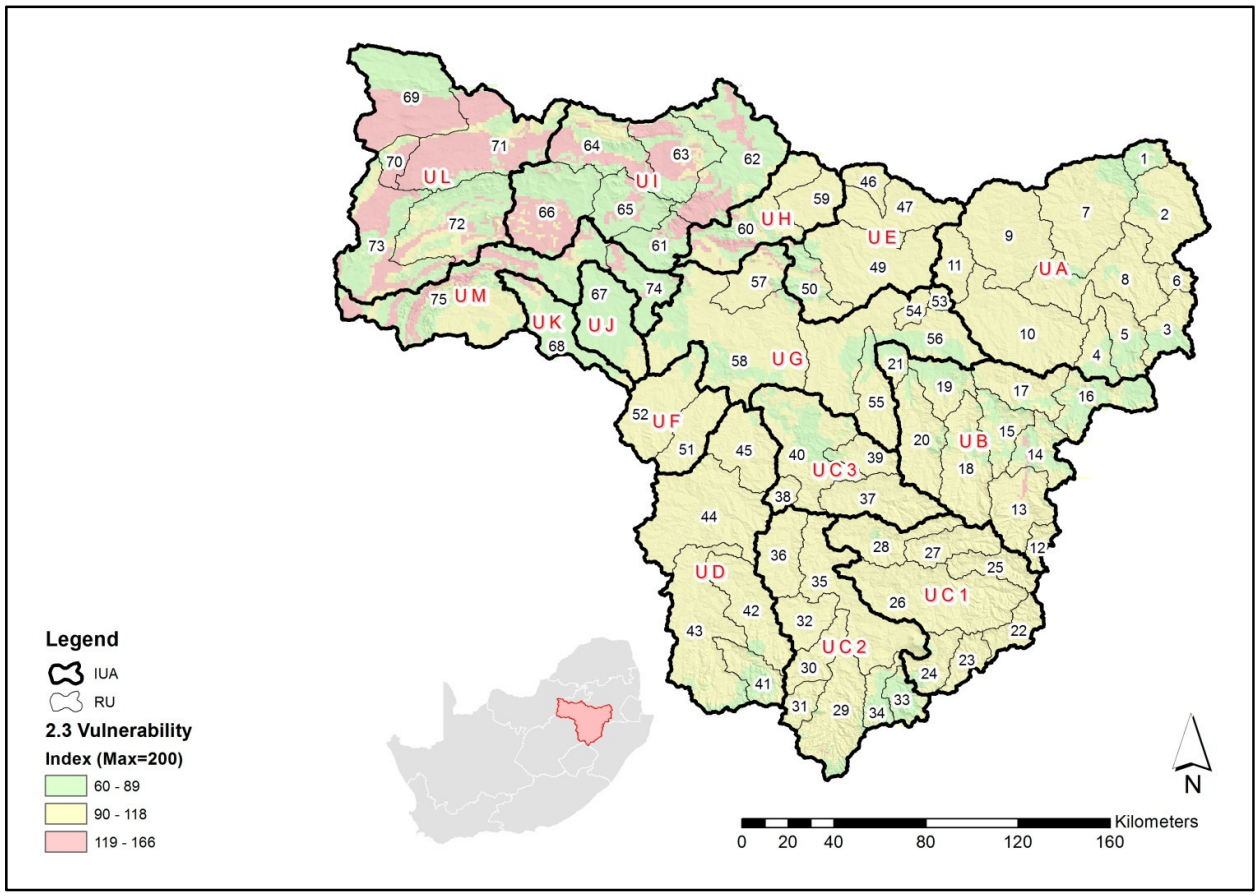


Figure 24: DRASTIC aquifer vulnerability

The rating guideline applied to each RU for evaluating aquifer vulnerabilities are shown in Table 14 and spatial distribution of the final ratings is shown in Figure 25.

Table 14: Aquifer vulnerability rating guideline

Rating	Guideline
0.0	RU's that are not vulnerable to pollution
0.5	RU's that are moderately vulnerable to pollution
1.0	RU's that are highly vulnerable to pollution

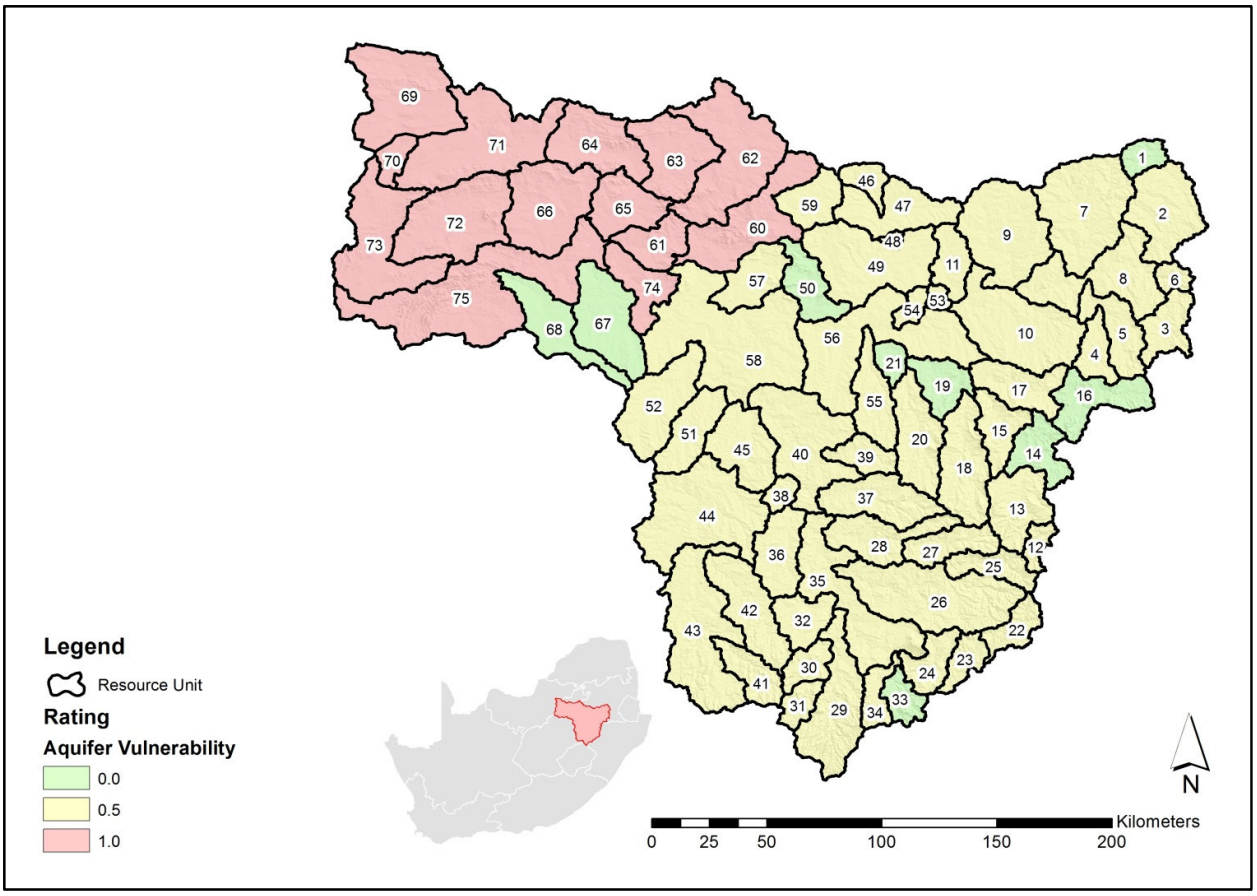


Figure 25: Spatial distribution of aquifer vulnerability rating

3.7.3 ECOLOGICAL IMPORTANCE

The sections that follow discuss the sub-criteria linked to the ecological importance and the rating guideline that applies to each of the sub-criteria.

3.7.3.1 Groundwater importance to wetlands

The wetland cover generated for the study area was used and only wetlands associated with possible groundwater dependence were considered. The spatial distribution of the wetlands dependant on groundwater are shown in Figure 26.

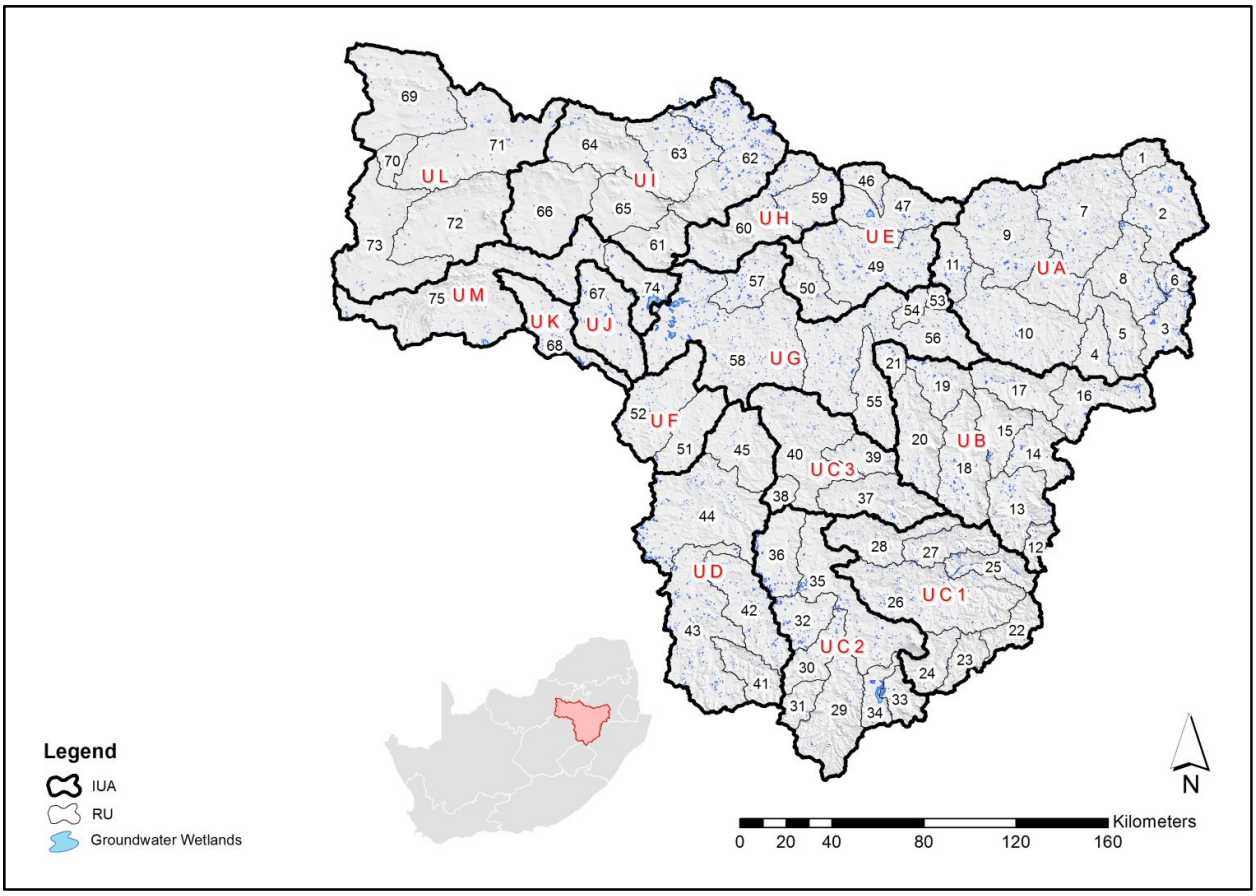


Figure 26: Wetlands dependant on groundwater

Evaluation of the wetlands posed difficult due to the large number and the uncertainty with regard to groundwater, therefore the wetland densities per RU was used in the evaluation. The rating guideline applied to each RU for evaluating groundwater importance to wetlands is shown in Table 15 and the spatial distribution of the final rating is shown in Figure 27.

Table 15: Groundwater importance to wetlands rating guideline

Rating	Guideline
0.0	RU's which contain wetlands with low groundwater importance
0.5	RU's which contain wetlands with moderate groundwater importance
1.0	RU's which contain wetlands with high groundwater importance

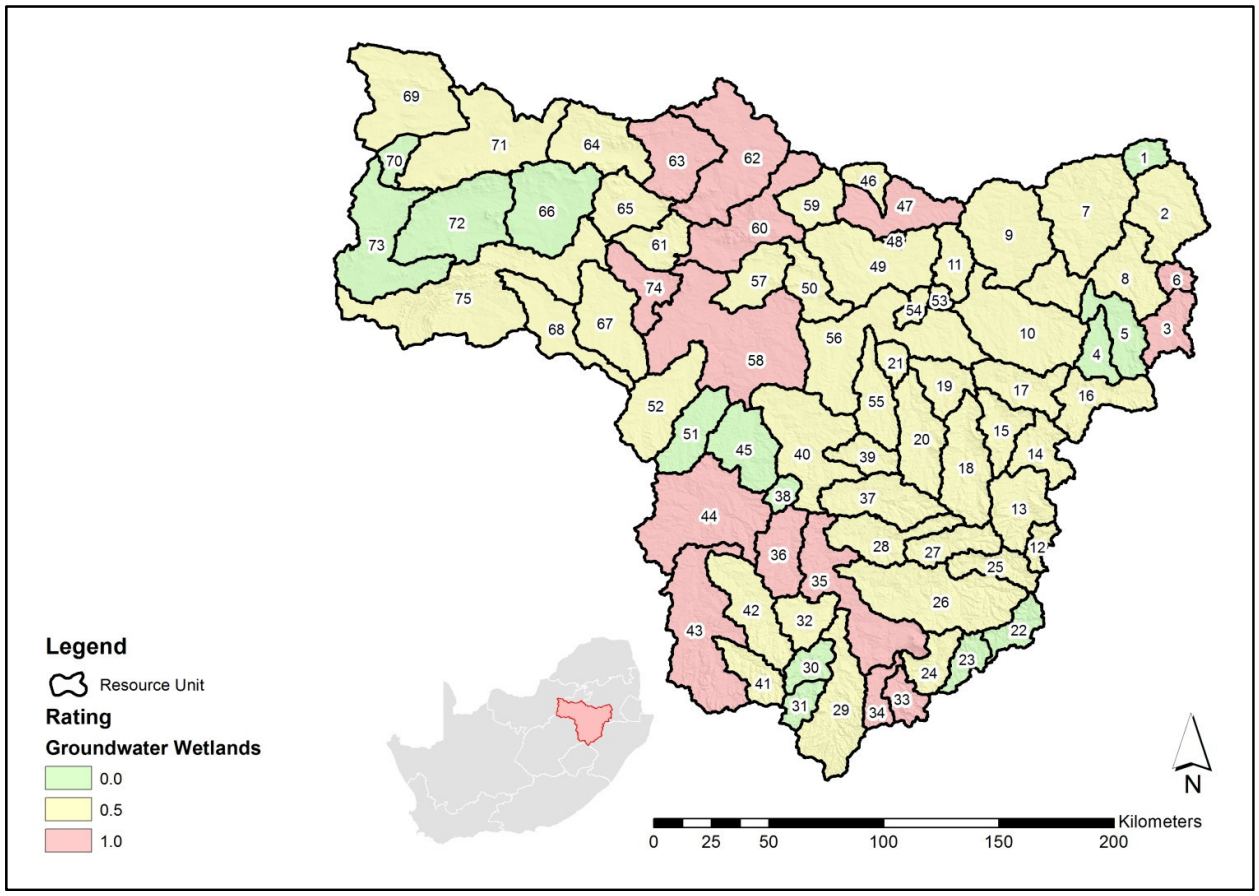


Figure 27: Spatial distribution of wetlands dependant on groundwater rating

3.7.3.2 Surface-groundwater water interaction

Surface-groundwater interaction is an on-going field of research and this component is very expensive to measure. This has resulted in models being used to predict the groundwater contribution to baseflow. For the purpose of the prioritisation tool the estimated groundwater contribution to baseflow (GRDM, Van Tonder, 2000) was expressed as a percentage of the MAR. The resultant map is shown in Figure 28.

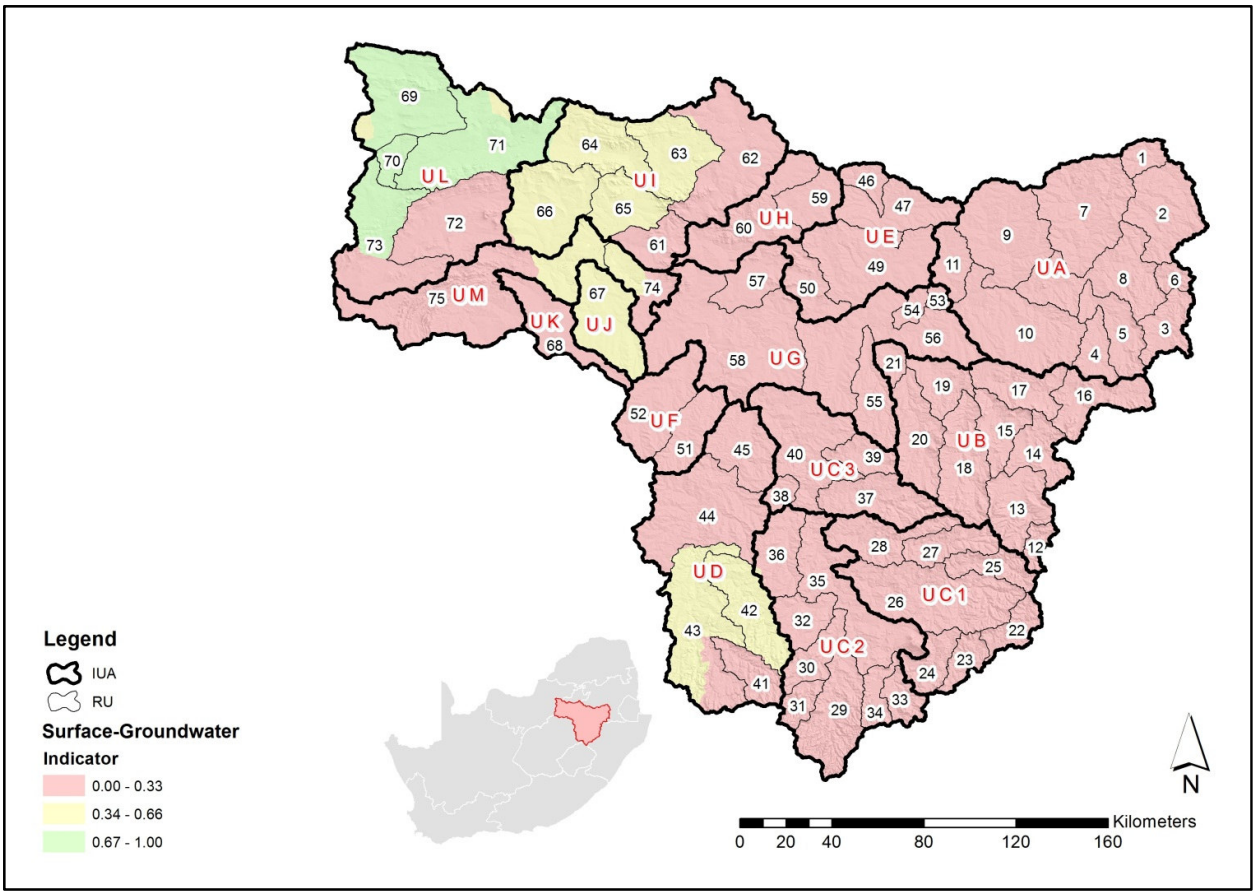


Figure 28: Surface-groundwater interaction

The rating guideline applied to each RU for evaluating the surface-groundwater interaction is shown in Table 16 and the spatial distribution of the final ratings is shown in Figure 29.

Table 16: Surface-groundwater interaction rating guideline

Rating	Guideline
0.0	RU's which contain insignificant GW-SW interaction
0.5	RU's which contain moderate GW-SW interaction
1.0	RU's which contain significant GW-SW interaction

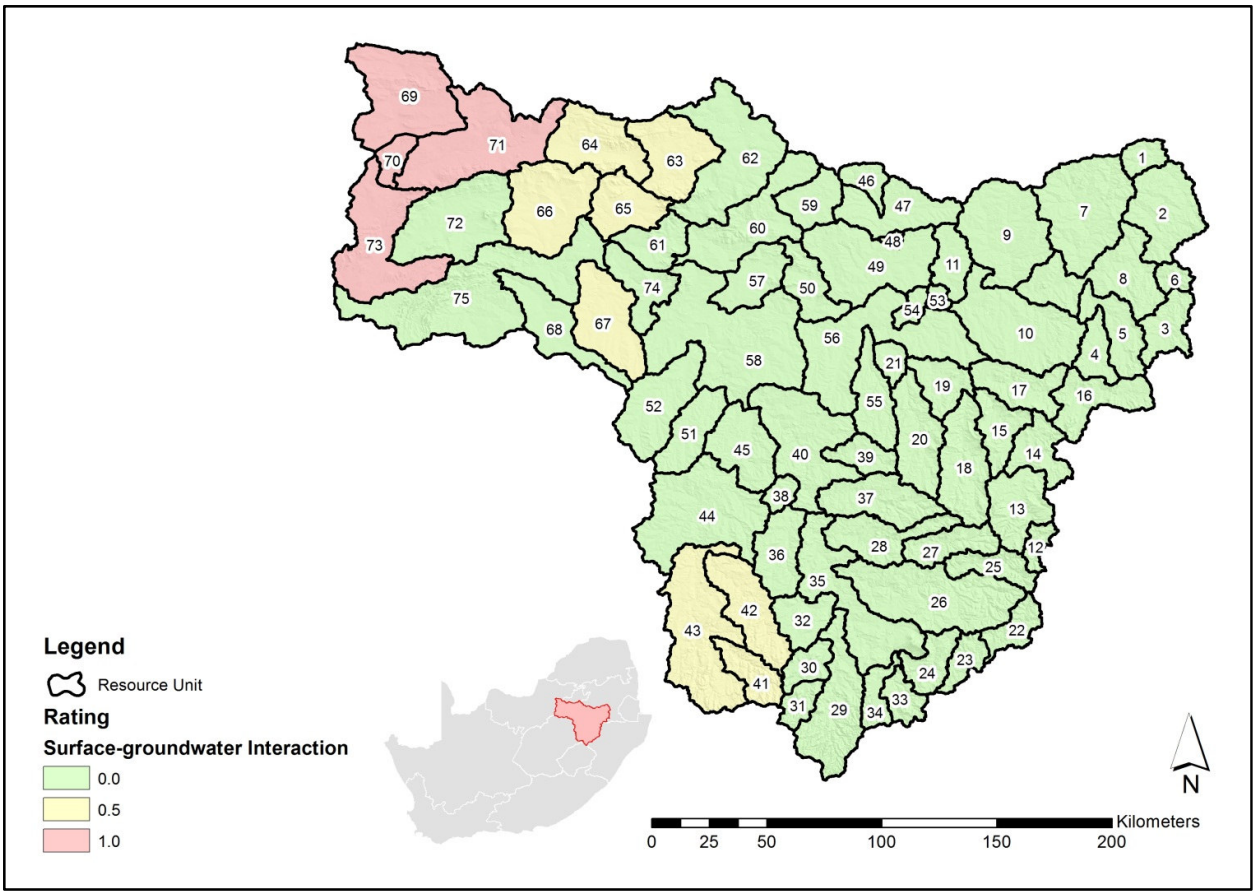


Figure 29: Spatial distribution of surface-groundwater interaction rating

3.7.3.3 Important groundwater fauna

This sub-criteria has been included for the sake of completeness, but no database exist that can be used to apply this specific sub-criteria. Table 17 shows the rating guideline to be used once this type of data is available.

Table 17: Important groundwater fauna rating guideline

Rating	Guideline
0.0	RU's which contain little groundwater fauna
0.5	RU's which contain moderate groundwater fauna
1.0	RU's which contain major groundwater fauna

3.8 MANAGEMENT CONSIDERATIONS

A dataset that shows the existence of management plans is not available and this criterion relies heavily on the inputs from the public participation. It is assumed that existing mines will have management plans and therefore existing mining locations is used as secondary indicator to where management plans might exist. Figure 30 shows existing mining positions (reference of dataset is unknown, obtained from the NWU Geography Department).

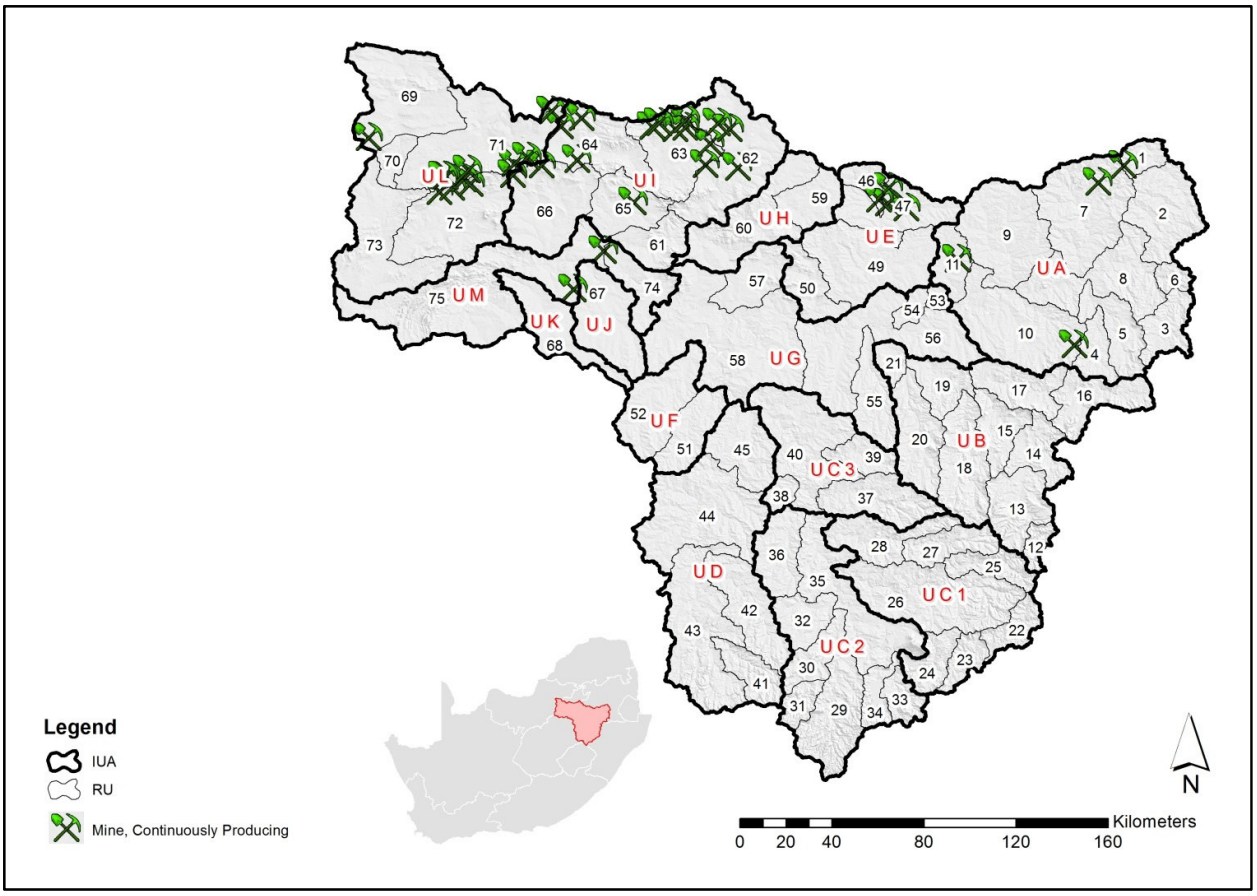


Figure 30: Current mining positions assumed to have management plans

Table 18 shows the rating guideline to be applied to the selected RU's and the spatial distribution of the final ratings is shown in Figure 31.

Table 18: Contribution to economy rating guideline

Rating	Guideline
0.0	RU's which do not contain groundwater resources for which management plans exist
1.0	RU's which contain groundwater resources for which management plans exist

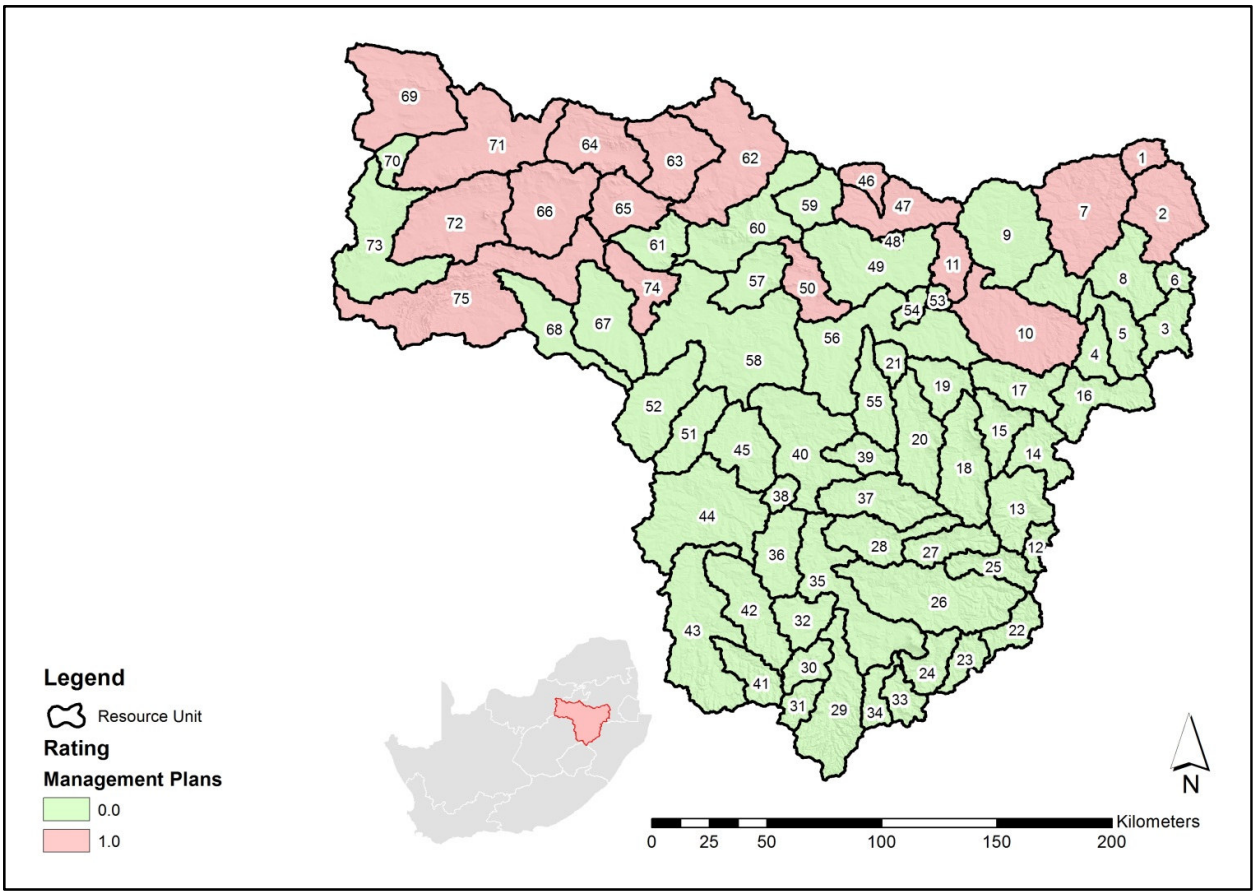


Figure 31: Spatial distribution of management plans rating

4 FINDINGS

4.1 PRIORITY RIVER RESOURCE UNITS FOR THE UPPER VAAL WMA

The application of the RUPT and refinement by stakeholders resulted in the selection of 27 priority River RUs for the Upper Vaal WMA. These RUs and associated IUAs as well as their relationship to the PES-EIS desktop study, Water Resource Classification study, and Reserve studies are detailed in Table 19. The location of these Resource Units is shown in Figure 32.

Table 19: Priority River Resource Units selected for the Upper Vaal WMA.

RU	IUA	Reach (PES-EIS)	Site name	Hydronode (WRC)	EWR site	Level of Reserve
8	UV-A	C11J-01838	EWR1	EWR1	EWR1	Comprehensive
10	UV-A	C11L-01945	VC4	UA-8		
13	UV-B	C13D-02416	C13C	UB-2		
14	UV-B	C13D-02284	C1KLIP-UNSPE1	UB-3		
21	UV-B	C13H02077	C13H	UB-9		
26	UV-C1	C82A-02542	UV28	UC1-4		
34	UV-C2	C81E-02930	C8NUWE-CONFL	UC2-6		
35	UV-C2	C82C-2505	EWR8	EWR8	EWR8	Comprehensive
36	UV-C2	C82D-02490	C82D	UC2-7		
40	UV-C3	C82H-02200	VC9	UC3-4		
43	UV-D	C83E-02579	C83E_N	UD-3		
45	UV-D	C23H-02395	VC17	UD-5		
46	UV-E	C12D-01576	VC6	UE-1		
47	UV-E	C12F-01722	WA1	UE-2		
50	UV-E	C12G-01963	UV WV	UE-5		
58	UV-G	C12J-02091	C12J	UG-4		
60	UV-H	C21C-01675	EWR 9	EWR9	EWR9	Comprehensive
62	UV-I	C21F-01447	EWR11	EWR11	EWR11	Comprehensive
63	UV-I	C22C-01509	VC11	UI-1		
64	UV-I	C22A-01315	VC12	UI-2		
65	UV-I	C22E-01619	VC13	UI-3		
66	UV-I	C22K-01765	VC14	UI-4		
67	UV-J	C22K-01795	C22G	UJ-1		
68	UV-K	C23A-01811	UV53	UK-1		
71	UV-L	C23G-01406	VC19	UL-2		
73	UV-L	C23L-01827	VC20	UL-4		
75	UV-M		EWR5	EWR5	EWR5	Comprehensive

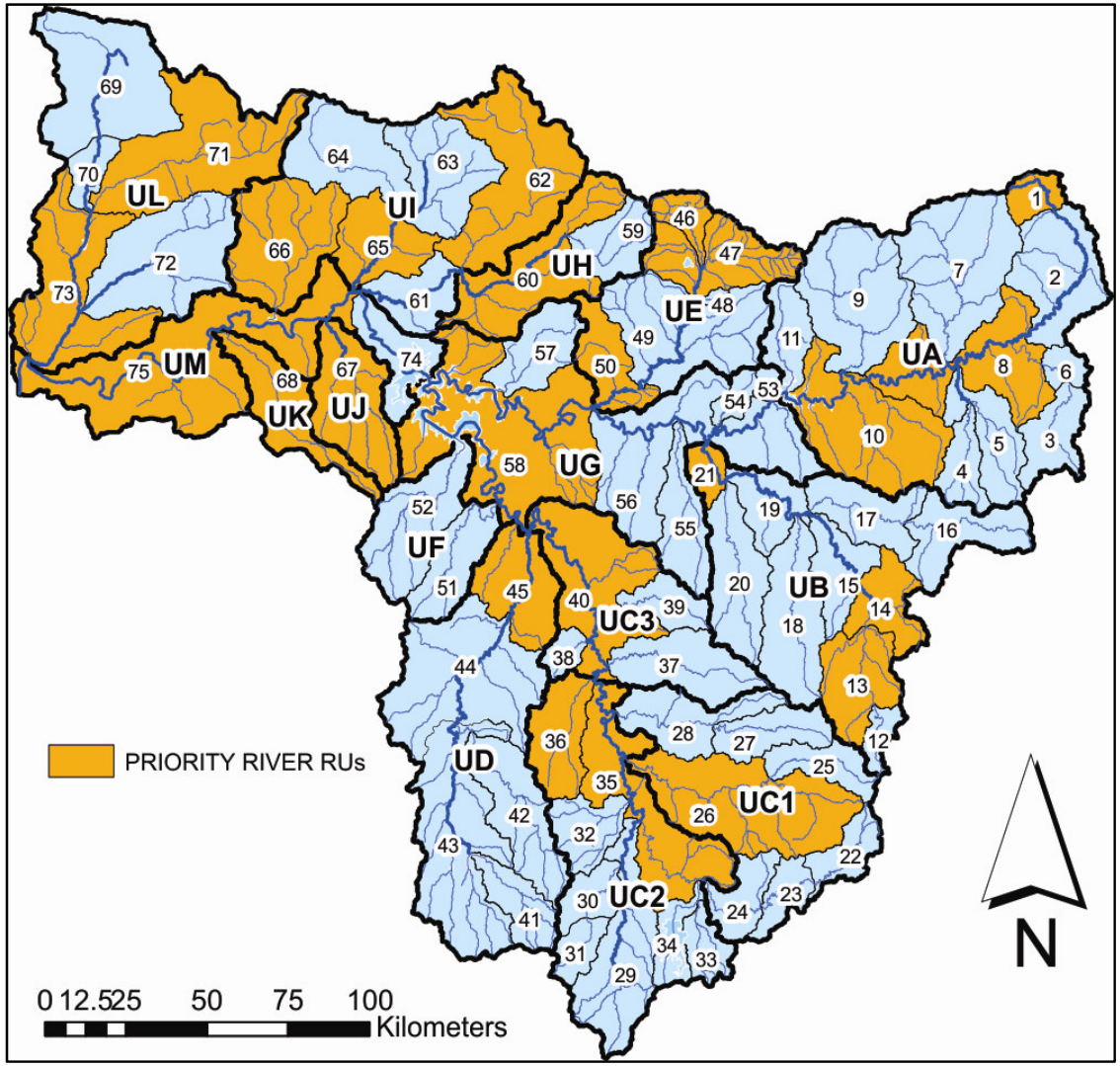


Figure 32: River Resource Units prioritised for the Upper Vaal WMA

4.2 PRIORITY WETLAND ECOSYSTEMS FOR THE UPPER VAAL WMA

The approach adopted for identifying priority wetlands allowed for a structured step-by-step process to be followed[2]. Through this process key aspects / criteria were taken into consideration and scored / weighted appropriately during the desktop assessment phase. Through the use of available spatial datasets, the desktop assessment allowed for the prioritization of wetland systems from both a user and protection perspective. Taking into consideration the practicality of monitoring priority wetlands it was decided to focus on the top five percent of the of priority wetlands, which included approximately 350 wetlands (Figure 33).

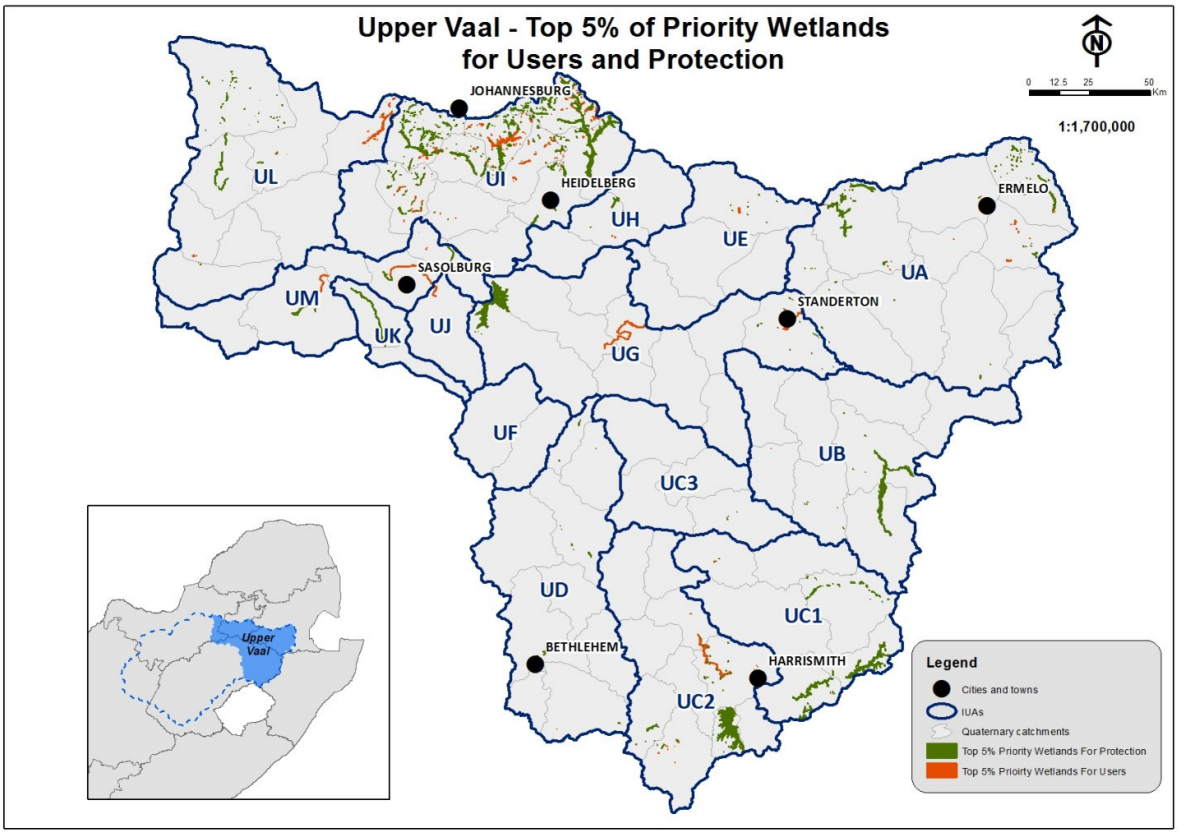


Figure 33: Top 5% of priority wetlands for users and protection

Candidate wetlands from this initial assessment of priority wetlands were then selected based on existing recommendations for priority wetlands (DWA 2010), and a stakeholder consultation process. The twelve wetland systems that were identified as part of the comprehensive reserve determination study of the integrated Vaal River System (DWA 2010), which corresponded to the initial priority layer, were taken into consideration. These include:

- Gerhard Minnebron;
- Blaau Pan System;
- Benoni pans;
- Boovenste Oog;
- Seekoeivlei (RAMSAR status);
- Suikerbos floodplain complex (peat wetlands);
- Blesbokspruit (RAMSAR status);
- Klip River wetland (low ecological status, high functionality, flood retention, water quality);
- Vanger peat wetland (white winged fluff tails, currently good PES - near pristine);

[2] Bredin *et al*. (manuscript in prep).

- Murphy's Rust (white winged fluff tail, currently good PES);
- Braamhoek (breading wattled crane, fluff tail, peat wetland); and
- Wonderfonteinspruit.

A range of key stakeholders were consulted to help identify candidate wetlands for RQP determination, based primarily on biodiversity value, and / or functional importance. A list of these stakeholders, together with brief notes on the inputs obtained is summarized in Appendix F and G.

Following this approach a total of 36 potential candidate wetlands were selected. A stakeholder workshop was then held to finalise the list of priority sites and to continue with the sub-component and indicator selection process. This was held on 20th and 21st of November 2013 and was attended by the following stakeholders:

- Jacqueline Jay (DWS);
- Paul Meulenbeld (DWS);
- Marc De Fontaine (Rand Water);
- Gary Marneweck (Wetland Consulting Services);
- Douglas Macfarlane (Eco-Pulse Environmental Consulting Services); and
- Ian Bredin (INR).

In addition, a meeting with Nacelle Collins (DETEA FS) was held on the 22nd of November.

Through stakeholder / specialist consultation it was determined that 20 wetlands[3] be considered as priority wetlands in the Upper Vaal. The location of each of these wetland ecosystems were then mapped as a final output of the prioritization process (Figure 34). Table 20 provides a summary of the 20 priority wetlands selected for the Upper Vaal catchment.

[3] It should be stressed that significantly more wetlands were identified as important but were not selected, primarily because it would not be feasible to monitor RQOs for all of them.

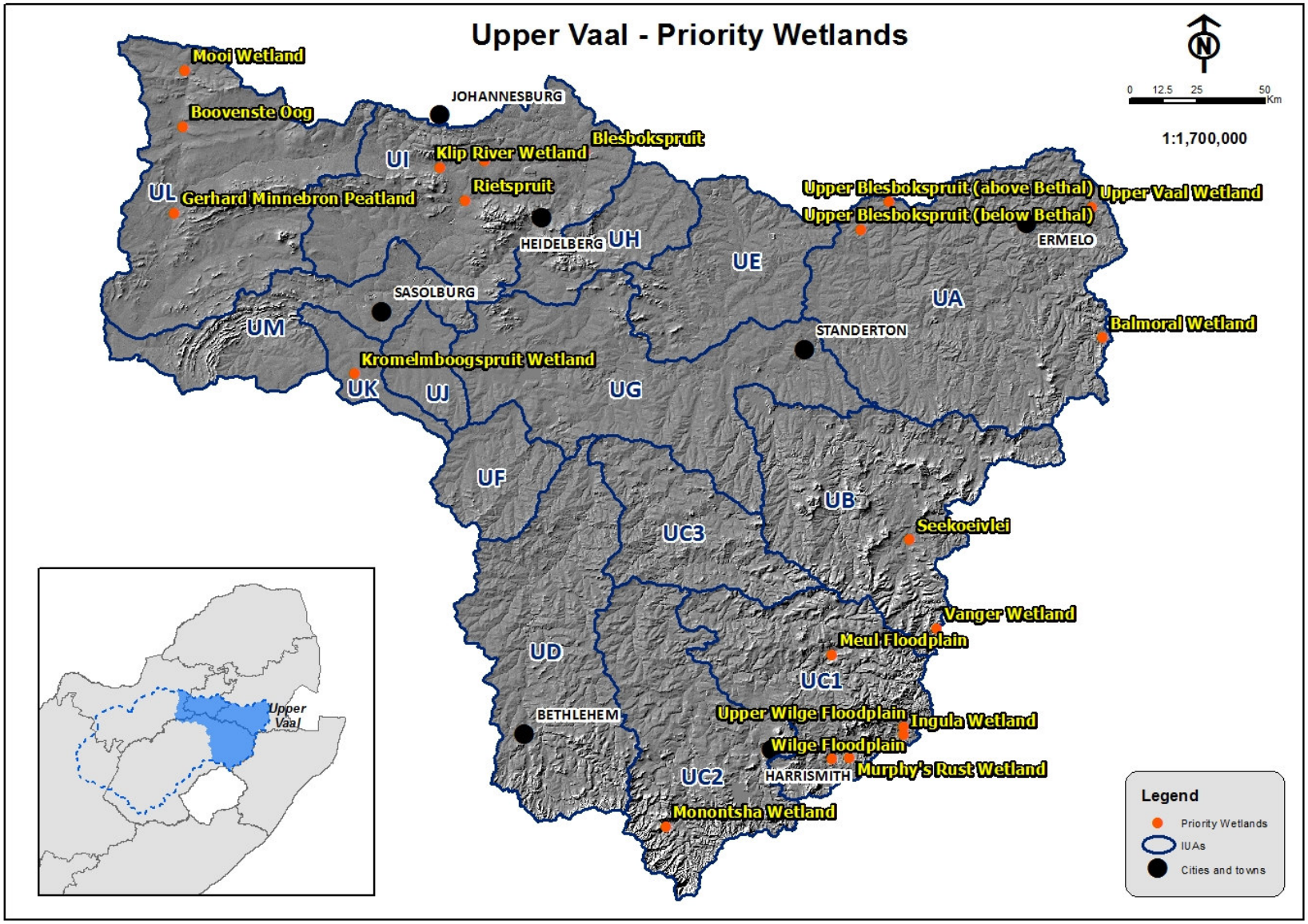

Upper Vaal - Priority Wetlands
Mooi Wetland
Boovenste Oog
JOHANNESBURG
Blesbokspruit
Klip River Wetland
UI
UL
Gerhard Minnebron Peatland
Rietspruit
HEIDELBERG
UH
UE
Upper Blesbokspruit (above Bethal)
Upper Vaal Wetland
Upper Blesbokspruit (below Bethal)
ERMELO
SASOLBURG
UA
UM
STANDERTON
Balmoral Wetland
Kromelmboogspruit Wetland
UK
UJ
UG
UF
UB
UC3
Seekoeivlei
Vanger Wetland
Meul Floodplain
UD
UC1
BETHLEHEM
Upper Wilge Floodplain
Ingula Wetland
Wilge Floodplain
HARRISMITH
Murphy's Rust Wetland
UC2
Monontsha Wetland
Upper Vaal
0 12.5 25 50 Km
1:1,700,000
Legend
Priority Wetlands
IUAs
Cities and towns

Figure 34: Upper Vaal catchment priority wetlands

Table 20: Upper Vaal catchment priority wetlands

IUA	Wetland Name	Wetland Type (HGM)	Protection	User	Coordinates	River RU	Rationale
UA	Bethal (above town)	Unchannelled Valley Bottom		1	26°26'53.18"S 29°31'18.41"E	9	High functional value, stream flow regulation.
UA	Bethal (below town)	Floodplain / Channelled Valley Bottom		1	26°32'27.10"S 29°25'33.61"E	9	Low ecological status, high functionality, water quality.
UA	Balmoral	Unchannelled Valley Bottom / Seeps	1		26°54'6.40"S 30°14'1.98"E	3	High biodiversity and functional value.
UA	Upper Vaal	Floodplain	1	1	26°28'2.04" 30°11'45.96"E	2	High biodiversity and functional value.
UB	Vanger	Unchannelled Valley Bottom	1		27°52'16.74"S 29°40'45.62"E	12	White winged fluff tail, currently good PES
UB	Seekoeivlei	Floodplain	1	1	27°34'28.53"S 29°35'21.85"E	13;14	High biodiversity and functional value. RAMSAR status
UC1	Murphy's Rust	Unchannelled Valley Bottom	1	1	28°18'6.72"S 29°23'13.57"E	23	White winged fluff tail, currently good PES
UC1	Ingula	Unchannelled Valley Bottom	1		28°13'32.96"S 29°34'5.56"E	22	White winged fluff tail, Cranes species, currently good PES
UC1	Wilge	Floodplain / Channelled Valley Bottom	1	1	28°18'22.25"S 29°19'46.57"E	23	High biodiversity and functional value.
UC1	Upper Wilge	Floodplain	1		28°11'59.61"S 29°34'9.02"E	22	White winged fluff tail, Cranes species, currently good PES.
UC1	Meul	Floodplain	1		27°57'31.24"S 29°19'43.43"E	25	High biodiversity and functional value.
UC2	Monontsha	Historically Unchannelled Valley Bottom now Channelled Valley Bottom		1	28°31'51.17"S 28°46'30.09"E	29	Low ecological status, high functionality, water quality.
UI	Blesbokspruit	Flooded wetland (artificially supported)	1	1	26°17'2.77"S 28°30'10.73"E	62	RAMSAR status. High biodiversity and functional value.
UI	Klip River Wetland	Unchannelled Valley Bottom (Channelized downstream)		1	26°20'1.64"S 28° 1'14.84"E	64	Low ecological status, high functionality, flood retention, water quality.
UI	Rietspruit	Floodplain		1	26°26'35.56"S 28° 6'24.09"E	63	Low ecological status, high functionality, flood retention, water quality.
UI	Natalspruit	Unchannelled Valley Bottom		1	26°18'40.87"S 28°10'11.76"E	63	Low ecological status, high functionality, flood retention, water quality.

IUA	Wetland Name	Wetland Type (HGM)	Protection	User	Coordinates	River RU	Rationale
UK	Kromelmboogspruit	Floodplain / Channelled Valley Bottom		1	27° 1'18.10"S 27°44'13.30"E	68	High biodiversity and functional value.
UL	Boovenste Oog	Peat wetland	1	1	26°11'53.16"S 27° 9'52.97"E	69	Peat wetland
UL	Mooi	Unchannelled Valley Bottom	1		26° 0'33.82"S 27°10'19.42"E	69	High biodiversity and functional value.
UL	Gerhard Minnebron	Peat wetland	1	1	26°29'6.24"S 27° 8'11.05"E	73	Peat wetland

4.3 PRIORITY DAM ECOSYSTEMS FOR THE UPPER VAAL WMA

The application of the above criteria resulted in the selection of 18 priority dams for the Upper Vaal catchment. The final selected priority dams are presented in Table 21 below.

Table 21: Selected priority dams for the Upper Vaal WMA

IUA	RU	Dam Name	Quarter-nary	Dam number	River	Year Est.	FSC Mm³	Why it was built (Purpose)
UA	4	Amersfoort	C11E	-	Skulpspruit	1987	0.993	Municipal, industrial - Amersfoort
	10	Grootdraai	C11L	C1R002	Vaal	1986	382.5	Municipal, industrial - Standerton, Sasol II&III, Tutuka Power Station
UB	20	Vrede/ Thembalihle	C13G	-	Spruitsonderdrift	1998	2.44	Municipal, industrial - Vrede
UH	60	Balfour	C21B	-	Suikerbosrant	1998	0.424	Municipal, industrial - Balfour
UM	75	Vaal Barrage	C22K	-	Vaal	1996	55.4	Municipal, industrial - Rand Water, Lethabo Power Station, Iscor, Sasol I
UL	71	Donaldson	C23D	-	Wonderfontein-spruit	1986	0.46	Recreation
	69	Klerkskraal	C23F	C2R003	Mooi	1987	8.25	Irrigation
	73	Boskop	C23G	C2R001	Mooi	1987	20.85	Irrigation
	72	Klipdrift	C23J	C2R005	Loopspruit	1918	13.6	Irrigation
UC2	33, 34	Sterkfontein	C81D	C8R003	Nuwejaarspruit	1987	2616.0	Municipal, industrial - Harrismith, Rand Water
	-	Driekloof	C81D	C8R007	Off-channel	1986	32.2	Hydro-electric, off-channel
	29	Fika-Patso	C81F	C8R008	Namahadi	1996	28.0	Municipal, industrial - Witsieshoek, Phuthadijhaba
	29	Swartwater	C81F	C8R002	Metsi-Matsho	1976	4.38	Municipal, industrial - QwaQwa
UC1	28	Warden	C82B	-	Cornelisspruit	No date	0.10	Municipal - Warden
UD	41	Saulspoort	C83A	C8R004	Liebenbergvlei	1986	16.87	Municipal, industrial - Bethlehem
	43	Loch Athlone	C83B	C8R005	Jordaanspruit	1925	3.74	Recreation
	43	Gerrands	C83B	C8R006	Gerrandsspruit	1905	1.35	Municipal, industrial - Bethlehem
UM	74	Vaal Dam	C83M	C1R001	Vaal		2609.8	Municipal, industrial, irrigation - Rand Water, Grootvlei Power Station, Deneysville, Sasolburg

The selection of sub-components (quantity, quality, habitat and biota) to determine specific RQOs will be undertaken during step 5 of the process.

4.4 PRIORITY GROUNDWATER RESOURCE UNITS AND ECOSYSTEMS FOR THE UPPER VAAL WMA

One of the most important findings to highlight was the fact that a lot of intimate knowledge about the areas represented by the RU's resides with the public. The available datasets however fail to address some of the critical issues in certain areas and this highlights the importance of the public participation process.

Although public participation can address gaps in the data, it can also skew the prioritisation process if not all areas are equally represented.

The final results of the prioritisation tool are shown in Figure 35.

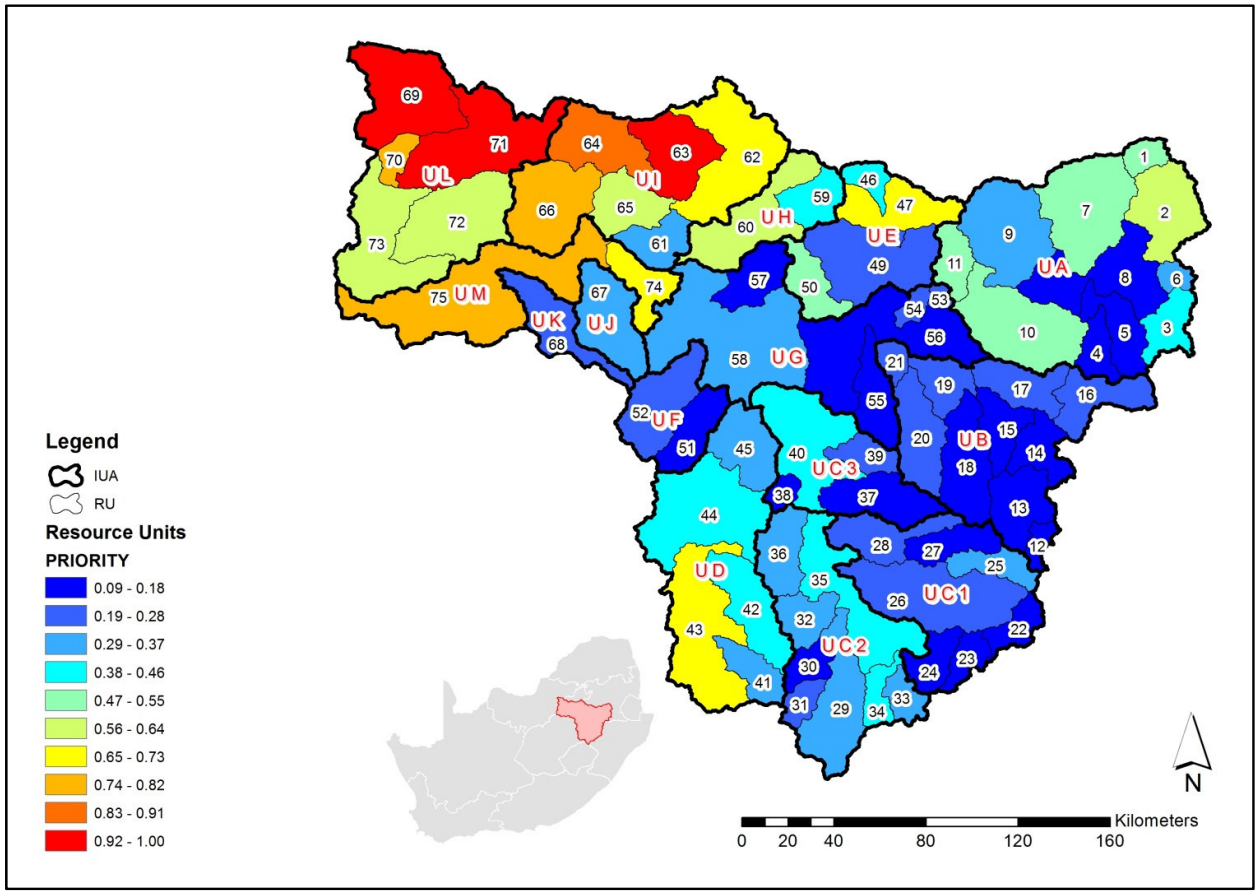


Figure 35: Upper Vaal groundwater RU prioritization

Due to the large number of groundwater resources units that were prioritised, stakeholders (regulators) promoted a cut-off point of 30 resource units which were the addressed for RQO determination. The top 30 priority groundwater resources units are shown in Figure 36.

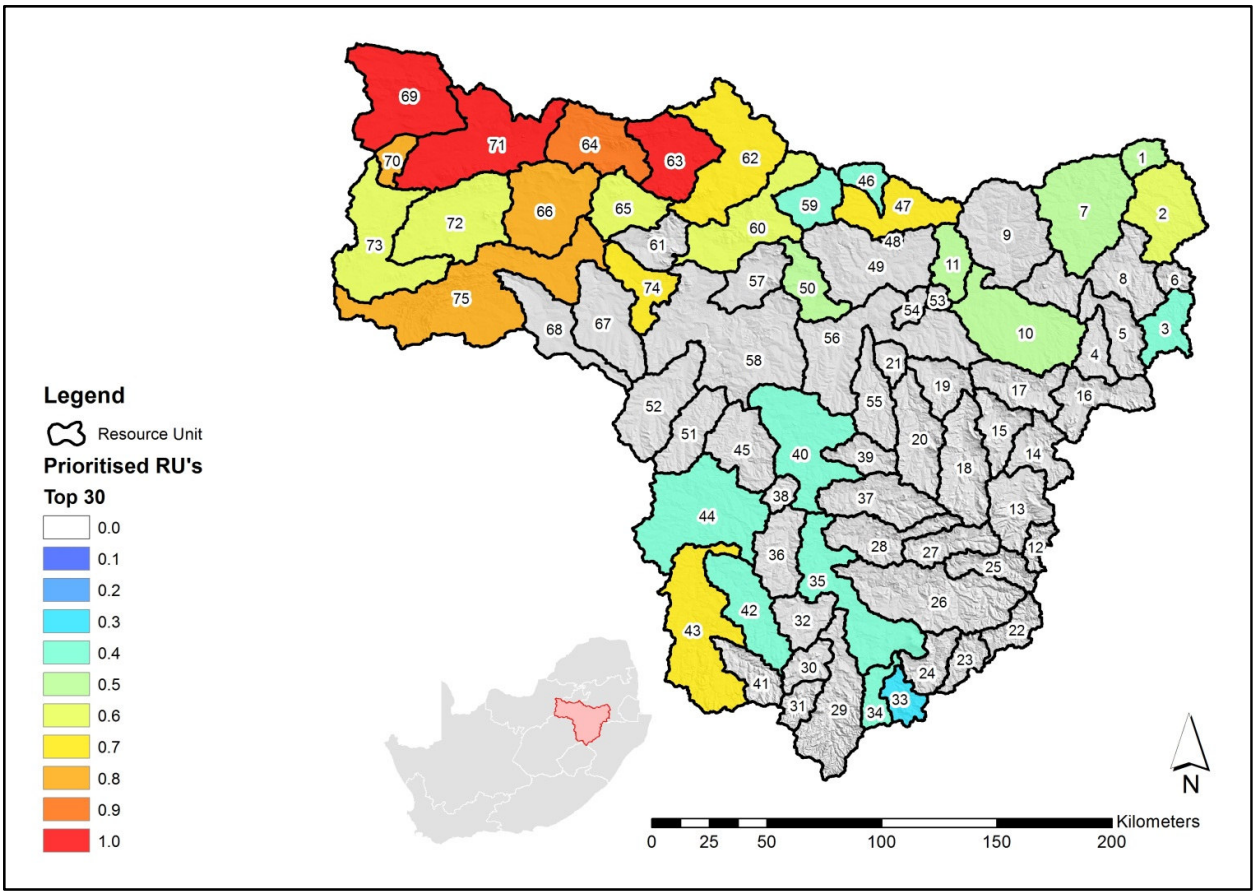


Figure 36: Top 30 groundwater resource units

4.5 STAKEHOLDERS COMMENT MANAGEMENT

Participants at the Upper Vaal WMA Resource Unit Prioritisation workshop held on the 24th to the 26th of July 2013 were invited to evaluate the workshop by completing a workshop evaluation questionnaire (APPENDIX F). The questions were structured to assess five areas namely:

- The purpose of the workshop,
- The participation level,
- The availability of information,
- The timing or scheduling of activities within the workshop and
- The facilitation of the workshop.

In total 23 evaluation sheets were received which is summarised below with questions and analysis of the responses.

4.5.1 THE PURPOSE OF THE WORKSHOP

Do you feel that the workshop achieved the stated objectives?

In response to the above question, a significant proportion (71%) of respondents found that the workshop had achieved its stated objectives and the remaining 29% felt it only partially achieved its objectives. The reasons stated for this is that some participants felt that the wetland and dam presentations were not due for release yet i.e. premature release of information which needed to be supplemented. Another respondent found that the pace was too fast as they were not a professional in the field.

4.5.2 THE PARTICIPATION LEVEL

Were you able to contribute meaningfully?

When asked whether they were able to make a meaningful contribution towards the prioritisation of resource units, 78% of participants stated that they had. Twelve percent 12% of participants responded that they were not fully able to contribute. The other 9% responded that they weren't able to able to contribute at all.

One Null response was received from a respondent who did not submit an answer in the provided fields. One of the afore mentioned respondents was new to the system and felt that (s)he could not make a meaningful contribution. The second respondent in the "Null" response category indicated that his/her contributions were limited to the Upper Vaal and this was a restriction to their contribution in the workshop. Other respondents added that they prefer to have received background information prior to the workshop.

4.5.3 THE AVAILABILITY OF INFORMATION

Were you provided with sufficient information?

The large majority (88%) of respondents agreed that they had received sufficient information to prioritise resource units. Nine (9%) of respondents only partially agreed.

Some participants indicated that there were gaps in the provided information by marking the "Partially" field in the evaluation form. Reasons for this response are shown by two respondents. One respondent felt that the cultural information was not considered as highly as other sub-criteria. Another stated that during the workshop sufficient information was provided, but prior to the workshop (s)he would have like some information.

4.5.4 THE TIMING OR SCHEDULING OF ACTIVITIES WITHIN THE WORKSHOP

Were you provided with sufficient time to contribute to the process?

Most respondents (90%) indicated that they were afforded sufficient time to contribute to the process. One respondent (5%) was not fully satisfied with the allocated time for stakeholder input and another respondent (5%) did not answer the question.

Was the length of the workshop adequate?

When asked about the duration of the workshop, 87 % of respondents indicated that they found the length of the workshop to be adequate. One (4 %) respondent indicated that (s)he found that the workshop was too long. Two responses (8%) were classified in the "Null" category. One belongs to a respondent who ticked two boxes and the other to a respondent who did not answer the question.

4.5.5 THE FACILITATION OF THE WORKSHOP

Was the workshop facilitation adequate?

Almost all (96%) of the respondents indicated that they found the workshop facilitation adequate with 1 null response (4%) from a respondent that did not answer the question.

5 LIMITATIONS AND UNCERTAINTIES

SOME OF THE KEY LIMITATIONS WHICH MAY INFLUENCE THE CONFIDENCE OF THE OUTCOMES OF THE RESOURCE UNIT AND ECOSYSTEM PRIORITISATION PROCESS WHICH SHOULD BE CONSIDERED WHEN IMPLEMENTING THESE PRIORITY RUS AND ECOSYSTEMS INCLUDE:

5.1 RIVERS

- Quantitate data availability was limited which necessitated the use of qualitative data and specialist solicitations. This limitation was particularly evident in the moderately to minimally impacted areas of the Water Management Area. Through the implementation of RQOs real data would be generated to evaluate the accuracy of RU prioritisation process.
- Stakeholder representation of some IUAs were limited which may have resulted in these areas being neglected during the prioritisation process.
- The requisite simplicity principal was adopted in the study to prioritise RUs. In addition, stakeholders considered the capacity and resource availability of the regional regulators to prioritise RUs for RQO determination. These may result in the prioritisation of insufficient RUs for RQO determination which may inadequately address the protection requirement of the vision of the RQO determination process (available from the WRC study).

5.2 WETLANDS

- It should be noted that available datasets used, were either datasets generated at a national scale or surrogate datasets. Therefore, the prioritisation of wetlands is based on broad scale datasets.
- The number of specialist / stakeholders who were able to attend the final stakeholder / specialist workshops.
- The requisite simplicity principal was adopted in the study to prioritise wetlands. In addition, stakeholders considered the capacity and resource availability of the regional regulators to prioritise wetlands for RQO determination. These may result in the prioritisation of insufficient RUs for RQO determination which may inadequately address the protection requirement of the vision of the RQO determination process (available from the WRC study).

5.3 DAMS

- Quantitate data availability was limited which necessitated the use of qualitative data and specialist solicitations. This limitation was particularly evident in the moderately to minimally impacted areas of the Water Management Area. Through the implementation of RQOs real data would be generated to evaluate the accuracy of RU prioritisation process.
- Stakeholder representation of some IUAs were limited which may have resulted in these areas being neglected during the prioritisation process.

5.4 GROUNDWATER

- Quantitate data availability was limited which necessitated the use of qualitative data and specialist solicitations. This limitation was particularly evident in the moderately to minimally impacted areas of the Water Management Area. Through the implementation of RQOs real data would be generated to evaluate the accuracy of RU prioritisation process.
- Stakeholder representation of some IUAs were limited which may have resulted in these areas being neglected during the prioritisation process.
- The requisite simplicity principal was adopted in the study to prioritise groundwater RUs. In addition, stakeholders considered the capacity and resource availability of the regional regulators to prioritise groundwater RUs for RQO determination. These may result in the prioritisation of insufficient RUs for RQO determination which may inadequately address the protection requirement of the vision of the RQO determination process (available from the WRC study).

6 WAY FORWARD

Step 4 of the RQO methodology entails prioritising sub-components for RQO determination and the selection of indicators for monitoring. Each of the prioritised RUs (detailed in this report) will therefore by subjected to more detailed analyses to identify which sub-components present in these RUs should be protected in order to support water resource dependent activities and/or maintain the integrity and ecological functioning of the water resource. This information is then used to prioritise sub-components for RQO determination.

Wetlands were prioritized for RQO determination through a systematic desktop GIS process and supplemented with priorities identified by key local stakeholders. A final subset of wetlands was then selected at a focussed stakeholder meeting based on their importance for biodiversity conservation and / or their functional importance. The focus during subsequent steps will be to select sub-components and indicators for RQO determination for these prioritised wetlands. Regional-level RQOs will also be developed to cater for the plethora of other wetland ecosystems not catered for through this resource unit based approach

7 ACKNOWLEDGEMENTS

We would like to acknowledge the contributions made by the stakeholders of the Upper Vaal Water Management Area who participated in the stakeholder workshop to the RQO determination process. The information and direction provided by these stakeholders has made a noticeable contribution to the study. In addition we acknowledge the contributions made by scientists and consultants who provided information to the study team.

8 REFERENCES

Department of Water Affairs and Forestry, 1998. South African National Water Act (Act No. 36 of 1998). Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF), 2009. Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Lower Vaal Water Management Area Technical Component: Wetland/Pans Assessment report. Report no: RDM/ WMA10 C000/ 01/CON/0507. Pretoria, South Africa

Department of Water Affairs (DWA), 2010. Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: Wetland Report. Report authored Rountree, WM (Fluvius Environmental Consultants). Edited by Louw, D and Koekemoer, S. Report no: RDM/WMA8 C000/01/CON/0410.DWA

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

Department of Water Affairs, South Africa, August 2012. Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8, 9, 10: Management Classes of the Vaal River Catchment Report

Department of Water Affairs (DWA). 2012a. Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): INCEPTION REPORT. Report No.: RDM/WMA08/00/CON/RQO/0112. Chief Directorate: Water Ecosystems: Compliance. Study No.: WP10536. Prepared by the Institute of Natural Resources (INR) NPC. INR Technical Report No.: INR 493/14 (i). Pietermaritzburg, South Africa

Department of Water Affairs (DWA). 2012b. Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): GAP ANALYSIS REPORT. Report No.: RDM/WMA08/00/CON/RQO/0212. Chief Directorate: Water Ecosystems: Compliance. Study No.: WP10536. Prepared by the Institute of Natural Resources (INR) NPC. INR Technical Report No.: INR 493/14 (ii). Pietermaritzburg, South Africa.

Department of Water Affairs, South Africa, August 2012. Classification of Significant Water Resources (River, Wetlands, Groundwater and Lakes) in the Upper, Middle and Lower Vaal Water Management Areas (WMA) 8, 9, 10: Management Classes of the Vaal River Catchment Report

Department of Water Affairs (DWA). 2013a. Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): RESOURCE UNIT DELINEATION REPORT. Report No.: RDM/WMA08/00/CON/RQO/0113. Chief Directorate: Water Ecosystems: Compliance. Study No.: WP10536. Prepared by the Institute of Natural Resources (INR) NPC. INR Technical Report No.: INR 493/14 (iii). Pietermaritzburg, South Africa.

Department of Water Affairs (DWA). 2013b. Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): RESOURCE UNIT PRIORITISATION REPORT. Report No.: RDM/WMA08/00/CON/RQO/0213. Chief Directorate: Water Ecosystems: Compliance. Study No.: WP10536. Prepared by the Institute of Natural Resources (INR) NPC. INR Technical Report No.: INR 493/14 (iv). Pietermaritzburg, South Africa.

Department of Water and Sanitation (DWS). 2014a. Determination of Resource Quality Objectives in the Upper Vaal Water Management Area (WMA8): SUB-COMPONENT PRIORITISATION AND INDICATOR SELECTION REPORT. Report No.: RDM/WMA08/00/CON/RQO/0114. Chief Directorate: Water Ecosystems: Compliance. Study No.: WP10536. Prepared by the Institute of Natural Resources (INR) NPC. INR Technical Report No.: INR 493/14 (v). Pietermaritzburg, South Africa.

Kotze, D.C, Marneweck, G.C, Batchelor, A.L., Lindley, D.S. and Collins, N.B (2007). WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria.

Exigent Engineering Consultants, 2006. An inventory of wetlands in the Upper Olifants catchment.

Murray R, Baker K, Ravenscroft P, Musekiwa C and Dennis R (2011) A Groundwater Planning Toolkit for the Main Karoo Basin: Identifying and quantifying groundwater development options incorporating the

concept of wellfield yields and aquifer firm yields. WRC Report No: 1763/1/11 Water Research Commission, Pretoria.

South African National Standards (SANS), 2005. Drinking Water Quality Management Guide for Water Services Authorities, SANS, 241: 2005 Drinking Water Specification

9 APPENDICES

APPENDIX A: SUMMARY OF THE DATA USED TO SCORE THE DESKTOP APPLICATION OF THE RU PRIORITISATION TOOL FOR RIVERS IN THE STUDY.

Appendix A1: Summary of the data and associated processing methods used to score each criterion and sub-criterion in the RUPT for rivers in the study.

1. Position of the Resource Unit within the IUA

a) Location of the Resource Unit

Resource Units on large mainstem rivers at the downstream end of the IUAs are located at the edge of socio-economic zones where user requirements are likely to differ. Such Resource Units also aggregate the upstream impacts from the entire IUA and thus enable the assessment of management performance at meeting objectives for the upstream catchment.

The Upper Vaal WMA contains a total of 15 IUAs. In some instances it was difficult to identify which RU was located at the base. In such cases, these RUs were flagged for discussion with stakeholders. The following Resource Units are located at the base of each of the IUAs and have therefore been assigned a score of 1. The remainder of the Resource Units were scored as 0.

IUA number	Associated RU at the base of the IUA
UV-A	RU8
UV-B	RU21
UV-C1	RU28
UV-C2	RU36
UV-C3	RU40
UV-D	RU45
UV-E	RU50
UV-F	RU52
UV-G	RU58
UV-H	RU60
UV-I	RU65
UV-J	RU67
UV-K	RU68
UV-L	RU73
UV-M	RU75

2. Importance to users

a) Presence of cultural services

Cultural services are defined as the non-material benefits that people obtain from contact with ecosystems. They include recreational, aesthetic and spiritual benefits (TEEB, 2010). Resource Units which provide these benefits should be protected as they contribute to the wellbeing of society.

The WRC study for the Vaal WMAs undertook an ecosystem services assessment in which they assessed the following ecosystem services:

- Recreational fishing
- Subsistence fishing
- Other recreational aspects associated with the rivers
- Riparian vegetation usage
- Waste water dilutions
- Floodplain agricultural usage of subsistence purposes.

This information was generated via site visits and available literature and converted into a socio-cultural importance score (SCI). The SCI provides an indication of the river resource dependence by those who rely directly on such aspects for their survival. The SCI for each Resource Unit was converted into a relative percentage. These percentages were then converted into three classes namely 0-33%, 34-66% and 67-100% and scored as 0, 0.5 and 1 respectively within the RUPT.

b) Presence of significant vulnerable communities

Many poor communities are directly reliant on water resources for domestic water use, food, grazing, medicine, and building materials. Rivers provide an important source of water for many vulnerable communities in the Upper Vaal WMA. The Census 2011 data identifies the source of water for households across the country and classifies the source according to 11 categories. Two of these categories, namely dam/pool/stagnant water and rivers/streams have been used to identify the location of vulnerable communities who are dependent on natural surface water resources in the Upper Vaal WMA

All categories provided in Statistics South Africa 2011 Census data	Categories used as indicators of vulnerable communities
Piped water inside dwelling	Dam/pool/stagnant water River/stream
Piper water inside yard	
Piped water on community stand: distance less than 200m from dwelling	
Piped water on community stand: distance greater than 200m from dwelling	
Borehole	
Spring	
Rain-water tank	
Dam/pool/stagnant water	
River/stream	
Water vendor	
Other	

The number of households within each of the selected categories was calculated per ward. Households were assumed to be uniformly distributed across each ward. Where a ward was located across two Resource Units, an area percentage was used to calculate the number of households within the portion of the ward occurring in each Resource Unit. The total number of households for all wards occurring within a Resource Unit was then summed to give an indication of the total number of households dependent on natural surface water resources within each Resource Unit.

In order to identify Resource Units which include more vulnerable communities than another, quantiles were used. This method divides the total number of Resource Units into three equal categories. All Resource Units occurring in the category with the highest number of vulnerable households were scored as a 1, while all Resource Units falling into the middle category were scored as 0.5. All Resource Units falling into the category containing the least number of vulnerable households were scored as 0.

c) Use in meeting strategic requirements

The economic component of the WRC study undertook an assessment of the contribution of different sectors to the GDP per IUA. The values for the "power generation" sector were used in the current prioritisation process.

IUA	Total contribution of power generation to GDP (R million)	Relative percentage	Score

UV-UA	24331.26	83	1
UV-UB	0.00	0	0
UVC1-UVC3	0.00	0	0
UV-UD	0.00	0	0
UV-UE	0.00	0	0
UV-UF	0.00	0	0
UV-UG	0.00	0	0
UV-UH and UV-UI: C21D-C21G	0.00	0	0
Partly UV-UI:C22A-C22E; C22H & C22J	0.00	0	0
UV-UL	0.00	0	0
UV-UM incl. UV-UJ, UV-UK	29420.09	100	1

These values were converted into relative percentages, categorised according to three classes namely 0-33%, 34-66% and 67-100% and scored as 0, 0.5 and 1 respectively. All Resource Units occurring in the specified IUA were scored the same.

d) Presence of important regulating and supporting services

The only regulating and supporting service that was assessed for this criterion was the waste treatment function. A spatial layer was generated based on the physico-chemical metric from PES-EIS study to indicate demand whilst a supply layer was generated using stream order (assuming that bigger streams have greater capacity to assimilate waste). These two layers were then combined. Areas with both high supply and high demand were considered important for current use and scored as 1 whilst areas with high supply and low demand were considered important for future use and scored as 0.5.

e) Presence of activities supporting the economy

The economic component of the WRC study undertook an assessment of the contribution of different sectors to the GDP per IUA. The information in relation to mining, manufacturing and irrigation was used to assess the presence of activities supporting the economy.

IUA	**Value**	**Relative percentage**	**Score**
UV-UA	13885.54	14	0
UV-UB	1528.76	2	0
UVC1-UVC3	1475.77	2	0
UV-UD	1828.84	2	0
UV-UE	97244.41	100	1
UV-UF	14.23	0	0
UV-UG	36098.54	37	0.5
UV-UH and UV-UI: C21D-C21G	51705.24	53	0.5
Partly UV-UI:C22A-C22E; C22H & C22J	53848.70	55	0.5
UV-UL	12605.91	13	0
UV-UM incl. UV-UJ, UV-UK	38336.39	39	0.5

These values were converted into relative percentages, categorised according to three classes namely 0-33%, 34-66% and 67-100% and scored as 0, 0.5 and 1 respectively. All Resource Units occurring in the specified IUA were scored the same.

3. Level of threat posed to users

The data used to assess the threat posed to users of the resource unit was sourced from Dr Neels Kleynhans at the Department of Water and Sanitation. This data forms part of the 2011/2012 desktop assessment of the

PES/EIS of the WMA. For the purposes of the RUPT, three metrics were considered based on their potential to alter the in-stream condition of rivers within the resource unit. These included:

- Potential Instream Modification Activities
- Potential Flow Modification Activities
- Potential Physico-Chemical Modification Activities

Each of these metrics was scored as follows:

Threat description	Rating
None	0
Small	1
Moderate	2
Large	3
Serious	4
Critical	5

The maximum score from any of the three metrics was incorporated into the RUPT.

4. Ecological importance

a) Resource units with a high or very high EIS category

The Management Class report of the Water Resource Classification for the Vaal WMAs details the category for Ecological Importance and Sensitivity of each biophysical node in the study area. These categories range from "very high" to "very low". These categories were converted to scores for with "very high" assigned a score of 1, "high" assigned a score of 0.5 and the remainder of the categories scored as 0. The resulting scores for each Resource Unit were included in the prioritisation tool.

b) Resource units which have an A/B NEC and / or PES

The Water Resource Classification for the Vaal WMAs details both Present Ecological State information as well as the proposed ecological category for each biophysical node which must be met if the recommended Management Class is to be attained. This information was interrogated to identify those RUs which are currently or required to be in an A or B state. These categories were converted to a score with an A or A/B category scored as 1, a B category scored as 0.5 and the remainder of the categories scored as 0. The maximum score of either the PES or REC was included for the respective Resource Units within the prioritisation tool.

c) Resource units identified as National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project identifies a number of freshwater ecosystem priority areas necessary to meet national biodiversity goals for freshwater ecosystems. River FEPAs achieve biodiversity targets for river ecosystems and threatened/near-threatened fish species, and were identified in rivers that are currently in a good condition (A or B ecological category) (Nel *et al*., 2011). Resource Units which contained a FEPA were scored as 1 in the prioritisation tool. The NFEPA project also identified Phase 2 FEPAs. Phase 2 FEPAs are located in moderately modified (C) rivers and their condition should not be degraded further, as they may in future be considered for rehabilitation once good condition FEPAs (in an A or B ecological category) are considered fully rehabilitated (Nel *et al*., 2011). Resource Units containing a Phase 2 FEPA were scored as 0.5 in the prioritisation tool.

d) Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans

Aquatic biodiversity plans have been developed for a number of provinces. These plans incorporate NFEPA data which has already been considered as a separate sub-criterion in the Resource Unit prioritisation tool. To avoid double accounting, these plans were excluded from the assessment. However, the presence of conservancies and both formally and informally protected areas was interrogated. The National Protected Areas coverage was overlaid with the study area in a GIS environment to identify the location of protected areas relative to each Resource Unit. No conservancies or informally protected areas were located in this WMA. Resource Units which contained a formally protected area were scored as 1. The protected areas considered during the assessment are detailed below:

- Alice Glockner Provincial Nature Reserve
- Rondebult Bird Sanctuary
- Klipriviersberg Municipal Nature Reserve
- Abe Bailey Provincial Nature Reserve
- Boskop Dam Nature Reserve
- Vaaldam Nature Reserve

5. Level of threat posed to ecological components of the resource unit

The same scores as those reflected under the "Level of threat posed to users" criterion were used for this criterion.

6. Management considerations

a) Resource Units with PES lower than a D category or lower than the accepted Gazetted Category

The Resource Directed Measures Integrated Manual (1999) sets out a default rule which states that "the management class is determined in relation to the present state, but at a level which represents a goal of no further degradation for water resources which are largely modified, and at least a move toward improvement for water resources which are critically modified". Similarly, the National Water Resources Strategy (2002) states that "any water resource which demonstrates 'Unacceptable' conditions is deemed to be unsustainable. In these cases the management class will be determined as a minimum of 'Heavily used/impacted' (the lowest management class), and management will aim to rehabilitate the water resources to this state". In line with this thinking, the Water Resource Classification for the Upper Vaal WMA considers that an E category is unsustainable and cannot be recommended as an ecological condition. This principle was also adopted in the RQO methodology. Consequently, any Resource Units with a PES lower than a D category must be prioritised for management action. Six Resource Units in the Upper WMA have a PES of a "D/E" or "E" and have therefore received a score of 1 in the prioritisation tool. A further nine have a PES lower than the accepted Gazetted Category. These RUs have therefore also received a score of 1 in the prioritisation tool.

7. Practical considerations

a) Monitoring points

The Department of Water and Sanitation undertakes a number of national monitoring programmes including the National Chemical Monitoring Programme (NCMP), the National Microbiological Monitoring Programme (NMMP) and the River Health Programme (RHP). In addition, the Department has a number of routine water quality monitoring sites and Ecological Water Requirement (EWR) sites. The location of these monitoring sites relative to each of the Resource Units was identified. Resource Units which contained either a EWR or RHP site were scored as 1 while those Resource Units which contained any other monitoring site received a score of 0.5. The maximum score assigned to each Resource Unit was included as the final score for this sub-criterion in the Resource Unit prioritisation tool.

b) Accessibility

No desktop data was available to score this sub-criterion and it was therefore excluded from the initial prioritisation process.

c) Safety risk

No desktop data was available to score this sub-criterion and it was therefore excluded from the initial prioritisation process.

Appendix A2: RU scores for each criterion and sub-criterion applied in the desktop application of the RUPT for rivers in the study.

RESOURCE UNIT PRIORITISATION TOOL																					
Criterion	Sub-criteria	RU 1	RU 2	RU 3	RU 4	RU 5	RU 6	RU 7	RU 8	RU 9	RU 10	RU 11	RU 12	RU 13	RU 14	RU 15	RU 16	RU 17	RU 18	RU 19	RU 20
Position of resource unit within IUA		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Importance for users (Current & anticipated future use)	Cultural services	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	0	1	0.5	0.5	0.5	0.5
	Presence of significant vulnerable communities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Use in meeting strategic requirements and international obligations	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Presence of supporting and regulating services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Presence of activities supporting the economy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threat posed to users	Level of threat posed to users	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
Ecological Importance	Resource units with a high or very high EIS category	0	0	0	0	0	0	0	0.5	0	0	0	0.5	0.5	0	0	0	0	0	0	0
	Resource units which have an A/B NEC and / or PES	0.5	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0	0	0	0.5	0	0
	Resource units identified as National Freshwater Ecosystem Priority Areas	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1	1	1
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threat faced by ecological component of the RU	Level of threat posed to ecological components of the resource unit	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
Management Considerations	Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0
Practical Considerations	Availability of monitoring data	0.5	0.5	1	1	0.5	0.5	0.5	1	0.5	0	0.5	1	0.5	0	1	0.5	0	0	1	0.5
	Accessibility of resource unit for monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Safety risk associated with monitoring resource units.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PRIORITISATION SCORES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.16	0.01	0.08	0.07	0.06	0.02	0.07	0.07	0.07	0.07
		0.12	0.10	0.06	0.10	0.10	0.06	0.10	0.11	0.10	0.10	0.13	0.07	0.13	0.12	0.10	0.00	0.10	0.12	0.10	0.10
		0.15	0.02	0.05	0.05	0.02	0.02	0.02	0.05	0.02	0.00	0.02	0.05	0.15	0.13	0.05	0.02	0.00	0.13	0.05	0.02
		0.37	0.22	0.21	0.25	0.22	0.19	0.22	0.51	0.22	0.20	0.31	0.12	0.36	0.31	0.21	0.04	0.17	0.31	0.22	0.19
		0.7	0.4	0.4	0.5	0.4	0.4	0.4	1.0	0.4	0.4	0.6	0.2	0.7	0.6	0.4	0.1	0.3	0.6	0.4	0.4

RESOURCE UNIT PRIORITISATION TOOL																					
Criterion	**Sub-criteria**	RU 21	RU 22	RU 23	RU 24	RU 25	RU 26	RU 27	RU 28	RU 29	RU 30	RU 31	RU 32	RU 33	RU 34	RU 35	RU 36	RU 37	RU 38	RU 39	RU 40
Position of resource unit within IUA		1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
Importance for users (Current & anticipated future use)	Cultural services	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	1	0.5	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5	0.5
	Presence of significant vulnerable communities	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Use in meeting strategic requirements and international obligations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Presence of supporting and regulating services	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0
	Presence of activities supporting the economy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threat posed to users	Level of threat posed to users	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	1	0.5	0	0.5	1	1	1	0.5	0.5	0.5	0.5	0.5
Ecological Importance	Resource units with a high or very high EIS category	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Resource units which have an A/B NEC and / or PES	0	1	0.5	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
	Resource units identified as National Freshwater Ecosystem Priority Areas	0	1	0	1	0	1	1	1	0	0	0	0	1	0	0	0	1	1	1	1
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threat faced by ecological component of the RU	Level of threat posed to ecological components of the resource unit	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	1	0.5	0	0.5	1	1	1	0.5	0.5	0.5	0.5	0.5
Management Considerations	Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Practical Considerations	Availability of monitoring data	0	1	0	0.5	1	0.5	1	0.5	1	0.5	0	0.5	0.5	1	1	0	1	0	1	0.5
	Accessibility of resource unit for monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Safety risk associated with monitoring resource units.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PRIORITISATION SCORES	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.25
		0.07	0.06	0.07	0.07	0.01	0.07	0.07	0.07	0.18	0.07	0.02	0.07	0.13	0.13	0.13	0.07	0.07	0.07	0.07	0.07
		0.06	0.15	0.08	0.10	0.02	0.10	0.10	0.10	0.13	0.06	0.02	0.06	0.16	0.13	0.13	0.06	0.10	0.10	0.10	0.10
		0.00	0.05	0.00	0.02	0.05	0.02	0.05	0.02	0.05	0.02	0.00	0.02	0.02	0.05	0.05	0.00	0.05	0.00	0.05	0.02
		0.38	0.26	0.15	0.19	0.07	0.19	0.22	0.44	0.35	0.16	0.03	0.16	0.32	0.31	0.31	0.38	0.22	0.17	0.22	0.44
		0.7	0.5	0.3	0.4	0.1	0.4	0.4	0.9	0.7	0.3	0.1	0.3	0.6	0.6	0.6	0.7	0.4	0.3	0.4	0.9

RESOURCE UNIT PRIORITISATION TOOL																					
Criterion	Sub-criteria	RU 41	RU 42	RU 43	RU 44	RU 45	RU 46	RU 47	RU 48	RU 49	RU 50	RU 51	RU 52	RU 53	RU 54	RU 55	RU 56	RU 57	RU 58	RU 59	RU 60
Position of resource unit within IUA		0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1
Importance for users (Current & anticipated future use)	Cultural services	0.5	0.5	0.5	0.5	0	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0.5	0.5	0.5	0
	Presence of significant vulnerable communities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Use in meeting strategic requirements and international obligations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Presence of supporting and regulating services	0	0	0.5	0	0	0.5	1	0	0.5	0	0	0	0	0	0	0.5	0	0.5	0	0.5
	Presence of activities supporting the economy	0	0	0	0	0	1	1	1	1	1	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Threat posed to users	Level of threat posed to users	1	0.5	1	0.5	0.5	1	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5	0.5	0.5
Ecological Importance	Resource units with a high or very high EIS category	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5
	Resource units which have an A/B NEC and / or PES	0	0	0	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
	Resource units identified as National Freshwater Ecosystem Priority Areas	1	0	0	1	1	1	1	1	0	1	0	0.5	1	0	1	0	0	0.5	0	0
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Threat faced by ecological component of the RU	Level of threat posed to ecological components of the resource unit	1	0.5	1	0.5	0.5	1	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5	1	0.5	0.5	0.5	0.5
Management Considerations	Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Practical Considerations	Availability of monitoring data	0.5	0.5	1	1	1	1	1	0	0.5	1	1	1	1	1	0	1	0.5	1	0	1
	Accessibility of resource unit for monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Safety risk associated with monitoring resource units.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PRIORITISATION SCORES	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.25	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.25
		0.13	0.07	0.14	0.07	0.06	0.16	0.18	0.09	0.11	0.16	0.07	0.07	0.14	0.08	0.08	0.15	0.08	0.09	0.08	0.09
		0.16	0.06	0.13	0.12	0.12	0.16	0.16	0.10	0.06	0.16	0.06	0.08	0.16	0.06	0.10	0.13	0.06	0.08	0.08	0.08
		0.02	0.02	0.05	0.17	0.17	0.05	0.05	0.00	0.02	0.05	0.05	0.05	0.05	0.05	0.00	0.05	0.02	0.05	0.13	0.05
		0.32	0.16	0.31	0.36	0.60	0.37	0.39	0.19	0.19	0.62	0.18	0.45	0.35	0.19	0.18	0.32	0.17	0.47	0.29	0.46
		0.6	0.3	0.6	0.7	1.2	0.7	0.8	0.4	0.4	1.2	0.4	0.9	0.7	0.4	0.4	0.6	0.3	0.9	0.6	0.9

RESOURCE UNIT PRIORITISATION TOOL																
Criterion	**Sub-criteria**	RU 61	RU 62	RU 63	RU 64	RU 65	RU 66	RU 67	RU 68	RU 69	RU 70	RU 71	RU 72	RU 73	RU 74	RU 75
Position of resource unit within IUA		0	0	0	0	1	0	1	1	0	0	0	0	1	0	1
Importance for users (Current & anticipated future use)	Cultural services	0	0.5	0.5	1	1	1	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0
	Presence of significant vulnerable communities	0	0	0.5	1	0	0	0	0	0	0	0	0	0	0	0
	Use in meeting strategic requirements and international obligations	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1
	Presence of supporting and regulating services	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0.5	0	1
	Presence of activities supporting the economy	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0	0.5	0.5
Threat posed to users	Level of threat posed to users	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1
Ecological Importance	Resource units with a high or very high EIS category	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0.5
	Resource units which have an A/B NEC and / or PES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Resource units identified as National Freshwater Ecosystem Priority Areas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans	0	1	1	1	0	0	0	0	0	0	1	0	1	1	0
Threat faced by ecological component of the RU	Level of threat posed to ecological components of the resource unit	0.5	1	1	1	1	1	0.5	1	1	1	1	1	1	1	1
Management Considerations	Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)	0	0	1	1	1	1	0	0	0	0	1	1	0	1	1
Practical Considerations	Availability of monitoring data	1	1	1	1	1	0.5	1	1	0.5	1	1	1	1	1	1
	Accessibility of resource unit for monitoring	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Safety risk associated with monitoring resource units.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PRIORITISATION SCORES	0.00	0.00	0.00	0.00	0.25	0.00	0.25	0.25	0.00	0.00	0.00	0.00	0.25	0.00	0.25
		0.08	0.15	0.17	0.19	0.16	0.15	0.12	0.18	0.13	0.13	0.13	0.13	0.14	0.17	0.19
		0.06	0.15	0.15	0.15	0.13	0.13	0.06	0.13	0.13	0.13	0.15	0.13	0.15	0.17	0.18
		0.05	0.05	0.17	0.17	0.17	0.15	0.05	0.05	0.02	0.05	0.17	0.17	0.05	0.17	0.17
		0.19	0.35	0.50	0.51	0.71	0.43	0.48	0.60	0.28	0.30	0.46	0.43	0.59	0.51	0.79
		0.4	0.7	1.0	1.0	1.4	0.8	0.9	1.2	0.5	0.6	0.9	0.8	1.2	1.0	1.5

APPENDIX A3: MOTIVATION FOR CHANGES TO SCORES FROM DESKTOP RU PRIORITISATION TOOL WHICH RESULTED IN THE AMENDED PRIORITISATION TOOL.

1. **Position of resource unit in IUA**

RU	Desktop	Workshop	Motivation for change
8	1	1	Selected as this is a site upstream of the dam.
10	0	1	New priority- two RUs at base.
11	0	1	New priority- two RUs at base.
24	0	1	Three outlets in UC1 and main stem river.
26	0	1	Three outlets in UC1 and main stem river.
35	0	1	New priority.
36	1	1	Node needs to move to the main stem.
51	0	1	UF has two main stem rivers.
61	0	1	Also an outlet in UI.
66	0	1	Prioritise because IUA has three main stem outlets.

2. **Resource units which provide important cultural services**

RU	Desktop	Workshop	Motivation for change
43	0.5	1	Community use and spiritual significance.
60	0	0.5	Score increased to 0.5 -stakeholder knowledge
61	0	1	Score changed to high -stakeholder knowledge
74	0	1	Score changed to high -stakeholder knowledge
75	0	1	Score changed to high -stakeholder knowledge

3. **Resource units which are important in supporting livelihoods of significant vulnerable communities.**

No changes

4. **Resource units which are important in meeting strategic requirements and international obligations.**

RU	Desktop	Workshop	Motivation for change
27	0	1	Memel area wetlands - Ramsar considerations
62	0	1	Blesbokspruit - Ramsar site
75	1	1	Vredefort Dome World Heritage site

5. **Resource units that provide supporting and regulating services**

RU	Desktop	Workshop	Motivation for change
1	0	0.5	Augmented flow
7	0	0.5	Sewage issues
9	0	0.5	Sewage issues because of poorly maintained network
53	0	0.5	Standerton WWTW area and pollution.
62	0	0.5	Volume of untreated sewage, issue of licences also not in line with requirements and density is also a factor.

6. Resource units most important in supporting activities contributing to the economy in the catchment

RU	Desktop	Workshop	Motivation for change
3	0	0.5	Inter-basin transfer scheme comes in here where water is used for power generation. Tugela-Klein Vaal Transfer Scheme
6	0	0.5	Inter-basin transfer scheme comes in here where water is used for power generation. Tugela-Klein Vaal Transfer Scheme
8	0	0.5	Inter-basin transfer scheme comes in here where water is used for power generation. Tugela-Klein Vaal Transfer Scheme
10	0	0.5	Usuthu and Little Vaal Transfer scheme
11	0	0.5	Tutuka power station
34	0	0.5	Transfer into Nuwejaarspruit. Water not released into the Vaal, power generation function mainly.
43	0	1	Prioritising the habitat and state that allows river to act as a conduit for water from Lesotho
44	0	1	Linked to Ash River and its morphological supply of ecosystem infrastructure
45	0	1	
58	0.5	1	Increased priority because of LHWP

7. Level of threat posed to users

RU	Desktop	Workshop	Motivation for change
1	0.5	1	Mining- future use in the IUA
2	0.5	1	Mining- future use in the IUA
3	0.5	0	Downgrade score because very little happens in this RU
4	0.5	0	Downgrade score because very little happens in this RU
5	0.5	0	Downgrade score because very little happens in this RU
6	0.5	0	Downgrade score because very little happens in this RU
7	0.5	1	Increase due to mining
9	0.5	1	Mining- future use in the IUA
16	0	0.5	Changed after discussion with stakeholders
49	0.5	0.5	Was discussed for change. Waterval catchment. Main stem bad quality but the tributaries are fine.
60	0.5	1	Bad water quality
61	0.5	1	Bad water quality
69	1	0.5	Local knowledge and limited use
70	1	0.5	Local knowledge and limited use

8. Resource units with a high or very high EIS category

RU	Desktop	Workshop	Motivation for change

16	0	1	11 species of astragalus found in this area & goldie barbs (Sandspruit: contact Byron Grant)
17	0	1	
35	0	1	Suggested for change-query
40	0	1	Fish refugia
58	0	1	Fish refugia

9. Resource units which have an A/B NEC and / or PES

RU	Desktop	Workshop	Motivation for change
1	0.5	0	Seems incongruent as this has significant mining activity - Upper Vaal upstream of Ermelo
44	0.5	0	These two RUs queried because of the transfer scheme-query the classification motivation for this score
45	0.5	0	

10. Resource units identified as National Freshwater Ecosystem Priority Areas

No changes for this sub-criterion.

11. Resource units identified as a priority in provincial / fine scale aquatic biodiversity plans

RU	Desktop	Workshop	Motivation for change
13	0	1	Seekoevlei Nature Reserve
14	0	1	
22	0	1	Pumping scheme and nature reserve
75	0	1	Vredefort Dome

12. Level of threat posed to ecological components of the resource unit

RU	Desktop	Workshop	Motivation for change
1	0.5	1	Threats from mining high in these RUs
2	0.5	1	Threats from mining high in these RUs
6	0.5	1	Threats from mining high in these RUs
7	0.5	1	Threats from mining high in these RUs
8	0.5	1	Threats from mining high in these RUs
9	0.5	1	Prospecting license in this RUs
13	0.5	0	Downgrade – stakeholder input
14	0.5	0	Downgrade – stakeholder input
15	0.5	0	Downgrade – stakeholder input
17	0.5	0	Downgrade – stakeholder input
18	0.5	0	Downgrade – stakeholder input
19	0.5	0	Downgrade – stakeholder input
20	0.5	0	Downgrade – stakeholder input

21	0.5	0	Downgrade – stakeholder input
22	0.5	0.5	New pump storage scheme in this RU
23	0.5	0	Downgrade – stakeholder input
24	0.5	0	Downgrade – stakeholder input
26	0.5	0	Downgrade – stakeholder input
27	0.5	0	Downgrade – stakeholder input
28	0.5	0	Downgrade – stakeholder input
30	0.5	0	Downgrade – stakeholder input
32	0.5	0	Downgrade – stakeholder input
33	1	0.5	Remember the potential releases from Sterkfontein in this RU (this was subsequently changed during the Workshops –RU downgraded in discussion)
34	1	0.5	
35	1	0.5	Downgrade – stakeholder input
39	0.5	0	Downgrade – stakeholder input
41	1	0	Very little activity in this RU
42	0.5	0	Downgrade – stakeholder input
44	0.5	1	Releases from Polihali Dam for future
45	0.5	1	
49	0.5	1	Intensive agriculture
55	0.5	0	Downgrade – stakeholder input
58	0.5	1	Releases from Polihali Dam for future
59	0.5	0.5	
68	1	0.5	Downgrade – stakeholder input

13. Resource units with PES lower than a D Category or lower than the accepted gazetted category (NEC)

RU	Desktop	Workshop	Motivation for change
1	1	0	Compare to latest PES/EIS
34	0	1	Has E/F in latest PES/EIS study Nuwejaarspruit
43	0	1	As and Jordaan rivers -Lesotho IBT too
46	0	1	Compare to latest PES/EIS
47	0	1	Compare to latest PES/EIS
62	0	1	Latest PES/EIS data
73	0	1	Latest PES/EIS data
74	1	0	Downstream of Vaal Dam-recovery of system

14. Availability of EWR site data or other monitoring data(RHP, DWAF gauging weirs etc.) located within reach

RU	Desktop	Workshop	Motivation for change
1	0.5	1	WQ monitoring by DWS in these RUs
2	0.5	1	
7	0.5	1	3 monitoring points available here

9	0.5	1	3 monitoring points available here
10	0	0.5	WQ monitoring point available-Geelklipspruit (Rand Water) Resource Unit is downstream of Majuba power station
14	0	1	Upper Klip monitoring site
20	0.5	1	WQ site -Vrede area
49	0.5	1	2 monitoring points here
66	0.5	1	Flow and Quality data available for this RU

15. Accessibility of resource unit for monitoring

No changes made for this sub-criterion.

16. Safety risk associated with monitoring resource units

No changes made for this sub-criterion.

APPENDIX B- CRITERIA AND ASSOCIATED WEIGHTINGS USED IN PRIORITIZING WETLANDS FOR RQO DETERMINATION. INITIAL GIS DATASETS ARE SHADED IN GREY

Level 1	Weight	Level 2	Weight	Level 3	Weight	Level 4	Weight	Level 5	Weight	Level 6
Priority Wetlands for Users	0.667	**Importance for Users**	0.089	Cultural Services	0.2	Ramsar Sites				
					0.2	Important Bird Areas (IBAs)				
					0.6	Protected Areas (PAs)				
			0.352	Livelihood Support	0.153	Income Levels				
					0.083	Population Density				
					0.192	Dwelling Type				
					0.571	Water Source				
			0.559	Regulating & Supporting Services	0.2	Flood Attenuation		Supply	0.5	Wetland Type
									0.5	Rip-Wet Modification
					0.2	Sediment & Erosion Control	0.5	Supply		Wetland Type
							0.5	Demand		Rip-Wet Modification
					0.6	Water Quality Enhancement	0.5	Supply		Wetland Type
							0.5	Demand	0.5	Population Density
									0.5	PES/EIS: Physico-Chemical
	0.333	**Threat to Users**			0.5	Population density				
Priority Wetlands for Protection (Environment)	0.333	**Threat to Resources**			0.5	PES/EIS: Pressures	0.311	Rip-Wet Modification		
							0.493	Pot Flow Modification		
							0.196	Pot Physico-Chemical Modification		
	0.667	**EIS**	0.75	Ecological Importance	0.255	PAs				
					0.132	Ramsar Sites				
					0.49	NFEPA	0.14	Wetland Vegetation		

Level 1	Weight	Level 2	Weight	Level 3	Weight	Level 4	Weight	Level 5	Weight	Level 6
								Groups		
							0.339	Rank (Importance)		
							0.152	WETFEPA		
							0.077	Wetland Clusters		
							0.23	PES		
							0.062	FEPA Catchments		
					0.122	REC				
			0.25	Sensitivity	0.5	Sensitivity: High Flows	0.5	Wetland Type		
							0.5	PES/EIS: Sensitivity	0.5	PES/EIS: Riparian-Wetland Instream vertebrates (ex. fish) intolerance water level / flow changes rating
									0.5	PES/EIS: Riparian-Wetland vegetation sensitivity to water levels rating
					0.5	Sensitivity: Low flows	0.5	Wetland Type		
							0.5	PES/EIS: Sensitivity	0.5	PES/EIS: Riparian-Wetland Instream vertebrates (ex fish) intolerance water level / flow changes rating
									0.5	PES/EIS: Riparian-Wetland vegetation sensitivity to water levels rating

APPENDIX C- SCORING AND WEIGHTING APPLIED TO DETERMINE IMPORTANT WETLANDS

Scoring and weighting applied to determine important wetlands from a cultural service perspective

CULTURAL SERVICES (CS)		
Criterion	**Description**	**Weighting**
Ramsar Sites	• Score = 0 or 1 • Ramsar weighted score. Calculated by scaling the Ramsar score to 0 or 0.2	0.2
Protected Areas (PA)	• Score = 0 or 1 • PA weighted score. Calculated by scaling PA score to 0 or 0.6	0.6
Important Bird Areas (IBA)	• Score = 0 or 1 • IBA weighted score. Calculated by scaling IBA score to 0 or 0.2	0.2
CS Score	**Calculated by adding weighted scores for Ramsar sites, PAs and IBAs. Score range = 0 - 1**	

Scoring and weighting applied to determine important wetlands from a livelihood support perspective

LIVELIHOOD SUPPORT (LS)		
Criterion	**Description**	**Weighting**
Income Level	STATSSA data for monthly income per ward. Monthly income categories were based on % low and very low income levels. Very Low = 0 < Sum of earnings <= 800 Low = 800 < Sum of earnings <= 6400 The following categories were used: 0 – 50 % low/very low income = 0 51 – 70 % low/very low income = 0.25 71 – 80 % low/very low income = 0.50 81 – 90 % low/very low income = 0.75 91 – 100 % low/very low income = 1 Income level weighted score. Calculated by scaling income level to 0 - 0.0.153	0.153
Population Density	STATSSA data for population density per ward. Population density categories were based on number of people per square kilometer. The following categories were used: 0 – 200 people = 0 201 – 400 people = 0.25 401 – 600 people = 0.50 601 – 1000 people = 0.75 More than 1000 people = 1 Population density weighted score. Calculated by scaling the score to 0 - 0.083	0.083
Dwelling Type	STATSSA data for dwelling type per ward. Dwelling type categories were based on % of summed traditional dwellings and informal settlements per ward. The following categories were used: 0 – 5 % very low informal dwellings = 0 5.1 – 10 % low informal dwellings = 0.25 10.1 – 20 % moderate informal dwellings = 0.50 20.1 – 40 % high informal dwellings = 0.75 More than 40 % very high informal dwellings = 1 Dwelling type weighted score. Calculated by scaling the score to 0 - 0.192	0.192
Water Source	STATSSA data for water source per ward. Water source categories were based on % of communities within wards reliant on 'natural' water sources, which included rivers, wetlands, dams, springs and rainwater tanks. The following categories were used: 0 – 2.5 % very low reliance = 0 2.5 – 5 % low reliance = 0.25 5 – 10 % moderate reliance = 0.50	0.571

LIVELIHOOD SUPPORT (LS)		
Criterion	**Description**	**Weighting**
	10 – 20 % high reliance = 0.75 20 – 45 % very high reliance = 1 Water source weighted score. Calculated by scaling the score to 0 - 0.571	
LS Score	**Calculated by adding the weighted scores for income level, population density, dwelling type and water source. Score range = 0 - 1**	

Scoring and weighting applied to determine important wetlands from a regulating and supporting service perspective

REGULATING & SUPPORTING SERVICES (RSS)		
Criterion	**Description**	**Weighting**
Flood Attenuation (FA)	Supply: • Supply of FA was based on wetland type and the condition of the wetland. • Wetland type scores were based on HGM types: Floodplain = 1; Valley-bottom – channelled = 0.25; Valley-bottom – unchannelled = 0.5; Valley head seeps = 0.25; Seeps = 0.25; Flat = 0; Depression = 0. • Riparian – Wetland Zone Modification data from the PES/EIS project (DWA, 2012) was used as surrogate data to provide an indication of current pressures on aquatic resources. The data was scaled to a range of 0 – 1. • Wetland type and riparian – wetland zone modification data scores were weighted equally (weighting = 0.5). Scores were then rescaled to 0 - 0.2. Demand: • No demand score was generated for FA.	0.2
Sediment & Erosion Control (SEC)	Supply: • Supply of SEC was based on wetland type. • Wetland type scores: Floodplain = 1; Valley-bottom – channeled = 0.7 5; Valley-bottom – unchannelled = 1; Valley head seeps = 0.5; Seeps = 0.5; Flat = 0; Depression = 0. Demand: • Riparian – wetland zone modification data (PES/EIS Project data) was used as a surrogate data layer to highlight possible areas where there is a need for SEC based on the extend of modification to the riparian – wetland zone. The data was scaled to a range of 0 – 1. Supply and demand scores for SEC were equally weighted (weighting = 0.5). Scores were then rescaled to 0 - 0.2.	0.2
Water Quality Enhancement (WQE)	Supply: • Supply of WQE was based on wetland type. • Wetland type scores: Floodplain = 1; Valley-bottom – channelled = 0.75; Valley-bottom – unchannelled = 1; Valley head seeps = 0. 5; Seeps = 0. 5; Flat = 0.5; Depression = 0.5. Demand: • Population density (refer to livelihood support) and potential physic-chemical modification data (PES/EIS Project data) was used as surrogate data to establish a likely demand layer. Potential physic-	0.6

REGULATING & SUPPORTING SERVICES (RSS)		
Criterion	**Description**	**Weighting**
	chemical modification data was scaled to a range of 0 – 1. Data sets were weighted equally. Supply and demand scores for WQE were equally weighted (weighting = 0.5). Scores were then rescaled to 0 - 0.6.	
RSS Score	**Calculated by adding the weighted scores for flood attenuation, sediment & erosion control, and water quality enhancement. Score range = 0 - 1**	

Scoring and weighting applied to determine threats to wetlands

WETLAND THREATS		
Criterion	**Description**	**Weighting**
Population Density	STATSSA data for population density per ward. Population density categories were based on number of people per square kilometer. The following categories were used: 0 – 200 people = 0 201 – 400 people = 0.25 401 – 600 people = 0.50 601 – 1000 people = 0.75 More than 1000 people = 1 Population density weighted score. Calculated by scaling the score to 0 - 0.5	0.5
PES/EIS Pressures	A potential threats layer was developed using population density and three metrics from the PES/EIS Project data, namely: • Riparian – wetland zone modification (weighting = 0.311) • Potential flow modification (weighting = 0.493) • Potential physic-chemical modification (weighting = 0.196) • Each of the data sets were scaled to a range of 0 – 1, and then rescaled to each of their respective weightings. PES/EIS Pressures weighted score. Calculated by scaling the score to 0 - 0.5	0.5
Threat Score	**Calculated by adding the weighted scores for population density and PES/EIS pressures. Score range = 0 - 1**	

Scoring and weighting applied to determine wetlands of ecological importance

ECOLOGICAL IMPORTANCE		
Criterion	**Description**	**Weighting**
Protect Areas (PA)	• Score = 0 or 1 • PA weighted score. Calculated by scaling PA score to 0 or 0.255	0.255
Ramsar Sites	• Score = 0 or 1 • Ramsar weighted score. Calculated by scaling the Ramsar score to 0 or 0.132	0.132
NFEPA	NFEPA layer comprises summed scores of the following layers: • Threatened wetland vegetation groups (Weighting = 0.14) • Wetland rank (Importance) (Weighting = 0.339) • WETFEPA(Weighting = 0.152) • Wetland clusters(Weighting = 0.077) • PES (Weighting = 0.23) • FEPA catchments (Weighting = 0.062) <u>Threat status of the wetland vegetation group</u> The threat status of the wetland vegetation group is based on levels of	0.49

ECOLOGICAL IMPORTANCE		
Criterion	**Description**	**Weighting**
	transformation and protection of wetland ecosystems with similar characteristics. Wetlands occurring within a threatened wetland group are regarded as having a greater ecological importance than those occurring within wetland vegetation groups of lower threat status. The following ratings based on the threat status of wetland vegetation groups were applied: CR = 1; EN = 0.5; VU = 0.25; NT = 0. Scores were then rescaled to 0 - 0.14. Wetland Rank (Importance) Wetlands were ranked (1=most important to 6=least important) in terms of their importance. This provided a useful basis for comparing the relative importance of wetlands in contributing towards biodiversity objectives. The following ratings based on the rank of wetlands were applied: 1 = 1; 2 = 0.8; 3 = 0.6; 4 = 0.4; 5 = 0.3; 6=0. Scores were then rescaled to 0 - 0.339. WETFEPA Priority wetlands selected to meet national wetland conservation targets. The following ratings based on WETFEPA status were applied: 1 = 1; Others=0. Scores were then rescaled to 0 - 0.152. Wetland clusters Wetland clusters are groups of wetlands within 1 km of each other and embedded in a relatively natural landscape. This allows for important ecological processes such as migration of frogs and insects between wetlands. The following ratings based on FEPA field were applied: 1 = 1; Others=0. Scores were then rescaled to 0 - 0.077. FEPA catchment FEPAs support the biodiversity sector's input into the development of Catchment Management Strategies and into the Water Resource Classification process. This database including FEPAs, RehabFEPAs, Fish Support Areas and Upstream management areas therefore highlights catchments where water resource management (including wetland management) is important to meet biodiversity targets. The following ratings based on the FEPA Code were applied: 1 = 1; 2 = 0.75; 3 = 0.5; 4 = 0.25; Others=0. Scores were then rescaled to 0 - 0.062. NFEPA weighted score was calculated by adding the scores of six criteria discussed above and rescaling to a range of 0 – 0.49	
Recommended Ecological Category (REC)	• The REC scores for rivers were used as a surrogate for RECs for wetlands. The following ratings based on REC scores were applied: AB = 1; BC = 0.75; C = 0.5; C/D = 0.25; Other = 0. Scores were then rescaled to 0 - 0.122.	0.122
Ecological Importance Score	**Calculated by adding the weighted scores for PAs, Ramsar sites, NFEPA data, and REC. Score range = 0 - 1**	

Scoring and weighting applied to determine wetlands of ecological sensitivity

ECOLOGICAL SENSITIVITY		
Criterion	**Description**	**Weighting**
Sensitivity - High Flows	• Wetlands were scored based on their sensitivity to floods. Floodplains are regarded as most sensitive, followed by valley bottoms, seeps and pans. The following ratings based on wetland type were applied: Floodplain = 1; Valley-bottom – channelled =	0.5

ECOLOGICAL SENSITIVITY		
Criterion	**Description**	**Weighting**
	0.75; Valley-bottom – unchannelled = 0.5; Hillslope seep = 0; Depression = 0. Scores were then rescaled to 0 - 0.5. • A potential sensitivity layer was developed using two metrics from the PES/EIS Project data as surrogates. These include: o Riparian-wetland Instream vertebrates (excluding fish) intolerance water level / flow changes rating; and o Riparian-Wetland vegetation sensitivity to water levels rating. The PES/EIS data sets were weighted equally and scaled to between 0 – 1. The combined score was rescaled to 0 – 0.5.	
Sensitivity - Low Flows	• Wetlands were scored based on their sensitivity to low flows. Unchannelled valley bottom wetlands are regarded as most sensitive, followed by seeps and other wetland types. The following ratings based on wetland type were applied: Floodplain = 0.5; Valley-bottom – channelled = 0.5; Valley-bottom – unchannelled = 1; Hillslope seep = 0.75; Depression = 0.5. Scores were then rescaled to 0 - 0.5. • A potential sensitivity layer was developed using two metrics from the PES/EIS Project data as surrogates. These include: o Riparian-wetland Instream vertebrates (excluding fish) intolerance water level / flow changes rating; and o Riparian-Wetland vegetation sensitivity to water levels rating. The PES/EIS data sets were weighted equally and scaled to between 0 – 1. The combined score was rescaled to 0 – 0.5.	0.5
Ecological Sensitivity Score	**Calculated by adding the weighted scores for high flows and low flows. Score range = 0 - 1**	

APPENDIX E – PLOTTING PROCEDURE FOR EXPANDED DUROV DIAGRAM

Data Interpretation with Piper and Durov Diagrams

Many facilities for the interpretation of water quality monitoring data exist. Some of these are well-known methodologies, such as statistical evaluations, line and bar charts, or plots of borehole and water-level information. Other methodologies are less known. These are, for instance, the so-called specialized chemical diagrams. Of these, only the Piper and Expanded Durov Diagrams will be discussed.

Piper and Expanded Durov Diagrams

The Piper and Expanded Durov Diagrams allow the plotting of eight chemical parameters for a single water sample. Either surface or ground-water chemistries may be plotted.

The procedure is as follows:

- Calculate concentrations for Ca, Mg, Na, K, Cl, SO_4, NO_3, T. Alk. in units of milli-equivalents per litre.
- Calculate relative percentages for the cations and anions.
- Plot the percentages cations in the bottom left triangle.
- Plot the percentages anions in the bottom right triangle.
- Project the two points to the central block on the Piper or Durov Diagrams and make a mark where the two projections cross.

Interpretation is as follows:

- It is a matter of personal preference whether the Piper or Durov Diagrams are used.
- Both diagrams should primarily be used as visual displays, summarizing the chemistry of all samples taken at a site, or at many sites.
- Of particular value is the identification of pollution trends, through the aid of these diagrams. A comparison between plots of successive sampling exercises, will clearly show whether or not trends in the chemistry of the water are developing. Trends to observe are:

  1) Sodium enrichment - typical of processes such as waste water discharge, chemical extraction of minerals from ore, dewatering of deep mines, return flow from irrigation or natural deterioration of the ground-water quality by ion exchange within the aquifer.

  2) Sulphate enrichment - typical of most mining environments.

  3) Calcium enrichment - typical of lime dosing to neutralize acid water.

  4) Chloride enrichment - typical of leachate from domestic waste and dewatering of deep mines.

A word of caution though: the ground-water chemistry is one of the most complex natural systems to predict, because of the many natural processes/parameters that could affect it. The following are but a few examples of chemical changes which could occur within an aquifer:

- Dissolution of soluble elements, such as Na, K, Cl and HCO_3.
- Precipitation of oversaturated species.
- Ion exchange and adsorption onto clays, such as Ca-adsorption and Na-release.
- Chemical reaction between two waters mixing.
- Natural decay of substances, such as modern pesticides.
- Bacterial oxidation/reduction, such as pyrite oxidation and sulphate reduction.
- Dispersion of pollutants through the aquifer.
- Convection during flow of pollutants through the aquifer.
- The aquifer hydraulic constants, such as transmissivity, storativity, gradients and boundary conditions.

The specialized diagrams and other techniques for the interpretation of the data, included within WasteBase and WasteManager, should therefore be used with circumspection. The identification of trends should be done by all waste disposal managers. However, if undesirable pollution trends develop, which cannot obviously be linked to operations, it should best be left to the geohydrologist to suggest remedial action.

PIPER DIAGRAM

The chemical composition of ground water reflects the processes which are responsible for the different constituents it contains: Wind blowing over the ocean carries mainly sodium chloride landwards. Oxygen, nitrogen and carbon dioxide dissolve when the humidity in the air condenses. Additional carbon dioxide and humic acids dissolve when water percolates through the soil containing organic matter.

The ground water changes its composition as the water moves through the aquifer. Minerals dissolve and release salts; sulphides may oxidize; cations are exchanged; sulphides and nitrates can be reduced through bacterial action; evaporation leads to concentration; and once the solubility products are exceeded minerals are precipitated. Mixing with water of different origin also influences the composition.

Trilinear diagrams are used for the investigation of ions or groups of ions as a function of the concentration. On these diagrams the milli-equivalent percentages of the major cations and anions are plotted; and it has been found that the point at which an analysis plots is of considerable diagnostical value.

The Piper diagram is a combination of two trilinear diagrams and a central diamond field. In the diamond field the cations Ca^{2+}, Mg^{2+}, $Na^{+} + K^{+}$; and the anions SO_4^{2-}, Cl^{-} and $HCO_3^{-} + CO_2^{2-}$ are represented by a point, in the trilinear diagrams cat- and anions each separately.

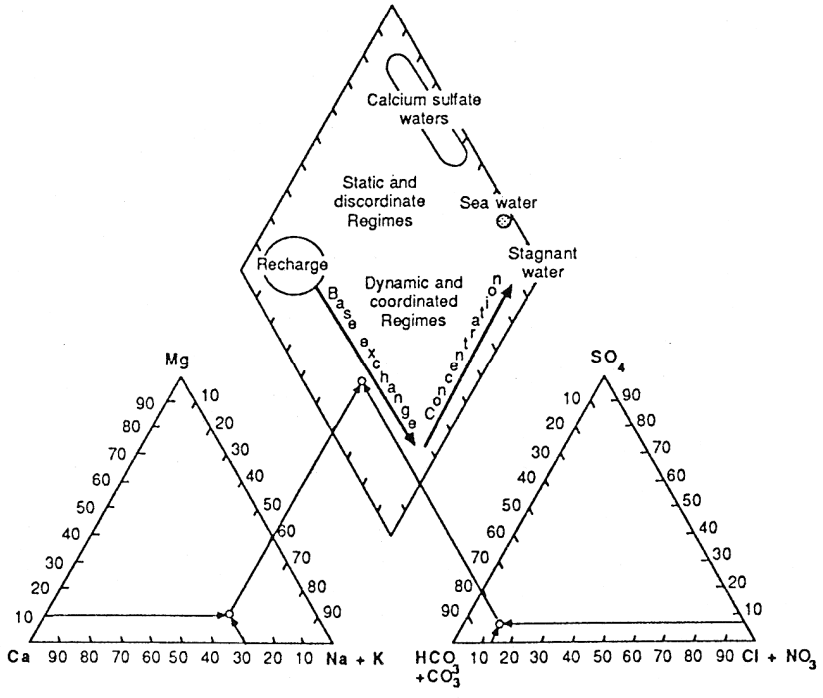
To convert the units mg/L normally given in an analysis to milliequivalents the determined quantities must be divided by the molecular weight of the respective ion and its valence. The constants for the conversion of the different ions are:

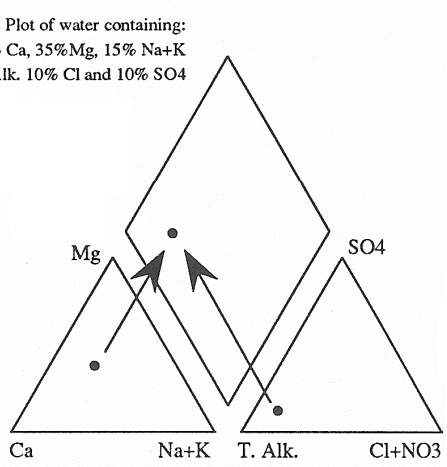
Cations		Anions	
Ca	1/20	HCO_3	1/61
Mg	1/12	CO_3	1/30
Na	1/23	Cl	1/35.5
K	1/39	NO_3	1/62
		SO_4	1/48

The percentage milli-eqivalents for the different cations are calculated by dividing the respective milli-equivalent values by the sum of the milli-equivalents of the cations. The percentage milli-equivalents for the anions are calculated accordingly.

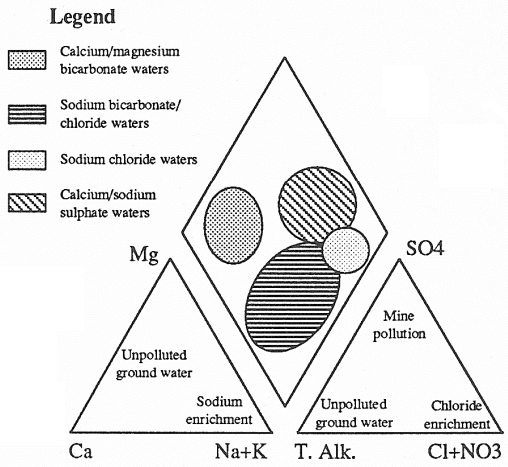
After the cat- and anions are plottes in the trilinear fields their position is projected in the central diamond field. Based on the position in the diamond field ground water can be divided into four categories, nl.:

- Recently recharged ground water rich in calcium and/or magnesium and bicarbonate.
- A dynamic regime with water rich in bicarbonate with increasing sodium (and potassium) concentrations.
- "Stagnant" or relatively old ground water at the end of the cycle with high sodium, chloride and/or sulphate values. It plots near the point for sea water.
- Calcium sulfate water as well as other relatively seldom encountered water which plots in the upper half of the diamond field.



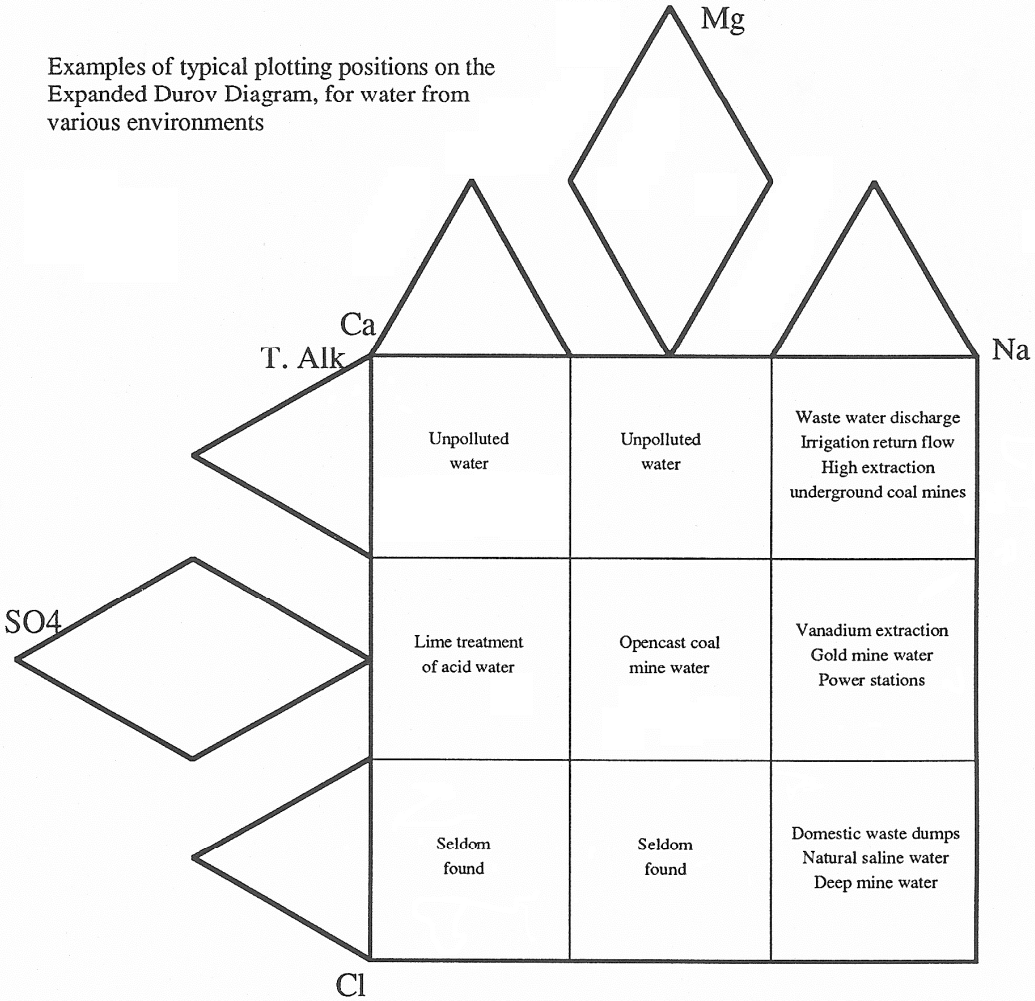


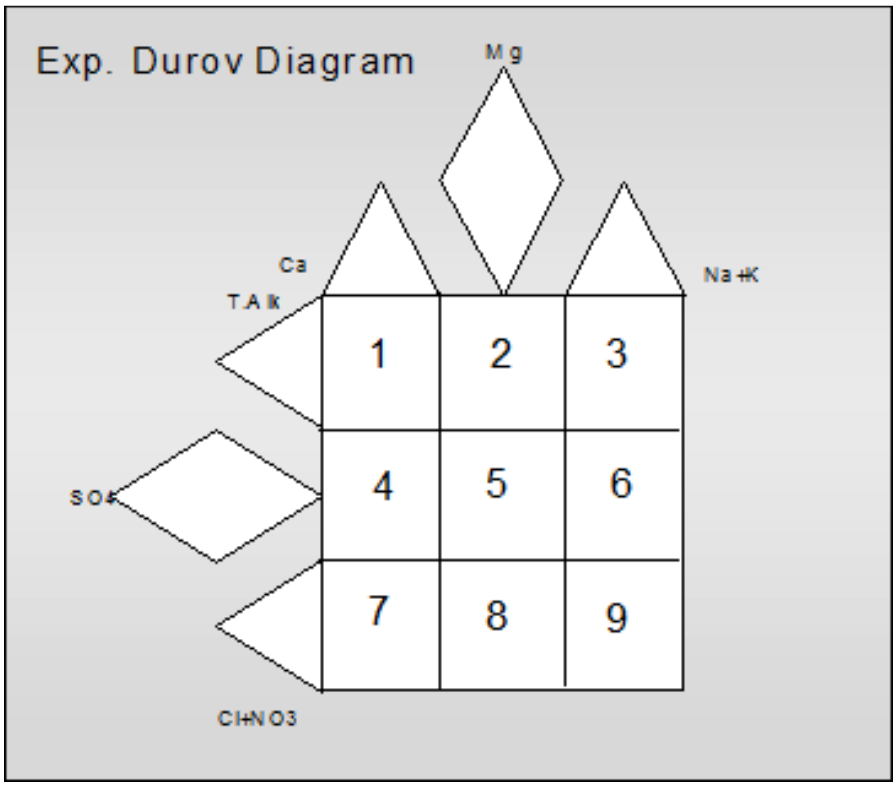
Plotting procedure on the Piper Diagram



Examples of typical plotting positions on the Piper Diagram, for water from various environments

Examples of typical plotting positions on the Expanded Durov Diagram, for water from various environments





Field 1: Fresh, very clean recently recharged groundwater with HCO_{3-} and CO_3 dominated ions.
Field 2: Field 2 represents fresh, clean, relatively young groundwater that has started to undergo Mg ion exchange, often found in dolomitic terrain.
Field 3: This field indicates fresh, clean, relatively young groundwater that has undergone Na ion exchange (sometimes in Na-rich granites or other felsic rocks), or because of contamination effects from a source rich in Na.
Field 4: Fresh, recently recharged groundwater with HCO_{3-} and CO_3 dominated ions that has been in contact with a source of SO_4 contamination, or that has moved through SO_4 enriched bedrock.
Field 5: Groundwater that is usually a mix of different types – either clean water from Fields 1 and 2 that has undergone SO_4 and NaCl mixing / contamination, or old stagnant NaCl dominated water that has mixed with clean water.
Field 6: Groundwater from Field 5 that has been in contact with a source rich in Na, or old stagnant NaCl dominated water that resides in Na-rich host rock / material.
Field 7: Water rarely plots in this field that indicates NO_3 or Cl enrichment, or dissolution.
Field 8: Groundwater that is usually a mix of different types - either clean water from Fields 1 and 2 that has undergone SO_4, but especially Cl mixing / contamination, or old stagnant NaCl dominated water that has mixed with water richer in Mg.
Field 9: Very old, stagnant water that has reached the end of the geohydrological cycle (deserts, salty pans, etc.); or water that has moved a long time and / or distance through the aquifer and has undergone significant ion exchange.

APPENDIX F - LIST OF KEY STAKEHOLDERS CONTACTED AND SUMMARY OF FEEDBACK OBTAINED

Stakeholder	Organization	Input provided
Hermien Roux	North West DEDECT	Could not provide any specific data. Suggested a number of contacts to follow up with further.
Jacqueline Jay	DWS	Highlighted the importance of a number of wetlands and activities within IUAs.
Malaika Koali-Lebona	Provincial Coordinator: North West SANBI	Highlighted the importance of a number of wetlands.
Marc De Fontaine	Rand Water	Highlighted the importance of a number of wetlands and activities within IUAs.
Mark Rountree	Fluvius Consulting Services	Highlighted the importance of a number of wetlands. Suggested a number of contacts to follow up with further.
Anton Linström	Wet-earth eco-specs	Could not provide any specific data. Suggested a number of contacts to follow up with further.
Martin Ferreira	Jeffares & Green (Pty) Ltd	Highlighted the importance of a number of wetlands, primarily pan systems.
Paul Meulenbeld	DWS	Highlighted the importance of a number of wetlands and activities within IUAs.
Nacelle Collins	DETEA FS	Highlighted the importance of a number of wetlands. Provided data on a number of priority wetlands.
Vukosi Ndlopfu	GDARD	Highlighted the importance of some wetlands in Gauteng section of the catchment.
Retief Grobler	Imperata Consulting	Highlighted the importance of a number of wetlands, particularly the Meul floodplain.
Terence McCarthy	WITS	Provided data on the Klip River wetland.
Gary Marneweck	Wetland Consulting Services	Highlighted the importance of a number of wetlands.
Piet-Louis Grundling	Ixhaphozi Enviro Services CC (I.E.S)	No feedback obtained.
Andre Beetge	Working for Wetlands and head of Mpumalanga Wetland Forum	No feedback obtained.
Frank Winder	North West University	No feedback obtained. Used available reports and presentations compiled by Frank on priority wetlands.
Doug Macfarlane	Eco-Pulse Consulting	Highlighted the importance of a number of wetlands.
Wynand Malherbe	University of Johannesburg	Could not provide any specific data.
Heidi Nieuwoudt	SANBI	Could not provide any specific data. Suggested a number of contacts to follow up with further.

APPENDIX G - KEY NOTES FROM THE SPECIALIST WORKSHOP

Wetland	Key Notes
Klip River Wetland	Highly controversial but important system.
Murphy's Rust	Good representative example with high biodiversity value. Also used for grazing and reed harvesting by local communities.
Parkhaven Pan	Stormwater dams. Idea was that cluster of wetlands still plays a role in the landscape. Water quality of Blauwpan very poor. Probably not significant enough to set an objective for. Exclude.
Benoni Pan	High societal value. Small bullfrog population. Potential recreational use. Too many similar wetlands. Exclude.
Heidelberg pans	Gary did work for University of North West – Centre of Environmental Management. Interesting pan, largely intact supporting good bullfrog population. Should ideally be rated as a FEPA wetland (expert input). Too many similar wetlands. Exclude.
Boovenste Oog	Feeds Klerkskraal dam providing supply for irrigators (NB from a user perspective). Peat land. Lodge made canoeing furrows down the wetland – unsure what has happened since. EIA was apparently received. Reserve completed.
Mooi wetland	Biodiversity priority site (FEPA wetland). Extensive unchannelled valley bottom area. Largely untransformed. Not included on peat database. Wetland fed largely by groundwater (Spring). RQO therefore needs to be aligned with groundwater. Apparently some new fish species in this area. RQOs have been set for the river. Mooi is clean and dilutes downstream polluted water.
Wonderfonteinspruit	Exclude
Gerhard Minnebrom	Leads into Boskop dam. Water supply to Potch. Frank Winder (North West) has detail about this system. Lot of articles and information about this wetland. Historic peat mining. Now stopped. Reserve done by WCS.
Natalspruit / Rietspruit	Some WQ objectives set for the river. NB for water quality enhancement & local communities? Could also consider the Rietspruit downstream. Need to consider RQOs for the rivers (cumulative impacts approach). Monitoring of erosion in catchment, reducing base flows etc. Need to ensure there is appropriate alignment. Major slimes dam upstream of Rietspruit.
Wilge	Good candidate wetland.
Bethal	Wetland below town: Wastewater return flows into the Blesbokspruit known to be problematic (Paul). Wetland therefore likely to be an important buffer between Bethel & Vaal. Wetland above town. Appears to be upstream of dam that provides water to community
Vaal Floodplain (Wet_U&P_2)	Some small but interesting floodplain features.
Wet_P_19	Range of pans close to Chrissiesmeer complex. Little evidence of biodiversity importance. Very large pans though (could prioritize on this basis). Exclude.
Wet_U&P_3 (Balmoral Wetland)	Wetlands in the catchment feeding into the Klein Vaal. "Seep zone" with many threats for coal mining in the catchment
Wet_U&P_4 (Phuthaditjhaba wetland)	Phuthaditjhaba wetland. Potentially important wetland from a water quality enhancement perspective. Also NB for erosion control (dispersive soils in this area). Exclude.
Wet U&P_5 (Suikerbosrand)	Karaan Beef wanted area to be classified as a Ramsar wetland to stop mining. Artesian springs. Floodplain with water going straight through (heavily incised with very infrequent overtopping). Wetland not doing a whole lot. Reserve in place for its protection. Exclude
Meul floodplain	Meul floodplain. NB from a biodiversity perspective. Poorly mapped in FEPA

Wetland	Key Notes
	coverage.
Wet_P_9 (Scheurklip)	NB for sediment retention (heavily eroded catchment) – communal grazing. WFWetland site. Exclude.
Wet_P_10	Wetland FEPA. Extensive degradation landscape (old wagon train impacts). Could well be identified as NB for cranes. Need confirmation. Too many similar wetlands. Exclude.
Wet_P_11 (Kromelemboogspruit)	Wetland FEPA. Extensive, largely untransformed wetland.
Wet_U&P_12	Potential site from a water quality enhancement perspective. Exclude.
Wet_P_13	Treat as per regional RQO's. Exclude.
Wet_P_14	Could look at rehabbing wetland to meet river RQO. Not an ideal system in its own right. Exclude.
Wet_P_16 (Klerkspruit)	Biodiversity site – protection (Not flagged as FEPA wetland). Exclude
Wet_U&P_17 (Spaarwater pan)	No site info. Exclude
Wet_U&P_18 / Blesbokspruit	To consider setting for main system. Water quality down Blesbokspruit pretty good. Decanting / discharge of saline water till 2017 expected. Volumes will increase and salt contents will increase. High Iron from Grootvlei. Lots of data for this and expert opinion. Use to obtain RQOs.
Wet_U&P_20 (M Lotto)	Leeupan. Perhaps could be a wetland FEPA. Exclude.
Suikerbosrand	A Reserve has been done for floodplain and river. Exclude.

APPENDIX H: GIS WORKSHOP EVALUATION QUESTIONNAIRE.

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

RESOURCE QUALITY OBJECTIVE DETERMINATION STUDY FOR THE UPPER VAAL WMA - RESOUCE UNIT PRIORITISATION WORKSHOP (29 – 31 JULY 2013)

WORKSHOP EVALUATION

NAME:			
1. Do you feel that the workshop achieved the stated objectives?	Yes	Partially	No
Comments:			
2. Were you able to contribute meaningfully?	Yes	Partially	No
Comments:			
3. Were you provided with sufficient information?	Yes	Partially	No
Comments:			
4. Were you provided with sufficient time to contribute to the process?	Yes	Partially	No
Comments:			
5. Was the workshop facilitation adequate?	Yes	Partially	No
Comments:			
6. Was the length of the workshop adequate?	Too long	Adequate	Too short
Comments:			
Additional comments/recommendations:			