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

WP10533

RESOURCE UNIT DELINEATION REPORT

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

Resource Unit Delineation 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 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 Study and were 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 RU's 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 Numerical Limits.
- 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 delineation of the IUAs and RUs for RQO determination in the Upper Vaal WMA (Step 1).

A total of 15 IUAs were already identified as part of the Upper Vaal WRC study and these existing IUAs were used in the development of RQOs for the Upper Vaal WMA. The delineation process resulted in a total of 75 RUs selected for the rivers component which was also used for the groundwater component. Numerous wetlands and dams were delineated that will be prioritised during step 4 of the RQO process.

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

Resource unit Delineation 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 Delineation 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 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 delineation of the IUAs and RUs for the Upper Vaal WMA (Step 1; DWA, 2011). Integrated Units of Analysis are finer-scale units aligned to watershed boundaries, in which socio-economic activities are likely to be similar. These homogenous units provide a useful indication of similar impacts in different areas of the catchment which should be considered in the determination of RQOs. A RU, on the other hand, is a stretch of river that is sufficiently ecologically distinct to warrant its own specification of Ecological Water Requirements (EWR). Resource Units are nested within IUAs and in the RQO process, are aligned to IUA boundaries. There are normally several RUs within a single IUA.

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, 2012). 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 include these components but rather adopted the outcomes from the WRC study (DWA, 2012). 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 1 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.

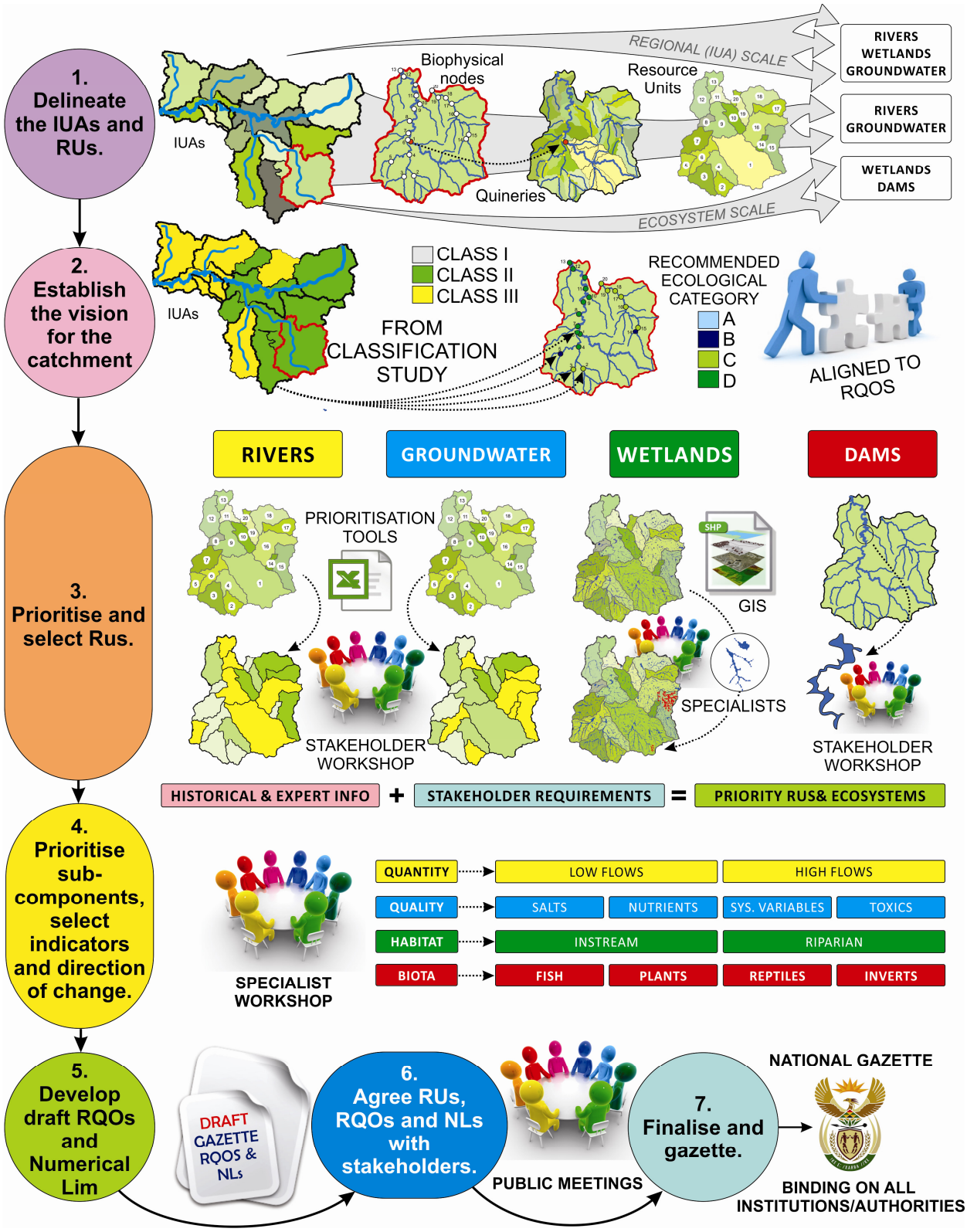

Figure 1: Schematic summary of the RQO determination procedure (adapted from DWA, 2011) which was implemented in this study.

3.2 RESOURCE UNIT DELINEATION OVERVIEW

The first step of the RQO process requires the delineation of IUAs and Resource Units RUs. A total of 15 IUAs have already been identified as part of the Upper Vaal WRC study (Table 1 and Figure 1).These existing IUAs have been used in the development of RQOs for the Upper Vaal WMA.

Table 1: IUAs and Nodes identified for the Upper Vaal WMA as part of the WRC study (DWA, 2012), and associated quaternary catchments

IUA	Nodes	Quaternary Catchment
UV-A	8VF5, C1VAAL-KVAAL, RE EWR 1, KIEINVAAL, UV9, C1RIET-AMERS, C1KVAA-UNSPE, UV17, EWR1, C1BLES-UNSPE, VC4, VC5	C11A, C11B, C11C, C11D, C11E, C11G C11H, C11J, C11K
UV-B	UV Uklip, C13C, C1KLIP-UNSPE1, EWR6 C13A, C1SAND-UNSPE, C13E, C1KLIP-UNSPE2, C13G, C13H	C13A, C13B, C13C, C13D, C13E, C13F, C13G, C13H
UV-C1	EWR7, 8WF1, 8WF3, UV25, UV28, UV Cor, C82B_N	C81A, C81B, C81L, C81M, C82A, C82B
UV-C2	8EF4, C81G, GG, C81J, C81C, C8NUWE-CONFL, EWR8, C82D	C81C, C81E, C81F, C81G, C81J, C82C, C82D
UV-C3	UV31, VC8, UV35, VC9	C82G, C82F, C82H
UV-D	VC15, C83D, C83E_N, VC16, VC17	C83A, C83D, C83E, C83G, C83H
UV-E	VC6, WA1, VC7, WA2, UV WV	C12D, C12F, C12G
UV-F	UV45, C8KLIP-VAALD	C83K, C83L
UV-G	EWR2, 8VF3, C12A, EWR3, C12K, C12J	C11M, C12A, C12H, C12K, C12J
UV-H	C21A, EWR 9	C21A, C21C
UV-I	EWR10, EWR11,VC11, VC12, VC13, VC14	C21G, C21F, C22C, C22D, C22E, C22J
UV-J	C22G	C22G
UV-K	UV53	C23B
UV-L	C23F, RE EWR 2 MOOI, VC19, M2, VC20	C23E, C23F, C23G, C23K, C23L
UV-M	EWR4, EWR5	C22F, C23L

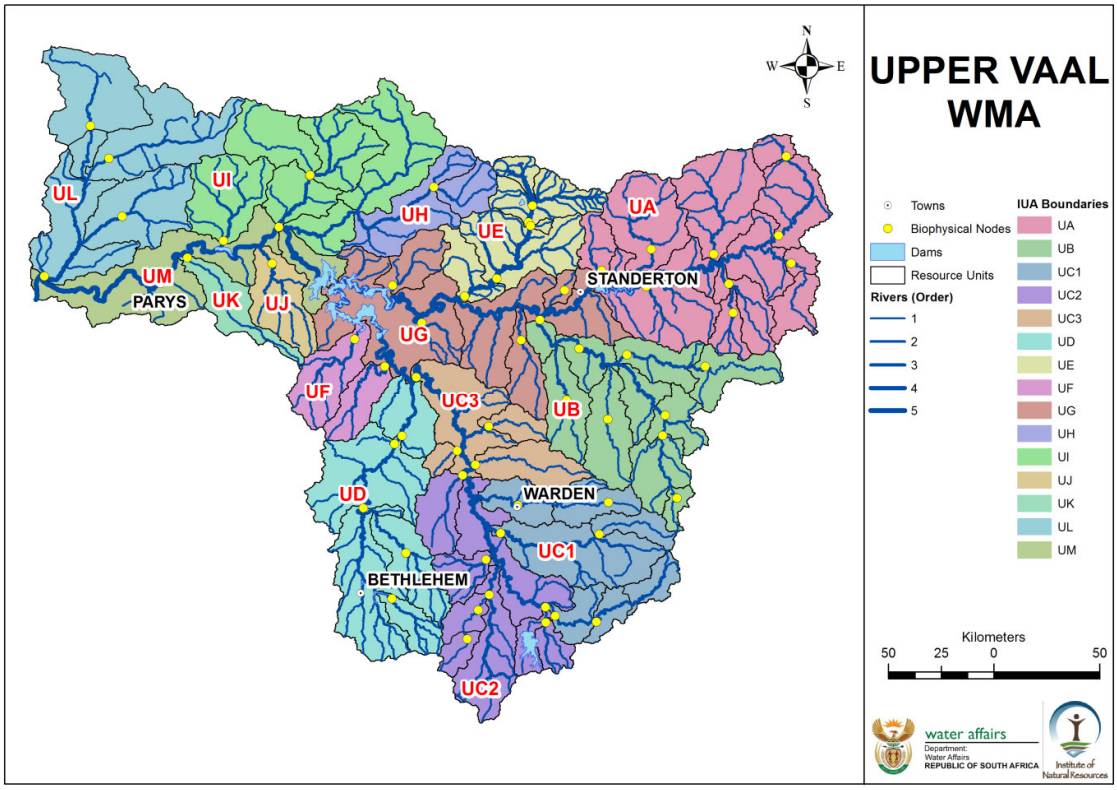

Figure 2: The location of IUAs in the Upper Vaal WMA

The following approaches have been applied in the delineation of RUs for rivers, wetlands, dams and groundwater.

3.3 RIVER RESOURCE UNIT DELINEATION FOR THE UPPER VAAL WMA

The WRC study has identified a total of 75 nodes for the Upper Vaal WMA including key nodes and desktop biophysical nodes (Table 1). Key nodes equate to the EWR sites and the selection process of these sites followed the Reserve site selection process. The WRC study however noted that large sections of the catchment were still unaccounted for and therefore selected additional desktop biophysical nodes. The selection of these desktop biophysical nodes was informed by information such as the Desktop EcoClassification results generated during the recent Reserve studies and the National Freshwater Ecosystem Priority Areas study. The WRC study states that every effort was made to select nodes that fairly represent different conditions and operational procedures in the catchment.

For the purposes of the RQO study however, the terrestrial area associated with each of the desktop biophysical nodes was also delineated to provide an area based River Resource Unit. This was necessary to facilitate an assessment of the socio-economic data and associated users requirements as well as the potential impacts of different land uses on water resources. The following key steps were undertaken as part of this delineation process.

3.3.1 DATA GATHERING

Spatial data for the Upper Vaal WMA was obtained from Pieter van Rooyen (WRP Consulting Engineers (Pty) Ltd). This data was accompanied by an Ecological Database which provided detailed metadata for all biophysical nodes and EWR sites in the Upper, Middle and Lower Vaal WMAs. Table 2 shows a list of the data that was received as well as those data sets that were used in the delineation process. In addition to these data sets, the national sub-quaternary data layer (obtained from DWA) was also used.

Table 2: Spatial data used in the Upper Vaal WMA resource unit delineation exercise

Folder	Shapefile (.shp)
Upper Vaal WMA	• **Biophysical Nodes*** • **EWR Sites*** • Upper Vaal catchment (x2) • Dams • **Integrated Units of Analysis*** • **Quaternary catchments*** • **Rivers*** • Provinces and international boundaries

***=data used for resource unit delineation**

3.3.2 SELECTION OF SCALE

Resource Unit delineation was conducted at the sub-quaternary scale as this level of spatial representation provides greater resolution of the data. Furthermore, the sub-quaternary scale has been used in other projects by the DWA. Therefore, working at this scale ensures that data from various projects is transferrable thereby minimizing scale discrepancies and providing a homogenous platform for data analysis.

3.3.3 DATA PROCESSING

Using ArcMap™ the above-mentioned layers (Table 2) were added into the document and symbolized accordingly. Thereafter, sub-quaternaries that intersected the IUAs were selected. The intersect function was used to ensure that adjacent sub-quaternary catchments that were part of the WMA were not excluded. The output of this step yielded sub-quaternary catchments that were within the IUAs. An edit session was entered into with the sub-quaternary layer as the layer to perform editing functions. Sub-quaternary catchments were merged to provide the RUs. The rivers and nodes within the IUAs provided the basis for resource unit delineation as the river catchments were followed i.e. the watershed area was included (quaternary catchments were also used to verify the validity of the delineated RU). The detailed steps undertaken as part of the River RU delineation process are detailed in Appendix A.

3.3.4 REVISION AND AMENDMENTS OF DATA

Once the data processing was complete, a number of challenges were encountered. Firstly, the use of sub-quaternary catchments as the units of assessment indicated delineation problems of IUAs in the Upper Vaal WMA. The RUs in the RQO process were delineated according to sub-quaternary boundaries but also had to be nested within an IUA. This necessitated the altering of some of the IUA boundaries from the WRC study (Figure 3).

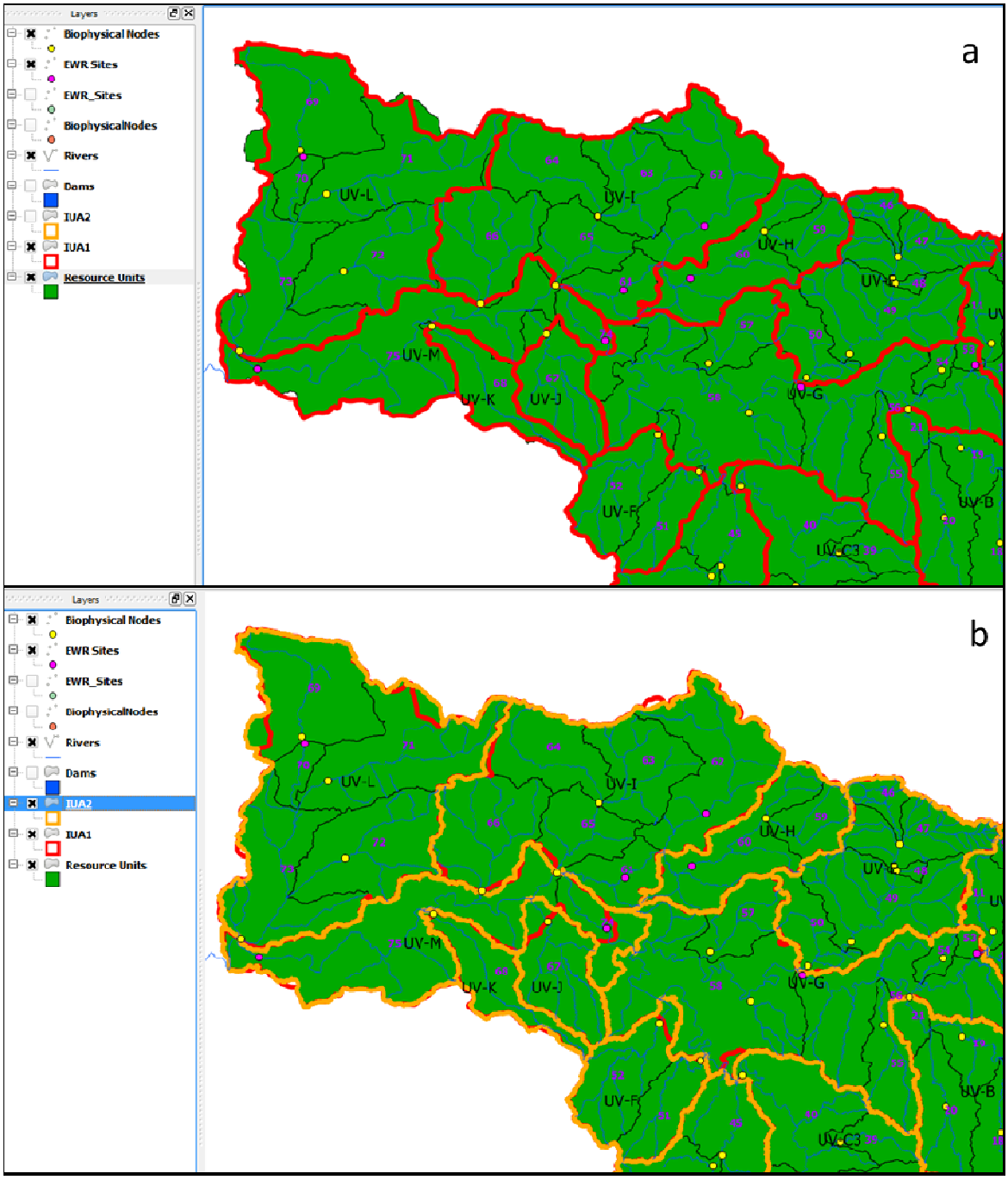

Figure 3: IUA delineation changes in the Upper Vaal WMA. Note the initial boundaries in red and amended boundaries in orange.

Secondly, the delineation of a RU assumed that a single node would be present per RU as each node has a corresponding Present Ecological State (PES) and REC. However, from the initial data processing it became apparent that some Resource Units had more than one node in them. This was often the result of the presence of an EWR site together with a biophysical node. To correct this problem, some of the initial RUs were split.

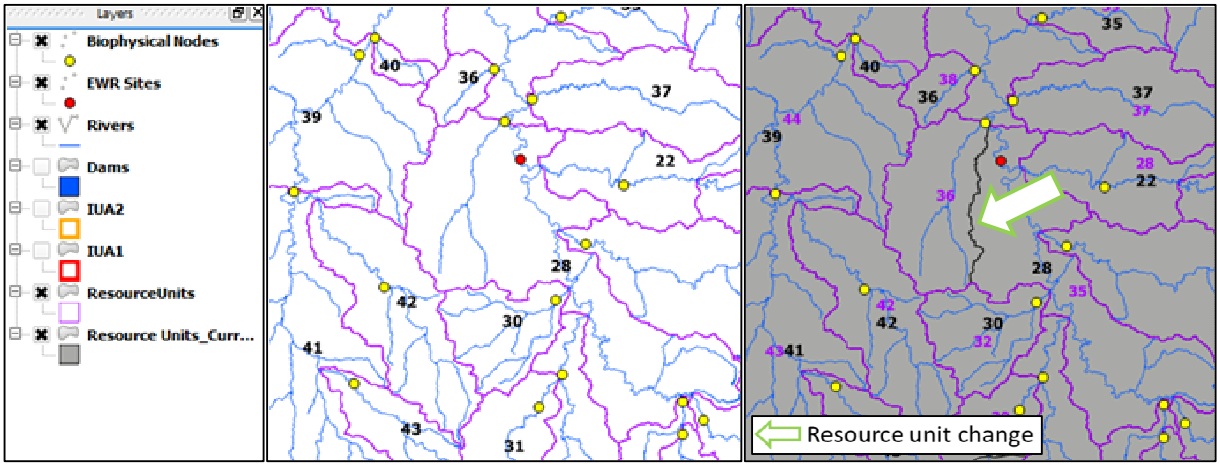

Figure 4: Example of changes to River Resource Unit boundaries

3.4 WETLAND ECOSYSTEM DELINEATION FOR THE UPPER VAAL WMA

Step 1 of the RQO process includes defining RUs. The objective of the first step is to gather available information for the catchment of concern and then to delineate RUs. Guidance provided in the RQO manual suggests that the Decision Support System for Wetland Reserve Determinations (DWAF, 1999) should be used to inform the delineation of wetland RUs. This suggests that wetlands meeting the following criteria should be considered as a minimum:

- Ramsar wetlands or wetlands with potential Ramsar status;
- Wetlands with national or provincial protected status;
- Large wetlands providing important ecological services (*e.g.* flood attenuation, crop production etc.);
- Large freshwater dams;
- Large wetlands fed by water sources on which major developments are planned, which could cause irreversible damage to the wetlands; and
- Wetlands supporting important populations of endangered species.

While some of these features can be identified from available spatial datasets, size of wetlands mapped, (which is one of the primary discriminators suggested) is largely a function of the scale of mapping and the level of classification applied. As a result, using size of mapped wetland units as a surrogate for importance is not a reliable attribute (at least from a GIS analysis perspective). At a coarse scale, clear wetland features may be identified as discrete units and mapped accordingly. With more detailed mapping, the connections between obvious wetland areas can be identified, and can result in the amalgamation of many smaller wetlands mapped at a courser scale. Equally, classification at increasingly fine levels helps to differentiate between wetland types but results in contiguous wetlands being cut into a number of sub-units which cannot be easily identified from available GIS datasets.

The National Freshwater Ecosystem Priority Areas (NFEPA) wetland layer was used as the base map of wetlands for the catchment. The attribute information available for the NFEPA wetland layer, in particular the ecological importance and sensitivity of wetland systems, was important for the prioritization and selection process (i.e. Step 3). Examples of the attributes from the NFEPA dataset for wetlands that may have specific relevance are indicated below:

- **Wetland condition**: This was modelled based on available Landcover data around wetland systems and informed by the condition of associated rivers where information was available.
- **Important provincial wetlands**: Here, important wetlands including peatlands will be identified by the provincial authorities.
- **Expert-identified important wetland systems**: This includes wetlands containing exceptional biodiversity importance, good intact examples of particular wetland types, and wetlands in which Working for Wetlands has undertaken rehabilitation work (based on available data).
- **Wetlands located in proximity to populations of threatened species**;

- **Wetlands within catchments highlighted for threatened species conservation**;
- **Rank of wetlands**: The final ranking of wetlands giving their relative importance based on available criteria; and
- **Wetland FEPAS**: Priority wetlands (Freshwater Ecosystem Priority Areas) identified for meeting National Freshwater Ecosystem Targets.

3.5 DAM ECOSYSTEM DELINEATION FOR THE UPPER VAAL WMA

Dams are single units within main stem rivers or tributaries. Off-channel dams are not associated with any rivers and are usually filled by the transfer of water from a nearby river system or dam. No specific tool was developed or used for the delineation of the dams of the Upper Vaal catchment. Various data bases and reports were used to identify the dams in the Upper Vaal catchment. Some of the main sources of information included:

- DWA Hydrological Information System (HIS)
- Water Situation Assessment Model (WSAM)
- Internal Strategic Perspective (ISP) study, 2004
- Any other relevant reports (Water Resources Classification study, Reserve studies, etc.)

The above information and the following rules were used to delineate the various dams:

i. Plotting of the larger dams (farm dams were excluded)
ii. Delineation using the full supply areas of the dams
iii. These delineations were overlaid with the resource units and all resource units associated with the dams were identified for further use in steps 4 and 5 of the RQO process
iv. The dam wall was used as the endpoint per dam.

3.6 GROUNDWATER RESOURCE UNIT AND ECOSYSTEM DELINEATION FOR THE UPPER VAAL WMA

The delineation of RUs was based on surface drainage areas. In general surface water reporting to DWA is based on quaternary catchment boundaries. This is done for various reasons which include:

- DWA In-house models utilise quaternary boundaries
- The WMA comprise of a subset of quaternary boundaries

Groundwater does not report to quaternary boundaries or RUs for the purpose of this document. This is due to the fact that aquifers are aligned with the geology rather than surface drainage regions. A comparison of the surface geology and the resource units are shown in Figure 5 which clearly illustrate the variability of the geology that occurs within the respective resource units.

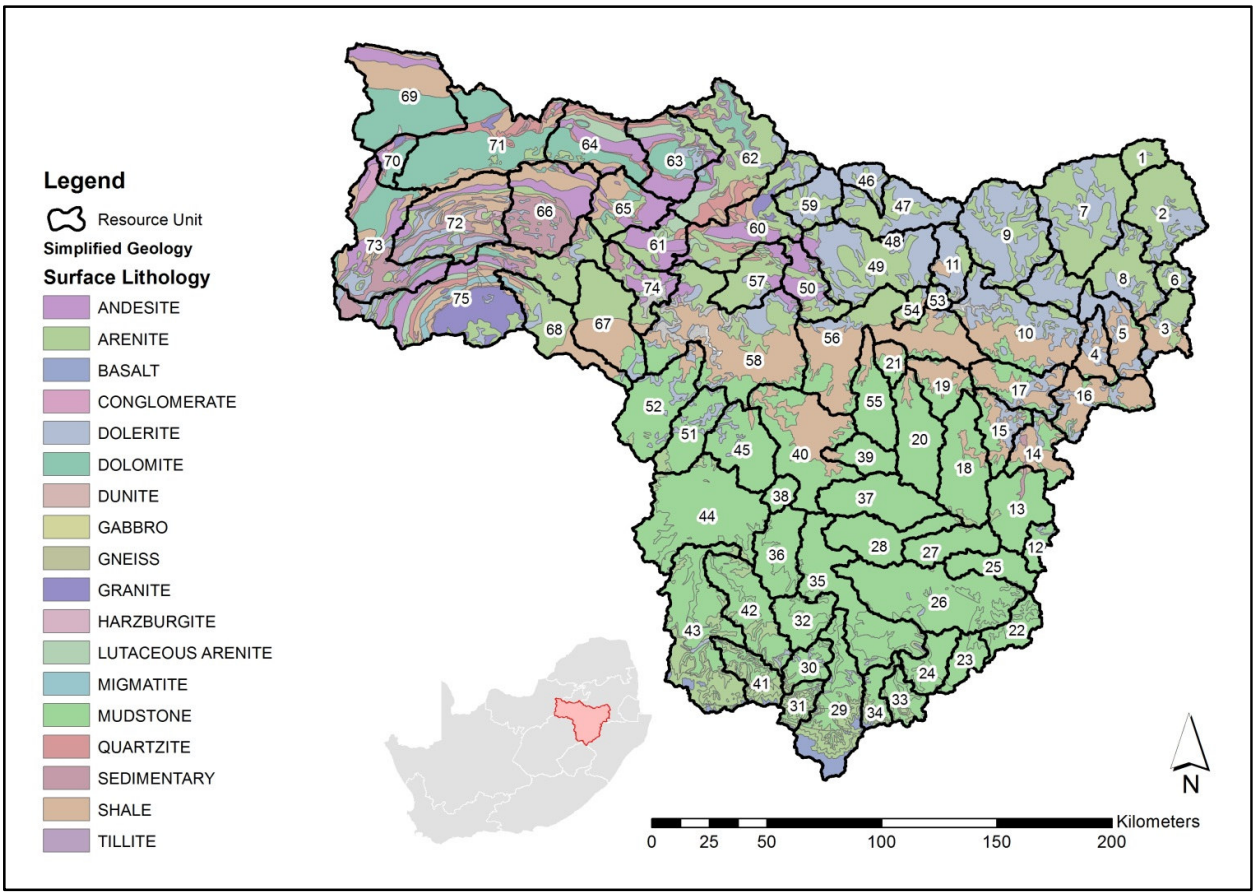

Figure 5: Surface geology vs. resource unit boundaries

General assumptions made to report groundwater within surface catchments (e.g. groundwater reserve determinations on quaternary boundary) are as follows:

- Shallow groundwater will follow the regional topography and surface water catchment boundaries will act as natural groundwater divides (Figure 6 (1)).
- Deeper groundwater will follow the deeper regional groundwater flow (Figure 6 (2) and (3)).
- The net groundwater flow through the surface catchment is assumed to be zero.

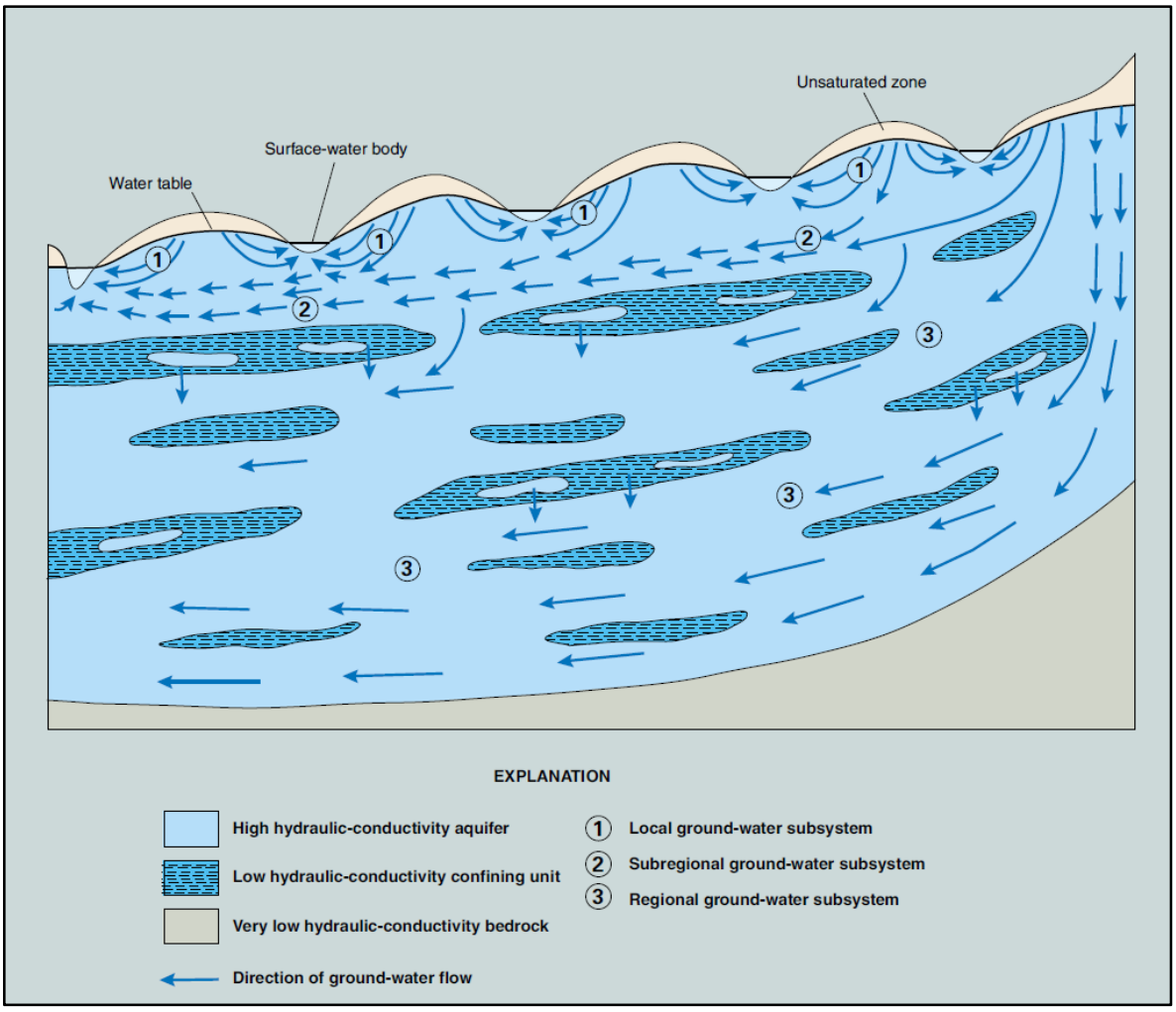

Figure 6: Groundwater flow systems (USGS, 1999)

The framework selected for the purpose of groundwater RU prioritisation, was based on the DWA RQO method (DWA, 2011) which was focussed on the prioritisation of surface RU's. The RQO development approach (DWA, 2011) requires a set of criteria and sub-criteria to be weighted and rated to calculate a priority rating which is then normalised.

4 FINDINGS

4.1 RIVER RESOURCE UNITS FOR THE UPPER VAAL WMA

A total of 75 River RUs were delineated for the Upper Vaal WMA (Figure 7). The location of these River Resource Units and associated biophysical nodes is shown in Figure 8. The IUA, biophysical node and corresponding river as well as the PES, REC (as required by the WRC) for each RU, and the management class for each respective IUA, is detailed in Table 3.

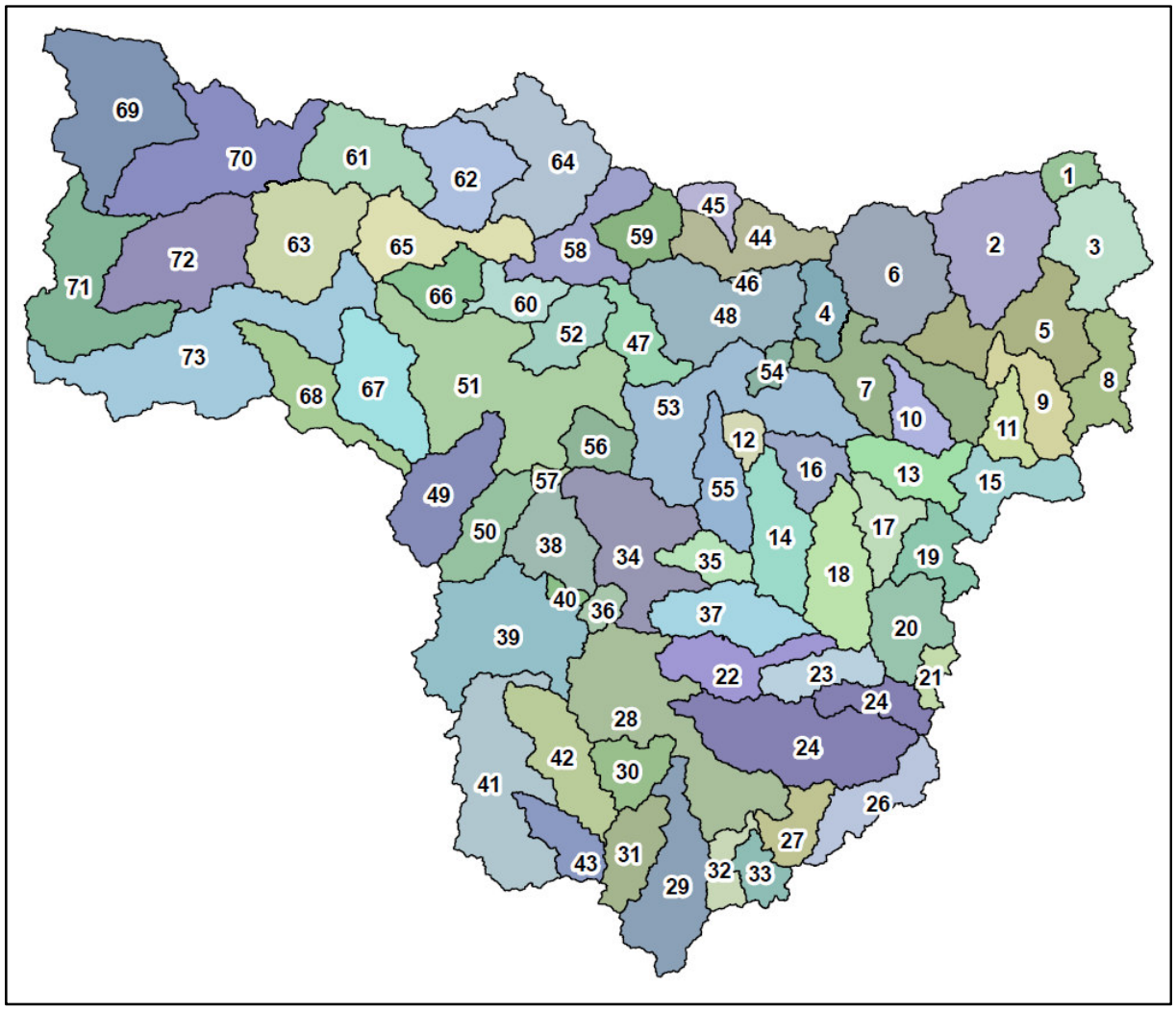

Figure 7: River Resource Units delineated for the Upper Vaal WMA

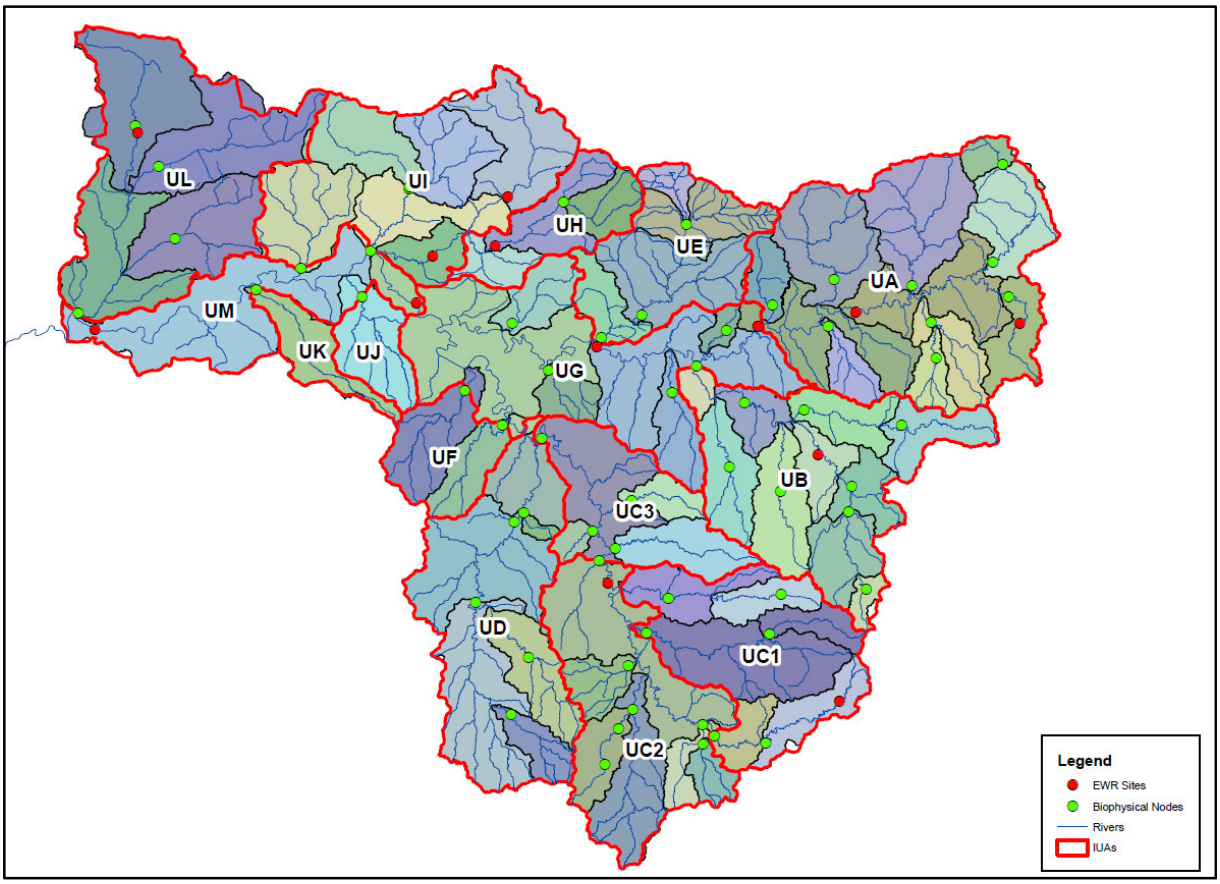

Figure 8: River Resource Units delineated for the Upper Vaal WMA showing EWR sites and biophysical nodes

Table 3: Summary data for each River Resource Unit delineated in the Upper Vaal WMA

IUA Name	Class for IUA	RU	Original node name (WRC study)	New node name (WRC study)	River Name	PES*	REC*
UA. Vaal River upstream of Grootdraai Dam	II	1	8VF5	UA.1	Vaal	B/C	B
		2	C1VAAL_KVAAL	UA.2	Vaal	C	C
		3	RE EWR 1 KLEINVAAL	EWR1RE	Vaal	C	C
		4	UV9	UA.3	Rietspruit	C	C
		5	C1RIET_AMERS	UA.4	Vaal	C	C
		6	C1KVAA_UNSPE	UA.5	Vaal	C/D	C/D
		7	UV17	UA.6	Vaal	C/D	C/D
		8	EWR 1	EWR1	Vaal	B/C	B/C (B)
		9	C1BLES_UNSPE	UA.7	Vaal	C/D	C/D
		10	VC4_C11L	UA.8	Vaal	B/C	B/C
		11	VC5_C11K	UA.9	Vaal	C	C
UB. Klip River (Free State)	II	12	UV_Uklip	UB.1	Vaal	B	B
		13	C13C	UB.2	Vaal	B/C	B
		14	C1KLIP_UNSPE1	UB.3	Vaal	B/C	B

IUA Name	Class for IUA	RU	Original node name (WRC study)	New node name (WRC study)	River Name	PES*	REC*
		15	EWR 6	EWR6	Vaal	B/C	B/C
		16	C13A	UB.4	Klip	C	C
		17	C1SAND_UNSPE	UB.5	Klip	C	C
		18	C13E	UB.6	Klip	B/C	B
		19	C1KLIP_UNSPE2	UB.7	Vaal	C/D	C/D
		20	C13G	UB.8	Klip	C	C
		21	C13H	UB.9	Vaal	C/D	C/D
UC1. Upper Wilge River	II	22	EWR 7	EWR7	Vaal	A/B	A/B
		23	8WF1	UC1.1	Vaal	B	B
		24	8WF3	UC1.2	Vaal	C	C
		25	UV25	UC1.3	Wilge	B	B
		26	UV28	UC1.4	Wilge	C	C
		27	UV_Cor	UC1.5	Wilge	C	C
		28	C82B_N	UC1.6	Wilge	C	C
UC2. Wilge River and tributaries	II	29	8EF4	UC2.1	Vaal	C/D	C/D
		30	C81G	UC2.2	Elands	C	C
		31	GG	UC2.3		B	B
		32	C81J	UC2.4	Wilge	C	C
		33	C81C	UC2.5	Nuwejaarspruit	B/C	B/C
		34	C8NUWE_CONFL	UC2.6	Wilge	C	C
		35	EWR 8	EWR8	Vaal	C	C
		36	C82D	UC2.7	Wilge	C	C
UC3. Lower Wilge River	II	37	UV31	UC3.1	Wilge	C	C
		38	VC8_C82G	UC3.2	Wilge	B/C	B/C
		39	UV35	UC3.3	Wilge	C	C
		40	VC9	UC3.4	Vaal	C/D	C/D
UD. Liebenbergsvlei River	III	41	VC15	UD.1	Liebenbergsvlei	C	C
		42	C83D	UD.2	Liebenbergsvlei	C	C
		43	C83E_N	UD.3	Liebenbergsvlei	C	C
		44	VC16	UD.4	Liebenbergsvlei	B/C	B
		45	VC17	UD.5	Liebenbergsvlei	B/C	B
UE. Waterval River	III	46	VC6	UE.1	Vaal	C	C
		47	WA1	UE.2	Vaal	D	D
		48	VC7	UE.3	Waterval	C	C
		49	WA2	UE.4	Vaal	D	D
		50	UV WV	UE.5	Vaal	D	D
UF. Kromspruit and Skulpspruit	II	51	UV45	UF.1	Wilge	C	C
		52	C8KLIP_VAALD	UF.2	Vaal	C	C
UG. Vaal River from Grootdraai Dam to Vaal Dam	II	53	EWR 2	EWR2	Vaal	C	C
		54	8VF3	UG.1	Vaal	C	C
		55	C12A	UG.2	Vaal	C	C
		56	EWR 3	EWR3	Vaal	C	C
		57	C12K	UG.3	Vaal	C	C
		58	C12J	UG.4	Vaal	C	C
UH. Suikerbosrand	II	59	C21A	UH.1	Vaal	B/C	B
		60	EWR 9	EWR9	Vaal	C	B/C

IUA Name	Class for IUA	RU	Original node name (WRC study)	New node name (WRC study)	River Name	PES*	REC*
River							
UI. Klip River (Gauteng)	III	61	EWR 10	EWR10	Vaal	C/D	C/D
		62	EWR 11	EWR11	Suikerbosrand	D	D
		63	VC11	UI.1	Klip River	E	D
		64	VC12	UI.2	Vaal	E	D
		65	VC13	UI.3	Vaal	E	D
		66	VC14	UI.4	Vaal	D/E	D
UJ. Taaibosspruit	III	67	C22G	UJ.1	Vaal	D	D
UK. Kromelmboogspruit	III	68	UV53	UK.1	Vaal	C	C
UL. Mooi River	III	69	C23F	UL.1	Vaal	C/D	C/D
		70	RE_EWR 2 MOOI	EWR2RE	Vaal	D	D
		71	VC19	UL.2	Mooi	E	D
		72	M2	UL.3	Mooi	E	D
		73	VC20	UL.4	Vaal	D	D
UM. Vaal River reach from Vaal Dam to C23L	III	74	EWR 4	EWR4	Vaal	C	B/C
		75	EWR 5	EWR5	Vaal	C/D	C

* The Present Ecological State (PES) and Recommended Ecological Category (REC) were extracted from DWA (2012).

4.2 WETLAND ECOSYSTEMS FOR THE UPPER VAAL WMA

The NFEPA wetland base layer for the catchment is illustrated in Figure 9 below. Table 4 provides an indication of the number of different wetland types throughout the IUAs, and the approximate areas for each of the wetland types.

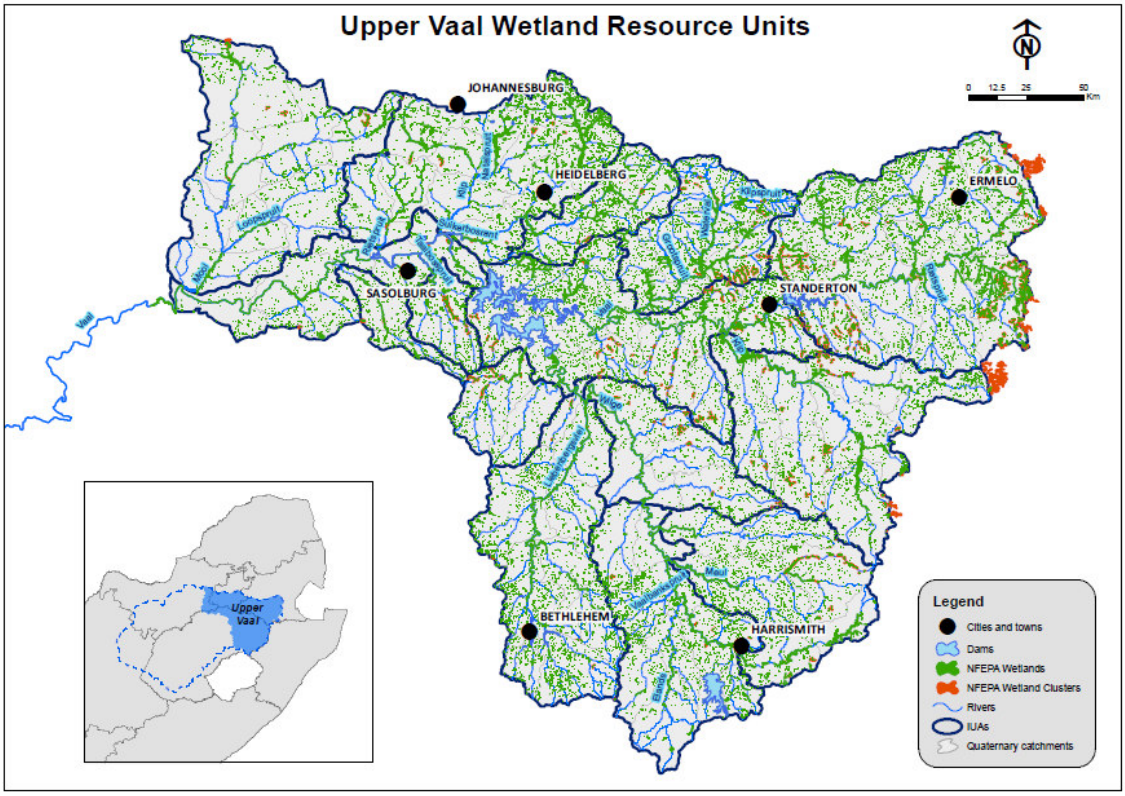

Figure 9: Upper Vaal wetland resource units

Table 4: Upper Vaal wetland resource units, number and area of wetland types

IUAs	Wetland Type	Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valley head seep	Total
UVA	No. of Wetlands	1738	495	1151	130	1235	527	271	5547.0
	Area (Ha)	9868.7	2844.4	1817.3	14568.2	2006.3	379.4	248.0	31732.4
UVB	No. of Wetlands	621	441	427	43	312	264	90	2198.0
	Area (Ha)	1780.2	1258.6	483.8	7743.0	352.4	664.4	73.9	12356.3
UVC1	No. of Wetlands	734	357	428	19	318	199	30	2085.0
	Area (Ha)	1628.8	650.1	181.9	4775.2	367.9	119.5	5.6	7729.0
UVC2	No. of Wetlands	697	315	331	44	321	255	96	2059.0
	Area (Ha)	6692.7	2372.3	1876.9	3547.5	505.2	235.7	180.5	15410.8
UVC3	No. of Wetlands	175	105	203	14	225	85	10	817.0
	Area (Ha)	175.9	200.4	84.4	2203.5	146.4	47.6	2.4	2860.6
UVD	No. of Wetlands	971	398	494	51	471	156	35	2576.0
	Area (Ha)	3141.4	2363.7	383.2	3921.2	546.6	95.0	25.6	10476.6
UVE	No. of Wetlands	607	201	504	76	565	327	101	2381.0
	Area (Ha)	3853.6	939.5	740.6	5107.3	1051.6	399.1	135.3	12226.9
UVF	No. of Wetlands	162	127	70	9	149	96	5	618.0
	Area (Ha)	307.9	207.8	30.2	645.4	109.0	47.7	2.7	1350.6
UVG	No. of Wetlands	1022	444	799	130	1016	302	237	3950.0
	Area (Ha)	5640.9	988.2	3793.2	28722.2	2138.3	508.8	1739.9	43531.5

IUAs	Wetland Type	Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valley head seep	Total
UVH	No. of Wetlands	525	149	265	33	293	131	34	1430.0
	Area (Ha)	1936.9	639.4	299.7	2227.7	421.9	133.7	18.1	5677.4
UVI	No. of Wetlands	892	325	662	69	664	670	91	3373.0
	Area (Ha)	6468.4	2236.4	1754.6	8154.5	2419.3	1212.6	100.6	22346.5
UVJ	No. of Wetlands	114	127	67	7	127	79	16	537.0
	Area (Ha)	416.6	372.7	37.6	176.1	95.7	173.3	120.7	1392.6
UVK	No. of Wetlands	67	98	68	1	149	63	5	451.0
	Area (Ha)	213.4	302.6	71.8	783.0	129.3	71.3	1.6	1573.0
UVL	No. of Wetlands	526	160	196	24	649	281	37	1873.0
	Area (Ha)	4687.8	668.1	236.7	1540.0	963.5	705.7	26.6	8828.4
UVM	No. of Wetlands	408	78	178	65	296	110	45	1180.0
	Area (Ha)	1670.3	671.2	195.4	4369.3	401.7	234.2	134.3	7676.3
TOTAL	No. of Wetlands	9259	3820	5843	715	6790	3545	1103	31075
	Area (Ha)	48483.5	16715.4	11987.0	88484.2	11655.1	5027.9	2815.8	185169.0

4.3 DAM ECOSYSTEMS FOR THE UPPER VAAL WMA

The approach resulted in a large number of dams being delineated that will be prioritised during step 4 of the RQO process. These delineated dams are listed in the following tables below:

- Dams delineated from the DWA HIS database as presented in Table 5.
- Major dams delineated using WSAM as presented in Table 6.
- Minor dams delineated using WSAM as presented in Table 7.
- Dams delineated based on the ISP study as presented in Table 8.

Table 5: Dams delineated from the DWA HIS database

Number	River and Dam Name
C1R001	Vaal River @ Vaal Dam
C1R002	Vaal River @ Grootdraai Dam
C2R001	Mooi River @ Boskop Dam
C2R003	Mooi River @ Klerkskraal Dam
C2R004	Mooi River @ Potchefstroom Dam
C2R005	Loop Spruit @ Klipdrift Dam
C2R011	Nigel Dam
B8R001	Matjiesvlei River @ Menin Dam
C8R002	Metsi-Matsho River @ Swartwater Dam
C8R003	Nuwejaar Spruit @ Sterkfontein Dam
C8R004	Liebenbergvlei @ Saulspoort Dam
C8R005	Jordaan River @ Loch Athlone
C8R006	Gerrands Spruit @ Gerrands Dam
C8R007	Driekloof Dam @ Driekloof Dam
C8R008	Namahadi River @ Fika-Patso Dam

Table 6: Major dams delineated using WSAM

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
GROOTDRAAI DAM	C11L	382500	3900
VREDE/THEMBALIHLE DAM	C13G	2440	68.44
VAAL BARRAGE	C22K	55444	1348
KLERKSKRAAL DAM	C23F	8250	383
BOSKOP DAM	C23G	20850	373
LAKESIDE DAM (POTCHEFSTROOM DAM)	C23H	2027	77.3
KLIPDRIF DAM	C23J	13580	472
DRIE KLOOF DAM	C81D	32170	190
STERKFONTEIN DAM	C81D	2616000	6725.8
FIKA-PATSO DAM- QWAQWA	C81F	28000	132
SAULSPOORT DAM	C83A	16870	400
VAAL DAM	C83M	2609799	32275

Table 7: Minor dams delineated using WSAM

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
TORBANITE DAM	C11A	1100	52
WESSEL DAM	C11A	56	2
WELGELEGEN 294IT DAM	C11B	92	0
AMERSFOORT DAM	C11E	993	66.7
WATERWESE DAM	C11E	200	5
WONDERFONTEIN DAM	C11E	245	12
DEHOOP DAM	C11E	113	9
WILLEM BRUMMER DAM	C11F	5800	214
VLYJUBA DAM	C11J	118	10
LEEUPAN DAM	C12D	56000	735

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
WINKELHAAK- EVANDER DAM	C12D	1650	54
WINKELHAAK MINES LOWER EMERGENCY DAM	C12D	141	21
DRIEFONTEIN 137 IS	C12D	756	0.4
HALVEPAN DAM	C12F	3100	44
PAARDEFONTEIN DAM	C12F	250	9
SUNVELDT DAM	C12F	108	5
SALVATION DAM	C12F	96	7
WITPOORT FARM DAM	C12G	140	7
GROOTVLEI	C12K	320	5
MODDERFONTEIN DAM	C12K	1110	6
EXCELSIOR DAM	C12L	130	4
WITKLEIFONTEIN DAM	C12L	65	5
HONIGFONTEIN DAM	C21A	75	5
KLIPPAN DAM	C21A	70	6
BLINKPOORT MINE DAM	C21B	70	1
BLINKPOORT- TWEEVLEI DAM	C21B	98	2
BLINKPOORT- BLOEKOMBOOM DAM	C21B	100	3
PETRUS VAN DER MERWE HAARHOFF DAM	C21B	575	24.5
JORDAAN DAM	C21B	90	4
PEET GELDENHUYS DAM	C21B	250	10
BALFOUR /SIYATHEMBA DAM	C21B	424	61
MODDERFONTEIN DAM	C21C	50	2
TWEEFONTEIN DAM	C21C	160	8
RYNFIELD NO.1-MEER	C21D	622	39
KLEINFONTEIN MEER	C21D	751	39
VLAKFONTEIN RESERVOIR	C21D	421	4
BENONINO RESERVOIR	C21D	122	1
HOLFONTEIN LEACHATE STORAGE DAM	C21D	77	1
ALEXANDER DAM	C21D	5056	101
MARIEVALE CONS. MINES LTD NO.2(7L6)	C21E	12000	38
MARIEVALE CONS.MINES LTD NO.1(7L7)	C21E	9400	32
MARIEVALE CONS.MINES LTD NO.1 SHAFT	C21E	312	0
MARIEVALE CONS.MINES LTD NO.3(7L5)	C21E	5400	16
VLAKFONTEIN NO.1 SHAFT VICINITY SLIMES DAM	C21E	77	25
HIPPO QUARRIES NO.5 SHAFT WASTE ROCK DUMP	C21E	207	0
HIPPO QUARRIES NO.6 SHAFT WASTE ROCK DUMP	C21E	440	0
HIPPO QUARRIES NO.4 SHAFT WASTE ROCK DUMP	C21E	2300	0
HIPPO QUARRIES SHAFT WASTE ROCK DUMP DAM NO.3	C21E	6000	0
ASTON LAKE	C21E	3200	210
UITKYK DAMNO.2	C21E	138	5
UITKYK NO.1-DAM	C21E	57	4
MARIEVALE CONS. MINES LTD NO.1 SHAFT	C21E	300	0

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
ROCK DUMP			
THE GROOTVLEI MINES PTY LTD NO.1(6L16)	C21E	27000	81
NIGEL DAM	C21E	226	52
NIGEL ONTSPANNINGSOORD DAM	C21E	1000	1000
DAGGAFONTEIN TAILINGS DAM	C21E	0	116.62
MARIEVALE CONS. MINES LTD NO.5 SHAFT WASTE DUMP	C21E	0	0
RIETFONTEIN WESTELIKE VLOED VERTRAGINGS DAM	C21E	1420	0
RIETFONTEIN OOSTELIKE VLOED VERTRAGINGS DAM	C21E	590	0
BRAKPAN NO3 RESERVOIR	C21E	200	2
FLOR-ARCADIA DAM	C21F	350	13
STERKFONTEIN DAM	C21G	190	14
TEVREDE BOERDERY NO.1-DAM	C21G	472	7
TEVREDE BOERDERY NO.2-DAM	C21G	350	8
DURBAN ROODEPOORT DEEP LTD11	C22A	1460	146
GMTS3/L/8 SLIMES DAM	C22A	48	12
ZONDI RESERVOIR	C22A	125	1
SOUTH DALE SLIME S3/L/32 WEST DAM	C22A	12420	54
SOUTHDALE SLIME S3/L/32 EAST DAM	C22A	5040	25
KLIPSPRUIT DAM	C22A	419	14
ORLANDO POWER STATION DAM	C22A	790	22
PRINCESS DAM	C22A	80	2.5
HAMBERG DAM	C22A	50	3
WITPOORTJIE NO2 RESERVOIR	C22A	75	3
HOMESTEAD/DIEPKLOOF 3/L/5 SLIMES DAM	C22A	95	0.5
DOORNKOP SLIMES DAM	C22A	20000	78
NO.7&8 SLIMES DAM, RAND LEASES	C22A	4000	0
MOOIFONTEIN RETURN 3/L/7 DAM	C22A	108	1
UPPER VAALVLEI CONTACT DAM	C22A	1000	100
CINDERELLA DAM	C22B	1536	77
GERMISTON RESERVOIR	C22B	91	1
MEYER'S HILL RESERVOIR	C22B	274	3
ALBERTON DAM	C22B	80	3
KLIP RIVIERS BERGN O1 RESERVOIR	C22B	587	5
EASTRAND GOLD AND URANIUM COLTD4L8	C22B	210	21
EASTRAND GOLD AND URANIUM COLTD4L14	C22B	40	3
KLIPRIVIERSBERG NO2 RESERVOIR	C22B	650	5
VANDYK DAM	C22C	420	28
MIDDEL MEER	C22C	467	22
EAST RAND GOLD AND URANIUM TAILINGS DAM	C22C	125.8	337
BRAKPAN NO2 RESERVOIR	C22C	122	1
FOREST HILL NO2 RESERVOIR	C22D	90	1

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
FOREST HILL NO3 RESERVOIR	C22D	114	1
MEREDALE DAM	C22D	122	1
MEREDALE NO2 DAM	C22D	200	2
LETHABOP RAW WATER RES NO1&2	C22F	885	6
FOREBAY RESERVOIR	C22F	694	21
LETHABO POWER STATION RAW WATER RESERVOIR NO.2	C22F	885	14
PETER WRIGHT DAM	C22H	1950	57
ELANDSFONTEIN DAM	C22H	45	0
POORTJIE DAM	C22H	637	3
LIBANON NO3 RESERVOIR	C22J	50	1
SASOL MARK4 DAM	C22K	255	11
SASOL MARK3 DAM	C22K	168	10
SASOLBURG RESERVOIR	C22K	103	1
DRIEFONTEIN NORTH STORMWATER DAM	C22K	60	0
LESUTOSKRAAL NO1-DAM	C23C	160	2
PANVLAKTE DAM	C23D	720	0
COOKEPLANT SLIMES DAM	C23D	20000	150
DONALDSON DAM	C23D	460	0
LUIPAARDSVLEI DAM	C23D	2100	65
ADMA DAM	C23E	72	4.8
BLYVOORUITZICHT NO.2 SLIMES DAM	C23E	146	8
CONTROL WATER DAM NO.7	C23E	575	22
BLYVOORUITZICHT RETURN WATER DAM NO.7	C23E	131	6
DWARSFONTEIN DAM	C23F	230	6
DEELKRAAL DAM	C23J	131	7
DRIEFONTEIN RESERVOIR	C23J	124	1
ELANDSRAND POLLUTION CONTROL DAM	C23J	238.5	6.5
ELANDSRAND DAM	C23J	138	3
SHAFT FRESHWATER DAM NO.1	C23J	203	6
SHAFT COFFER DAM NO.1	C23J	306	16
SHAFT RETURN WATER DAM NO.1	C23J	99	4
LEEUDOORN TAILINGS DAM 2	C23J	0	68.89
RAINFALL DAM	C81B	528	12
SILOE DAM	C81B	755	2
SUMMERSLIE DAM	C81C	271	0
NESSHURST DAM	C81C	347	17
BULLDOG DAM	C81C	82	4
GIBSON DAM	C81E	509	14
LOBELIA DAM	C81E	120	12
SARCLET DAM	C81E	1080	40
DU PLESSISDAL DAM	C81E	314	10
PLATKOP DAM	C81E	113	0
SWARTWATER DAM	C81F	4380	65.5
WELGELUK	C81K	207	6
MOUNTARABEL DAM B	C81M	63	23
NUGGET DAM	C81M	271	0
ALLUVIAAL RANDT DAM	C81M	244	0

Dam Name	Quaternary catchment	Full Supply Capacity (10^6m^3)	Full Supply Area (ha)
BUCKLANDDOWNS DAM	C81M	111	3
WILDEBOERLAAGTE DAM	C81M	113	7
HOEKPANPLAAS DAM	C82A	339	30
BLYDSCHAP DAM	C82A	509	6
WARDEN DAM	C82B	104	0
WARDENGRYP DAM	C82B	98	3
LIBERTAS DAM	C82B	226	89
NOOITGEDACHT DAM	C82B	339	138
DE HOOP DAM	C82C	80	4
EMDEN DAM	C82D	117	13
LANGVERWAG DAM	C82E	119	0
KROMDRAAI DAM	C82G	165	0
ALPHA DAM	C82H	236	9
GOEDEHOOP DAM	C83A	96	3
BOSTON A-DAM	C83A	414	7
MIEMIESRUST DAM	C83A	414	6
GERRANDS DAM	C83B	1347	50.7
LOCH ATHLONE DAM	C83B	3740	187
DE HOEK DAM	C83B	380	10
ELVINA DAM	C83C	417	16
MENIN DAM	C83C	691	80
SQUIBBS DAM	C83C	62	0.1
MERWEDE DAM	C83C	113	6
KRANSFONTEIN DAM	C83D	264	20
MEIRINGSKLOOF DAM	C83D	53	2
GELUK DAM	C83E	191	10
LANGLAAGTE DAM	C83E	113	6
BERVIE DAM	C83E	113	5
PIETERSFONTEIN DAM	C83E	113	11
KOFFER DAM	C83E	500	10
GELUK DAM	C83F	240	18
REITZ REWARD DAM	C83F	225	15
VERGELEGEN DAM	C83F	433	0
FREDERIKSDAL DAM	C83F	110	4
BUFFEL DAM	C83F	330	15
BIETJIE-WATER DAM	C83G	581	35
GELUKBUITELOOP-OPGAARDAM	C83G	480	15
DEALBATA DAM	C83G	113	5
TWEESPRUIT DAM	C83G	108	4
RUSTFONTEIN DAM	C83G	110	0
VAN ROOYENS DAM	C83G	108	8
MOOIRAND DAM	C83H	68	4
FREDERICKSDAL	C83H	400	10
ERFDAM DAM	C83J	113	8
JAGERSRUST WILDSPLAAS DAM	C83K	189	10
OU JAGERSRUST DAM	C83K	402	13
SWARTFONTEIN DAM	C83K	113	6

Table 8: Dams delineated based on the ISP study

Dam Name	Quaternary catchment	River
Grootdraai	C11L	Vaal
Vaal	C22K	Vaal
Klerkskraal	C23F	Mooi
Boskop	C23G	Mooi
Klipdrift	C23J	Loopspruit
Driekloof	C81D	Off-channel
Sterkfontein	C81D	Nuwejaarspruit
Saulspoort	C83A	Liebenbergvlei

5 LIMITATIONS AND UNCERTAINTIES

SOME OF THE KEY LIMITATIONS WHICH MAY INFLUENCE THE CONFIDENCE OF THE DELINEATION PROCESS WHICH SHOULD BE CONSIDERED WHEN IMPLEMENTING THESE PRIORITY RUS AND ECOSYSTEMS INCLUDE:

5.1 RIVERS

- There is an observed conflict between the IUA and RU boundaries. To address this problem, it is recommended that in future the delineation of IUAs be based on sub-quaternary (quinery) catchment boundaries.

5.2 WETLANDS

- Delineation was largely dependent on available NFEPA wetland data. While this was the only publically available dataset for the study area, it is known to substantially under-represent the distribution of wetlands in the catchment[1].
- Whilst a wide range of wetland assessments (including wetland delineation) have been undertaken by consultants in the catchment, this information is not readily available due to (i) confidentiality clauses with clients and (ii) the disaggregated nature of the data that makes data acquisition difficult.

5.3 GROUNDWATER

- Very little information is available to adequately delineate confined groundwater ecosystems in particular in the study area.
- The delineation process demonstrates how groundwater ecosystems do not conform to surface ecosystems which were used as a template for groundwater delineation.

1 Based on extensive work in the catchment, Wetland Consulting Services have found that hillslope seepage wetlands are under-represented by up to 60% in some areas of the catchment (Gary Marnerwick, *pers. comm*..)

6 ACKNOWLEDGEMENTS

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7 WAY FORWARD

The RUs provide the smallest discrete, manageable unit and are therefore important in the context of all other steps of the RQO process. However, given the large number of RUs within a selected catchment it is not possible to monitor all of these. The next step (Step 3) of the RQO process therefore entails a rationalisation process to prioritise and select the most useful RUs for RQO determination. The RUs detailed in the current report will therefore form the basis of this prioritisation process.

Selecting a sub-set of wetlands to take forward into further steps in the RQO process is likely to be a challenging process given the large number of wetlands in the study area. However, it is important to note that selection is undertaken again in Step 3 of the RQO process. This involves the prioritization and selection of RUs for RQO determination. Rather than following a tiered approach to selection (Step 1 then Step 3), a GIS analysis will be undertaken as part of Step 3 in order to evaluate the relative importance of all wetland units in the catchment. This analysis will be informed by the RU prioritization tool criteria (DWA, 2011) but will also need to be customised and refined based on available data. Additional criteria including the importance of wetlands to users and various practical considerations will be integrated into the prioritization process.

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9 APPENDIX

APPENDIX A: SUMMARY OF THE DETAILED STEPS APPLIED IN DELINEATING RIVER RESOURCE UNITS.

Preparation

1) Open ArcMap 10 ™ and select new map
2) Add the following layers: sub-quaternaries, quaternary catchments, IUAs, Nodes, EWR sites and Rivers
3) Select> Select by location> select features from sub-quaternary catchments >source layer: IUA> Spatial selection method: Target layer (s) features intersect the Source layer feature > OK
4) Close dialog box
5) Right click the sub-quaternary catchment layer > Selection> Create layer from selected features (this creates a new layer in the table of contents)
6) Right click on the new layer and export the data to a shapefile with the name of the WMA as the prefix e.g. UVaal_SubQuats
7) Add the data as a layer in the map

Editing (*ensure that the layers are in the correct projection before editing)

1) Right click on the WMA_SubQuats layer > Edit Features> Start Editing
2) Using the river pattern and nodes, select sub-quaternaries that form the river catchment. Note: This step can involve integrating more than one river catchment to a resource unit.
3) When the sub-quaternaries feeding to hydronode x have been selected click Editor > Merge (do this step as necessary for resource unit delineation)
4) Delete subquats that do not fall within the IUA or have a significant portion of their area outside the WMA.
5) Editor > Save Edits Stop editing.

Resource Units have now been delineated.

Attribute table

Once the resource units were delineated, the following fields were added to the table: resource unit number (RU_Num), IUA, Area (km2) and Perimeter (km). The resource number was assigned by the hydro node in the particular resource unit.