DETERMINATION OF RESOURCE QUALITY OBJECTIVES IN THE MIDDLE VAAL WATER MANAGEMENT AREA

WP10534

RESOURCE UNITS DELINEATION AND PRIORITISATION REPORT

REPORT NO.: RDM/WMA09/00/CON/RQO/0313

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EXECUTIVE SUMMARY

The Chief Directorate: Resource Directed Measures (RDM) has initiated the development of Resource Quality Objectives (RQO) for the Middle Vaal Water Management Area. The purpose of this study is to implement the RQO determination procedures in the Middle Vaal WMA and in so doing determine the RQOs of the significant resources for presentation to the delegated authority. It is recognised that the process of RQO determination of water resources requires a strongly driven stakeholder engagement and communication component supported and guided by the necessary technical and institutional components.

Establishment of RQOs is a mechanism through which the balance between sustainable and optimal water use and protection of the water resource can be achieved. RQOs are defined by the National Water Act as “clear goals relating to the quality of the relevant water resources” (DWAF, 2006).

RQOs are descriptive or quantitative, spatial or temporal, and ultimately allows realisation of the catchment vision by giving effect through the gazetting process. RQOs provide the basis for determining the allocatable water quality and water quality stress and are constituted based on the designated users of the water resource (e.g. recreational, aquatic ecosystem, industrial use, domestic etc), the goals defined to protect the water resource and the alignment to the catchment vision and class of the water resource.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource management class, the process will allow due of the consideration of the social and economic needs of competing interests by all who rely on the water resources. The RQO process will be applied taking account of the water use requirements, local conditions, socio-economic imperatives and system dynamics of the catchment.

As part of the RQO process the first step is to delineate the units of analysis and define Resource Units (RUs). Each integrated unit of analysis (IUA) represents a homogenous catchment area of similar impacts which must be considered in the determination of RQOs. A RU on the other hand is a stretch of river within an IUA that is sufficiently ecologically distinct to warrant its own specification. Groundwater RUs are defined separately and are based on a number of factors.

The IUA delineation of the Middle Vaal WMA was done as part of the water resource classification process, through which 8 IUAs have been delineated. The IUAs delineated form the basis for the RQO determination process. Based on the ecological specifications, ecological water requirements and biophysical nodes defined it is now necessary through the RQO process to delineate key rivers of the Middle Vaal into Resource Units (RU) and prioritise the RUs that require RQO development. This report therefore details the process of delineating and determining the resource units for the water resources in Middle Vaal WMA and prioritising those requiring RQO development.

Resource Units Delineation and Prioritisation Approach

The process followed in terms of IUA delineation was that described in the RQO Determination Guideline (February 2011). Delineation of RUs is required as it would not be appropriate to set the same RQOs for all water resources in a catchment.

The following was considered for delineation of RUs within the Middle Vaal WMA:

- IUA boundaries and sub-quartenary boundaries
- Geomorphological zones and Eco-regions
- EWR sites and location of biophysical nodes (in terms of the Classification study outputs)
- Ecological condition (based on the EWR and node information)
- Freshwater Ecosystem Priority Areas (FEPAs)
- Operation of the system
- Water quality sub-units/impacts
- Land use and anthropogenic activities
- Groundwater units
- Expert knowledge of the catchment area and system.

Thirty one surface water resource RUs were delineated. While the WRCS proposes RQOs for each resource unit, this may not always possible due the potentially large number of RUs that could be delineated for a catchment. A rationalisation process has therefore been developed as part of the RQO Determination Procedure (DWA, 2011) in order to prioritise and select the most useful RUs for RQO determination.

The rationalisation process for RU selection and prioritisation is based on a decision support tool that has been developed to guide and support the process. The 'Resource Unit Prioritisation Tool' incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs.

Based on the priority ratings obtained through application of the RU prioritisation tool, these rankings and weightings were used to select the priority RUs for RQO determination. The evaluation of the RU priority ratings for selection were done at a desktop level and discussed and confirmed at the stakeholder engagement workshops for the Middle Vaal WMA RQO study held in Klerksdorp and Welkom over 25 and 26 September 2013 respectively. The scores for all criteria are combined into a priority rating which scores the RUs relative to each other. This provides an integrated measure to inform the selection of priority RUs. Based on the evaluation process twenty eight river RUs and six dam RUs were prioritised. Three RUs were not selected. These include the most upstream catchments (headwaters) in the Renoster River catchment (R1), Vals River catchment (V1) and Upper Sand catchment (US1).

Delineation and Prioritisation Results

Thirty one surface water resource RUs were delineated and 28 have been prioritised; six dam RUs were delineated and prioritised; three groundwater priority areas were prioritised (Dolomite aquifer systems). The general groundwater areas have been described (Ventersdorp/Karoo Aquifer systems) and fifty wetlands/wetland clusters have been prioritised in the WMA. The results are tabulated below and shown in Figure E1, E2, E3 and E4.

RU	Delineation	Quartenary Catchment
IUA 8: VAAL RIVER		
VB1.1	Vaal River mainstem: Vermaasdrift to upstream Schoon spruit confluence	C24B
VB1.2	Vaal River mainstem: From the Schoonspruit confluence to just upstream Vals River confluence	C24J
VB1.3	Vaal River mainstem: From Vals River confluence to Bloemhof Dam	C25C, C25F
VB2	Tributary catchments (Vierfonteinspruit and 24J –south of Vaal River)	C24B, C24J
VB3	Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassiespruit tributary catchments	C24J, C25A, C25C, C25D
VB4	Sandspruit tributary catchment	C25C, C25B, C25F, C43B
VB5	Bamboespruit tributary catchment	C25E
VB6	Bloemhof Dam	C25E, C25F, C43D
TRIBUTARIES		
IUA 1: RENOSTER RIVER		
R1*	From origin to Vaalbankspruit and Vegkopspruit tributary confluences	C70A, C70B
R2	Downstream Vaalbankspruit tributary confluences to Koppies Dam	C70C
R3	Koppies Dam	C70C
R4	Downstream Koppies Dam to confluence with the Heuningspruit	C70E, C70D, C70F, C70G, C70H
R5	Downstream Heuningspruit confluence to confluence with the Vaal River	C70J, C70K
IUA 2: VALS RIVER		
V1*	Origin of Vals River to Pauciflora Spruit confluence	C60A
V2	Downstream Pauciflor Spruit confluence to Kroonstad	C60B, C60C, C60D, C60E, C60F
V3	Serfontein Dam	C60D
V4	Middelspruit tributary catchment	C60H
V5	From the Kroonval weir to the Vaal River confluence	C60G, C60J
IUA 3: SCHOONSPRUIT		
SK1	From origin of Koekemoerspruit to confluence with Vaal River	C24A, C24B
SK2	Schoonspruit eye	C24C
SK3	Taaibospruit tributary catchment	C24F
SK4	From Schoonspruit eye to Kaalspruit confluence	C24D, C24E
SK5	Kaalspruit and Buisfonteinspruit tributary catchment	C24G
SK6	Johan Neser Dam (Kklerksdorp Dam)	C24G
SK7	From Johan Neser Dam to confluence with the Vaal River	C24H
IUA 4: UPPER SAND RIVER		
US1*	Origin of Sand River to confluence of the Klipspruit	C42A, C42B, C42C
US2	Downstream Klipspruit confluence to Allemanskraal Dam	C42D, C42E
US3	Allemanskraal Dam	C42E
IUA 5: LOWER SAND RIVER		
LS1	Allemanskraal Dam to Merriespruit confluence	C42F, C42G, C42H,
LS2	Rietspruit tributary catchment	C42J

RU	Delineation	Quartenary Catchment
LS3	Downstream Rietspruit confluence to confluence with the Vet River	C42K, C42L, C43B
IUA 6: UPPER VET RIVER		
UV1	Klein Vet and Laaispruit tributary catchments	C41A, C41B
UV2	Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	C41C, C41D
UV3	Soutspruit tributary catchment	C41E
UV4	Erfenis Dam	C41E
IU7 : LOWER VET RIVER		
LV1	Erfernis Dam to confluence with Sand River	C41F, C41G, C41H, C41J
LV2	Downstream Sand River confluence to Bloemhof Dam	C43A, C43C, C43D
SELECTED GROUNDWATER PRIORITY UNITS		
Dolimitic RU G1 (RU SK2; SK3)	The demarcation of the quartenary catchment covers the whole dolomite aquifer unit.	C24F, C24C
Dolimitic RU G2 (RU SK3; RU SK4)	The groundwater unit falls within the quartenary catchment boundaries.	C24C, C24F, C24E
Dolimitic RU G3 (RU SK1)	The dolomite aquifer systems fall within the boundaries of the quartenary catchment and can be included in the surface water RU.	C24A, C24B
General: Ventersdorp/Karoo Aquifers	To be included in the RUs as demarcated for the surface water resources	
PRIORITY WETLANDS/WETLAND CLUSTERS		
SK1	Pan	C24A
SK2	Pan cluster to the north of Vetpan and Klippan	C24C
	Vetpan and Klippan	
	Rietpan pan and wetland complex	
	Schoonspruit eye and upper section of the Skoonspruit peatland	
SK3	Grootpan	C24F
	Pan cluster to the north of Coligny	
	Floodplain of the Taaibosspruit	
	Lower Kaalspruit	
	Lower section – floodplain of the Skoonspruit	
SK4	Two pans to the northwest of Ventersdorp	C24D, C24E
	Lower section of the Skoonspruit peatland	
	Skoonspruit wetland system	
SK5	Floodplain of the lower Skoonspruit	C24G
R4	Middle reaches of the Renosterrivier	C70E, C70D, C70F, C70G, C70H
	Middle reaches of the Heuningspruit	
	Grootvlei in a tributary of the Heuningspruit and on the Heuningspruit	
	Central and lower reaches of the Mahemspruit	
	Rietspruit tributary of the Heuningspruit	
	Middle to lower reaches of the Rietspruit	
R5	Wetland system to the south of Viljoenskroon	C70J, C70K
	Wetland on the farm Roodepoort	
	Northern section of Swartpan	

RU	Delineation	Quartenary Catchment
	Leeupan	
	Vaneedespan	
	Groot Rietpan	
V4	Middle reaches of the Otterspruit and its tributaries	C60H
	Pan cluster associated with the middle reaches of the Otterspruit	
	Tributary of the Otterspruit	
V5	Hertzogsvlei	C60G, C60J
	Southern section of Swartpan	
VB4	Upper reaches of the Sandspruit (immediately north of Kutloanong)	C25C, C25B, C25F, C43B
	Pan cluster around Wesselbron including Volstruispan to the north	
	Graspan	
	Mahemspan	
LS3	Ganspan and remaining pans that form the southern part of the Wesselbron pan complex	C42K, C42L, C43B
	Wetland system along the Mahemspruit	
	Flamingo Pan	
	Stinkpan	
	Witpan	
LV2	Brakpan	C43A, C43C, C43D
	Floodplain of the Vetrivier	
	Bultfontein pan and saltworks	
	Pan cluster to the south of Bultfontein	
VB5	Pan cluster along the watershed divide to the west of the Bamboesspruit	C25E
*	Surface water RUs not prioritised	

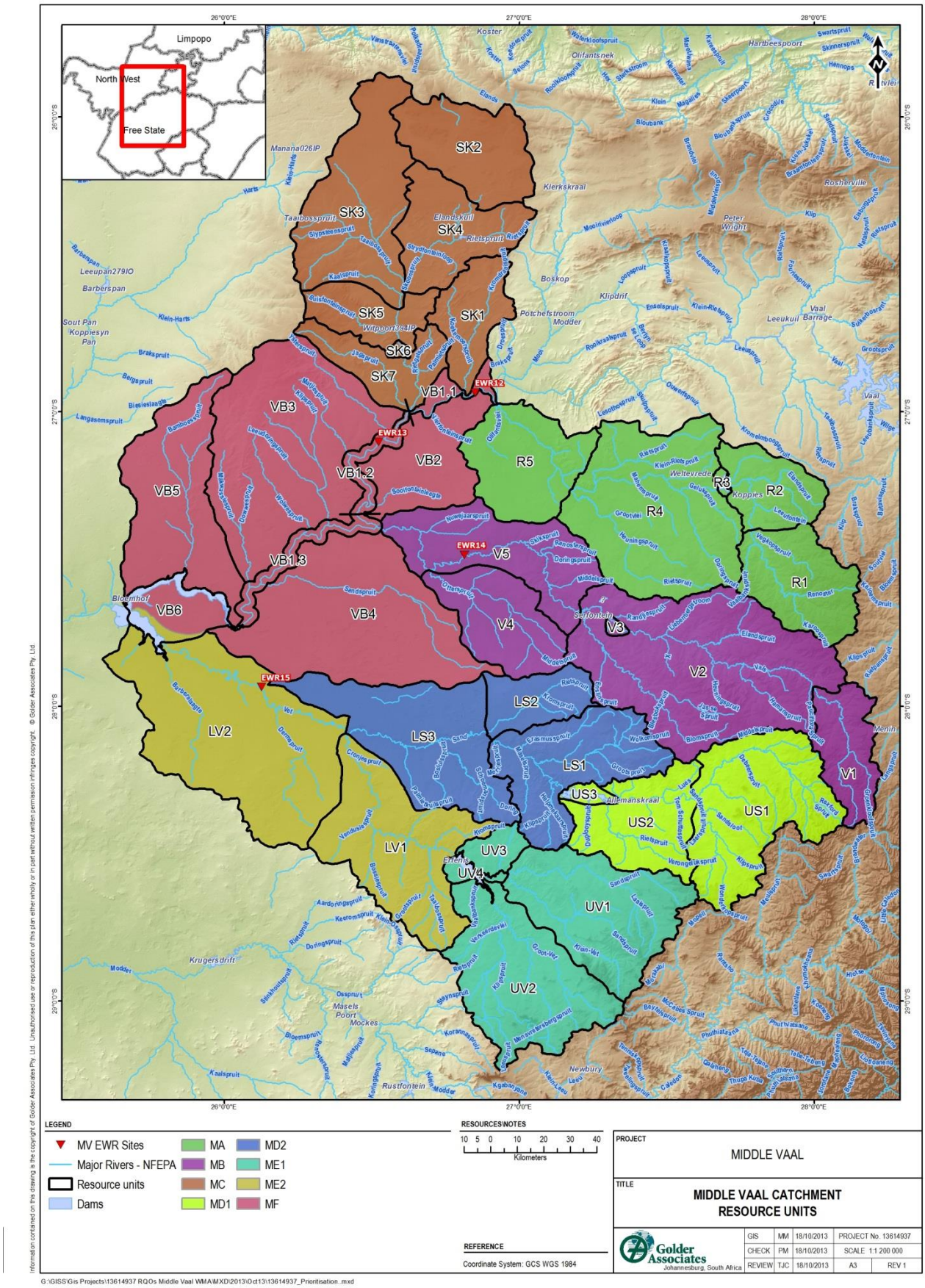

Figure E1: RUs delineated in the Middle Vaal WMA

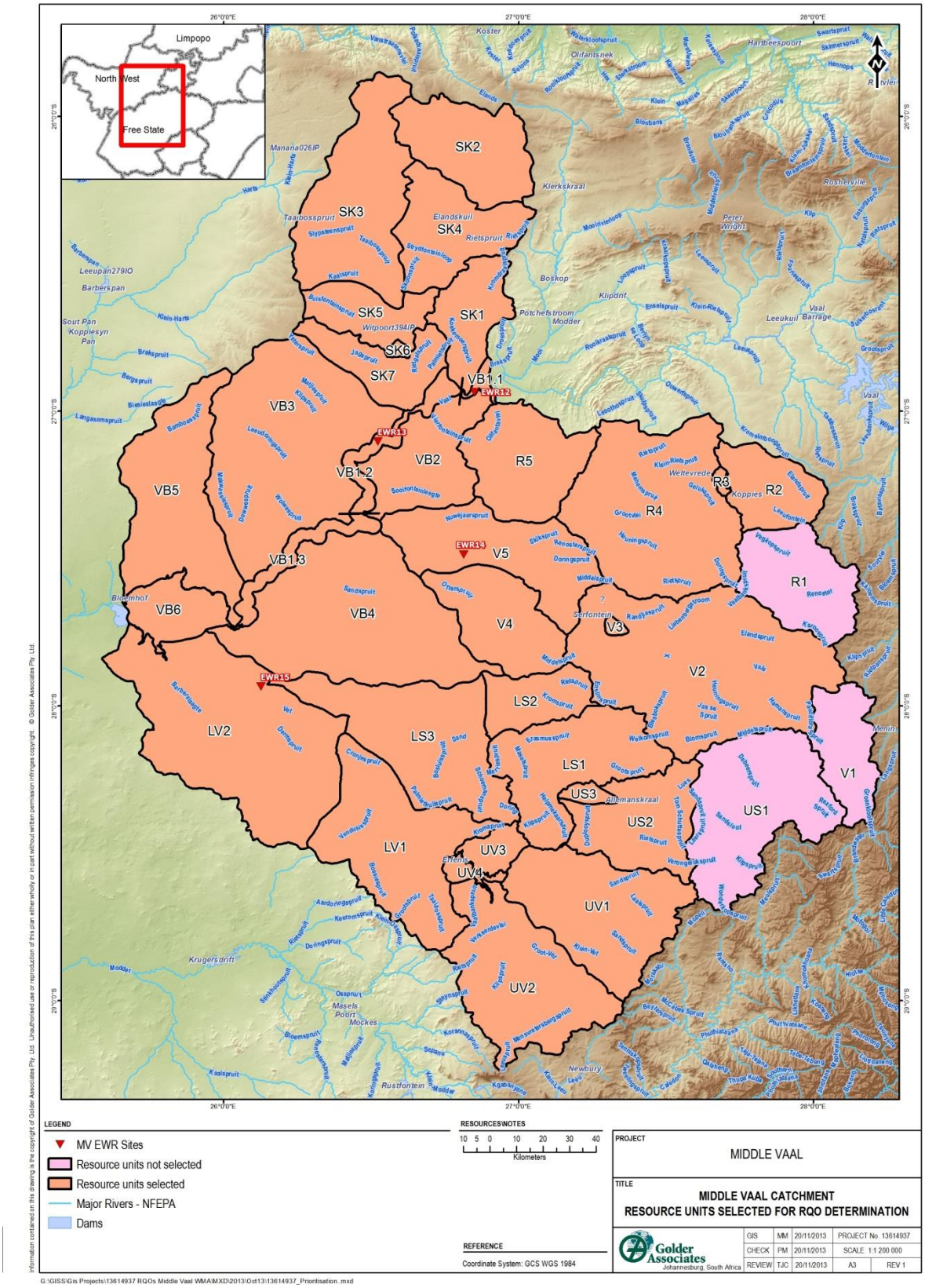

Figure E2: RUs prioritised and selected for RQO determination in the Middle Vaal

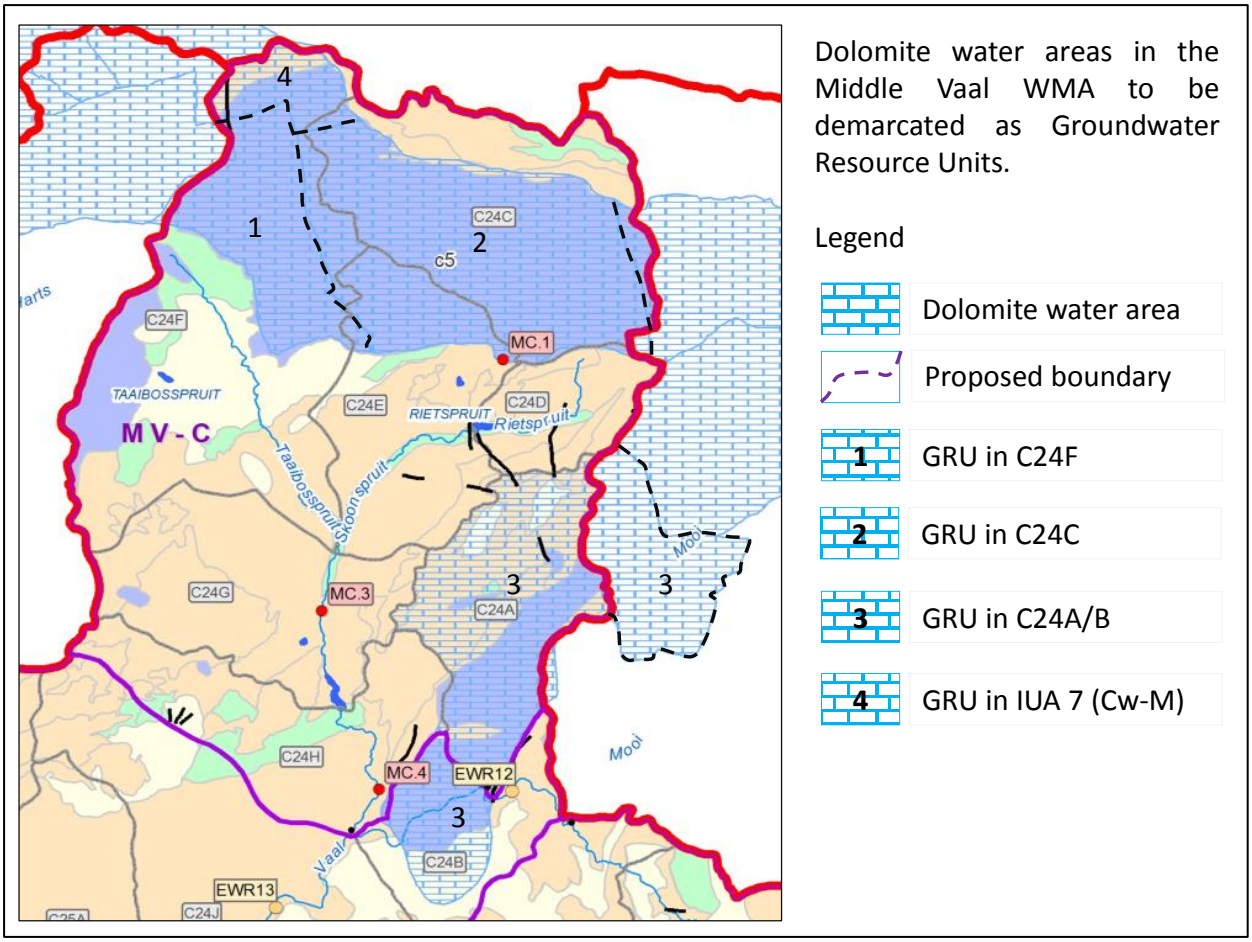

Figure E3: Groundwater priority areas (Dolomitic aquifer systems) identified in the Middle Vaal WMA

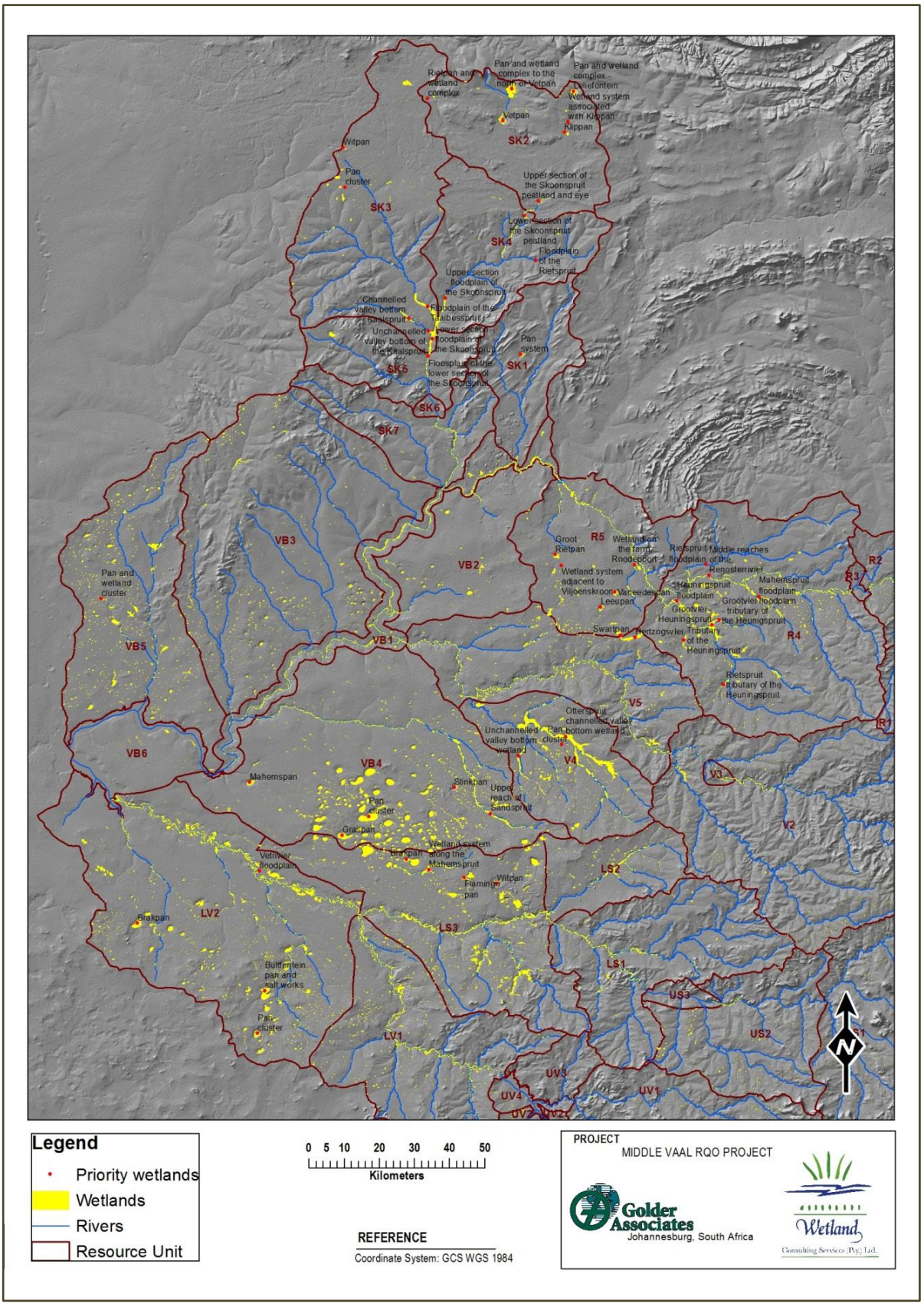

Figure E4: Wetlands/wetland clusters prioritised in the Middle Vaal WMA

LIST OF ABBREVIATIONS AND ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EIS	Ecological importance and sensitivity
EWR	Ecological Water Requirements
HGM	Hydrogeomorphic
IHI	Index of habitat integrity
IUA	Integrated Unit of analysis
IWRM	Integrated Water Resource Management
MC	Management Class
FEPA	Freshwater Ecosystem priority areas
NSBA	National Spatial Biodiversity Assessment
NWA	National Water Act
PES	Presentation Ecological State
QDS	Quarter Degree Square
RDM	Resource Directed Measures
RQOs	Resource Quality Objectives
SANBI	South African National Biodiversity Institute
WMA	Water Management Area
WRCS	Water Resource Classification System

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1 INTRODUCTION

1.1 BACKGROUND

The National Water Act (Act No. 36 of 1998) (NWA) is founded on the principle that National Government has overall responsibility for, and authority over, water resource management for the benefit of the public without, seriously affecting the functioning of the water resource systems. In order to achieve this objective, Chapter 3 of the NWA provides for the protection of water resources through the implementation of resource directed measures (RDM). As part of the RDM, a resource quality objective (RQOs) has to be determined for a significant water resource, as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries from which it can be deduced whether the resource is being stressed by existing management practices or not.

The NWA also requires that in determining RQOs, a balance be sought between the need to protect and sustain water resources and the need to protect them. The first stage in the protection of water resources, according to the NWA, is the development of a system to classify the nation's water resources. The Water Resources Classification System (WRCS) (DWAF, 2007) is a key framework into which the Reserve and RQOs both fit. The classification system, the Reserve and RQOs together are intended to ensure comprehensive protection of all water resources. An important consideration in the determination of RDM is that they should be technically sound, scientifically credible, practical and affordable.

The Chief Directorate: Resource Directed Measures (CD:RDM) of the Department of Water Affairs (DWA) is tasked with the responsibility of establishing clear goals relating to the quality of the relevant water resources. In 2012, the CD:RDM completed the classification of the water resources of the Middle Vaal WMA through which integrated units of analysis (IUAs) where defined and management classes determined. The CD:RDM has now identified the need to undertake the determination of RQOs for the water resources in the Middle Vaal WMA based on the outcomes of the classification process.

The purpose of this study is to implement the RQO determination procedures in the Middle Vaal WMA and in so doing determine the RQOs of the water resources for presentation to the delegated authority with the management classes that have been determined. Once approved the management classes and RQOs for the Middle Vaal WMA will be gazetted and thereafter be implemented.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource management class, the process will allow due of the consideration of the social and economic needs of competing interests by all who rely on the water resources. The RQO process will be applied in the Middle Vaal WMA taking account of the water use requirements, local conditions, socio-economic imperatives of the WMA as well as the system dynamics of the Vaal River System catchment.

As part of the RQO process the first step is to delineate the units of analysis and define Resource Units (RUs). Each integrated unit of analysis (IUA) represents a homogenous catchment area of similar impacts which must be considered in the determination of RQOs. A RU on the other hand is a stretch of river within an IUA that is sufficiently ecologically distinct to warrant its own specification. Groundwater RUs are defined separately and are based on a number of factors.

The IUAs for the Middle Vaal WMA have been delineated through the water resource classification

process. This process builds on the classification outputs and the results of the previous Reserve determination study and requires that the resource units for the water resources in Middle Vaal WMA now be determined.

1.2 STUDY AREA

The study area for the RQO study is the Middle Vaal WMA (WMA 9) which constitutes the middle portion of the Vaal River (Figure 1). The Middle Vaal WMA is part of the integrated Vaal River System and falls within the C drainage region of South Africa. The Middle Vaal WMA covers a catchment area of 52 563 km^2, and includes parts of the Free State and North-West Provinces. The Vaal River is the only main river in the WMA. It flows in a westerly direction from the Upper Vaal WMA, to be joined by the Koekemoerspruit, Skoonspruit, Rhenoster, Vals and Vet rivers as main tributaries, before flowing into the Lower Vaal WMA and then into the Orange River..

There are several dams that have been developed *viz.* Bloemhof Dam on the Vaal River, Allemanskraal Dam on the Sand River, Erfenis Dam on the Vet River, and Koppies Dam in the Renoster River.

Present land use in the WMA is characterised by gold mining, extensive dry land cultivation, particularly in the central parts. Irrigation is practised downstream of dams along the main tributaries as well as at locations along the Vaal River. The remainder of the WMA is natural grassland used for livestock farming. The economy in the WMA is mainly based on mining and agriculture as primary production sectors. The largest urban areas are Klerksdorp, Welkom and Kroonstad.

The Middle Vaal WMA comprises eight sub-catchments as listed in Table 1. The WMA consists of the C24, C25, C41, C42, C43, C60 and C70 tertiary catchments (Figure 1).

Table 1: Sub-catchments and related quaternary drainage regions within the Middle Vaal WMA

Primary Catchment	Sub-Catchment Areas	Quartenary Catchments	Average Gross Area (km^2)
C	Renoster	C70A-K	6656
	Vals	C60A-J	7871
	Schoon Spruit	C24C-G	5644
	Middle Vaal	C24A-B, C24H-J, C25A-C	8281
	Bloemhof	C25D-F	4959
	Allemanskraal	C42A-E	3628
	Erfenis	C41A-E	4724
	Sand	C42F-L	3927
	Vet	C41F-J, C43A-D	6873

The Middle Vaal WMA's water quality and flow is mainly controlled by activities that take place in the Upper Vaal WMA. The Middle Vaal WMA is dependent on the Upper Vaal WMA for meeting the bulk water requirements of its mining, industrial and urban sectors. Large quantities of water are transferred into the WMA to augment local water resources. These upstream activities include releases from the Vaal Dam and Vaal River Barrage, waste water treatment works discharges, urban runoff and gold mining activities on the Witwatersrand. In the Middle Vaal WMA discharges and decants from gold mining activities in the Mooi and Koekemoer Spruits have an impact on the continued salinity build up in the Vaal River. These impacts are subject to many catchment studies.

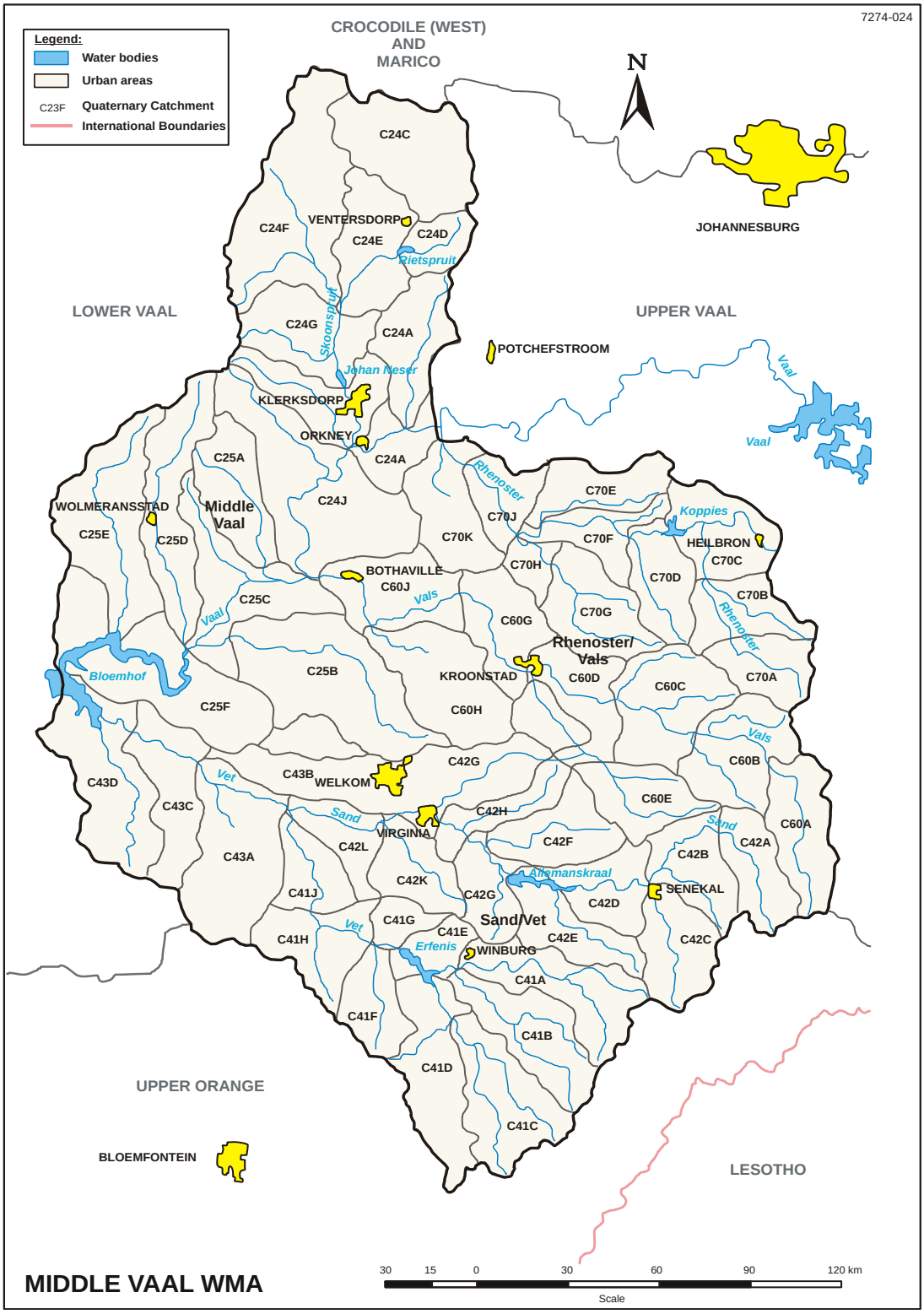

Figure 1: General layout of the Middle Vaal WMA

Management of water quality and quantity in the Middle Vaal WMA is therefore integrally linked to both the Upper and Lower Vaal WMAs. Water quality issues of concern in the Middle Vaal WMA are related to salinity, eutrophication and public health. The closure of mines may have further water quality impacts. High concentrations of TDS have been identified in the Middle Vaal River

which is impacting on water use in the catchment. Eutrophication as the other key water quality problem in the Middle Vaal River is highlighted by the hypertrophic status of the middle reaches of the Vaal River from the Vaal Barrage to Bloemhof Dam.

Two dolomite aquifer systems, the Ventersdorp-Grootpan DWA and the Klerksdorp-Orkney-Stillfontein-Hartebeesfontein (KOSH), are present in the upper reaches of the Schoonspruit and Mid Vaal sub-catchments (*viz*, C24C, C24E, C24F and C24A and C24B). These dolomite water resources are extensively used for irrigation (Schoonspruit groundwater and surface water systems) and impacted by mining activities in the KOSH area. Several studies have reviewed the status of these systems pre-2004; although recent impacts due to drought conditions and mining activities may not be well incorporated into the total hydrological context. Groundwater in the remaining part of the Mid Vaal Catchment is related to Karoo type aquifer systems which may have been impacted on a localized scale due to poor management of the quantities and qualities.

1.3 THE RESOURCE UNIT DELINEATION AND PRIORITISATION SUB-TASK

The definition of resource units forms part of Task 1 of the RQO determination process, "Delineate Integrated Units of analysis and Define Resource Units", specifically sub-tasks 1.5 to 1.7. It is required to facilitate effective management and necessitates the breakdown of a river into discrete manageable units, primarily from an ecological perspective. The resource units are generally ecologically homogenous in nature. The delineation of IUAs and prioritisation of RUs are undertaken as the initial steps of the RQO process. RQOs are then developed per RU within the context of the IUA catchment perspective.

In this study RQOs for rivers, groundwater, dams and wetland resources will be determined. To generate RQOs for these resources the existing seven step procedure methodology available from DWA (2011) has been expanded on to include dam and wetland methodologies.

The outcomes of this study will include RQOs for rivers, groundwater, wetlands and dam resources on five different scales as follows:

- rivers on a river RU scale (river RUs),
- priority groundwater resources on a system specific scale (priority groundwater RUs),
- general groundwater resources on a groundwater RU scale which is comparable with river RUs (general groundwater RUs),
- priority wetland resources on a system specific scale,
- priority dam resources on a system specific scale.

This report details the process of delineating and prioritising the resource units for the water resources in Middle Vaal WMA. It provides the information used to define the RUs and details the results of the delineated and prioritised RUs.

2 DELINEATION OF THE INTEGRATED UNITS OF ANALYSIS (IUAS)

The Water Resource Classification (WRC) and the confirmation of the Ecological Reserve for the Middle Vaal WMA were completed in 2012. Through this study the IUAs for the WMA were delineated and the EWR sites and river nodes were specified. These outputs form the classification study form the basis for the RQO determination process, and primarily for the RU definition.

In terms of the Middle Vaal WRC study, eight IUAs were delineated (DWA, 2012). These are listed in Table 2 and shown in Figure 2. The IUAs form the boundaries for RU delineation. A biophysical node may encompass one or more RUs. A biophysical node is an outcome of the classification process at which a desired ecological category (nested ecological category) for each river reach upstream of the node has been provided.

Table 2: IUAs delineated for the Middle Vaal WMA

IUA (Middle Vaal)	Catchment area	Quaternary catchment
MA	Renoster River	C70A – C70K
MB	Vals River	C60A-C60J
MC	Schoonspruit River	C24C – C24H and C24 A
MD1	Upper Sand River	C42A – C42E
MD2	Lower Sand River	C42F- C42L
ME1	Upper Vet River	C41A – C41E
ME2	Lower Vet River	C41F – C41J and C43A – C43D
MF	Vaal River from Renoster confluence to Bloemhof Dam	C24B, C24J, C25A –C25F

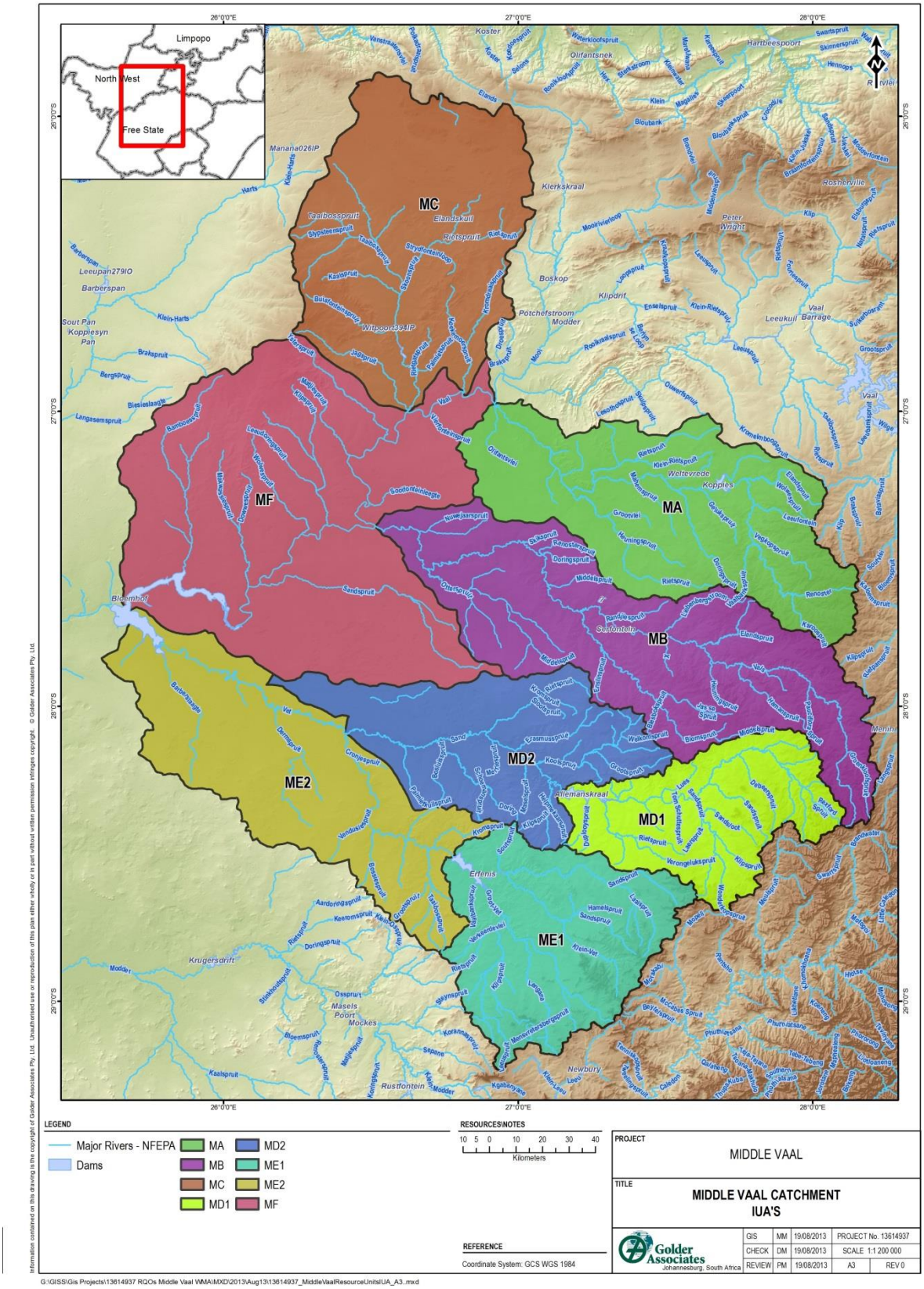

Figure 2: IUAs delineated in the Middle Vaal WMA

3 RESOURCE UNIT DELINEATION: SURFACE WATER

3.1 APPROACH

From an ecological perspective, rivers should be viewed as continuous longitudinal systems. Impacts that occur in upstream reaches are likely to affect downstream processes. As it would not be appropriate to set the same RQOs for the headwaters of a river as for the lowland reaches, RUs are required. The RUs are river reaches that are each significantly ecological different to warrant their own specification of the RQOs and as such the geographic boundaries of each must be clearly delineated (DWAF, 1999, Volume 3).

A RU is a section of a river that frequently has different natural flow patterns, reacts differently to stress according to their sensitivity, and requires individual specifications of the ecological requirements and RQOs appropriate for that reach, as compared to the rest of the river. The delineation of a catchment into RUs is done primarily on a biophysical basis, and where the hydrology, geomorphic characteristics (*i.e.* geomorphic zone), water quality attributes and river size remains relatively similar, a RU can be defined.

In addition management requirements also play a role in the delineation of a RU (DWAF, 1999, Volume 3). The purpose of distinguishing a RU of management requirements is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements. These management units are based on the principle of homogeneity of impacts in the demarcated RU. This may include the modification of flows in the system due to abstraction, regulation by impoundments and development along the RU and upstream from the RU which may influence the geomorphology and water quality conditions.

The RU delineation process considers the above aspects. Overlaying all the data does not necessarily result in a logical and clear delineation and expert judgement, a consultative process and local knowledge are required for the final delineation of the RUs. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of RUs.

3.2 RESOURCE UNIT CONSIDERATIONS FOR DELINEATION

The resource unit delineation was done based on the following considerations:

- IUA boundaries and sub-quartenary boundaries
- Geomorphological zones and Eco-regions
- EWR sites and location of biophysical nodes (in terms of the Classification study outputs)
- Ecological condition (based on the EWR and node information)
- Freshwater Ecosystem Priority Areas (FEPAs)
- Operation of the system
- Water quality sub-units/impacts
- Land use and anthropogenic activities

- Groundwater units
- Expert knowledge of the catchment area and system.

3.2.1 Eco-Regions (Level II)

Eco-Regional classification allows for the grouping of rivers according to similarities. The Eco-Region Level II information was used to delineate the catchment of the Middle Vaal WMA. The available Level II information was obtained from the DWAF, Directorate Resource Quality Services (D: RQS). Eco-regions integrate important physical variables, such as topography, landscape, geology, soils and vegetation cover, and as such, provided a basic template for identifying Resource Unit Boundaries. The study area includes three revised Level II Eco-regions (Kleynhans, *et al*., 2007). The Level II Eco-regions in the study area are as follows:

- *Highveld (eco-region 11)*: This eco-region (high lying region) is characterized by plains with low to moderate relief, and various grassland vegetation types. The altitude ranges between 1100 and 2100m. Rainfall is concentrated in early to late summer, with a coefficient of annual variation of <20 to 35%. Mean annual air temperatures are between 12 and 20°C.
- *Eastern Escarpment Mountains (eco-region 15)*: This eco-region is characterized by closed hills and mountains with moderate to high relief. Vegetation consists of a range of grassland types. The altitude ranges between 1100 and 3100 m. Rainfall is concentrated in early to late summer, with a coefficient of annual variation of <20 to 35%. Mean annual air temperatures are between <8 and 18°C.
- *Southern Kalahari (eco-region 29)*: This eco-region is characterized by plains with low to moderate relief, and vegetation consists of a variety of Kalahari Bushveld types. The altitude ranges between 500 and 1700 m. Rainfall is concentrated in mid to very late summer, with a coefficient of annual variation of 30 to >40%. Mean annual air temperatures are between 14 and 22°C.

The Eco-Regions of the Middle Vaal WMA are illustrated in Figure 3.

3.2.2 Geomorphological zonation

Geomorphology provides a basis of classification for the purpose of describing the physical habitat of riparian and aquatic ecosystems, as it encompasses the physical processes which have shaped the river channel. Rowntree and Wadeson (1999) have developed a zonal classification system for Southern African Rivers. In their classification for each zone of a river a geomorphological definition in terms of distinctive channel morphological units and reach types are given. On the basis of channel features a range of geomorphological zone classes have been defined and are described in Table 3.

The hierarchical classification approach of Rowntree and Wadeson (1999) was followed in the Reserve Determination Study of the Middle Vaal WMA. In terms of the Reserve study all rivers in the Middle Vaal WMA can be classified as a geomorhological Zone class E, Lower Foothills.

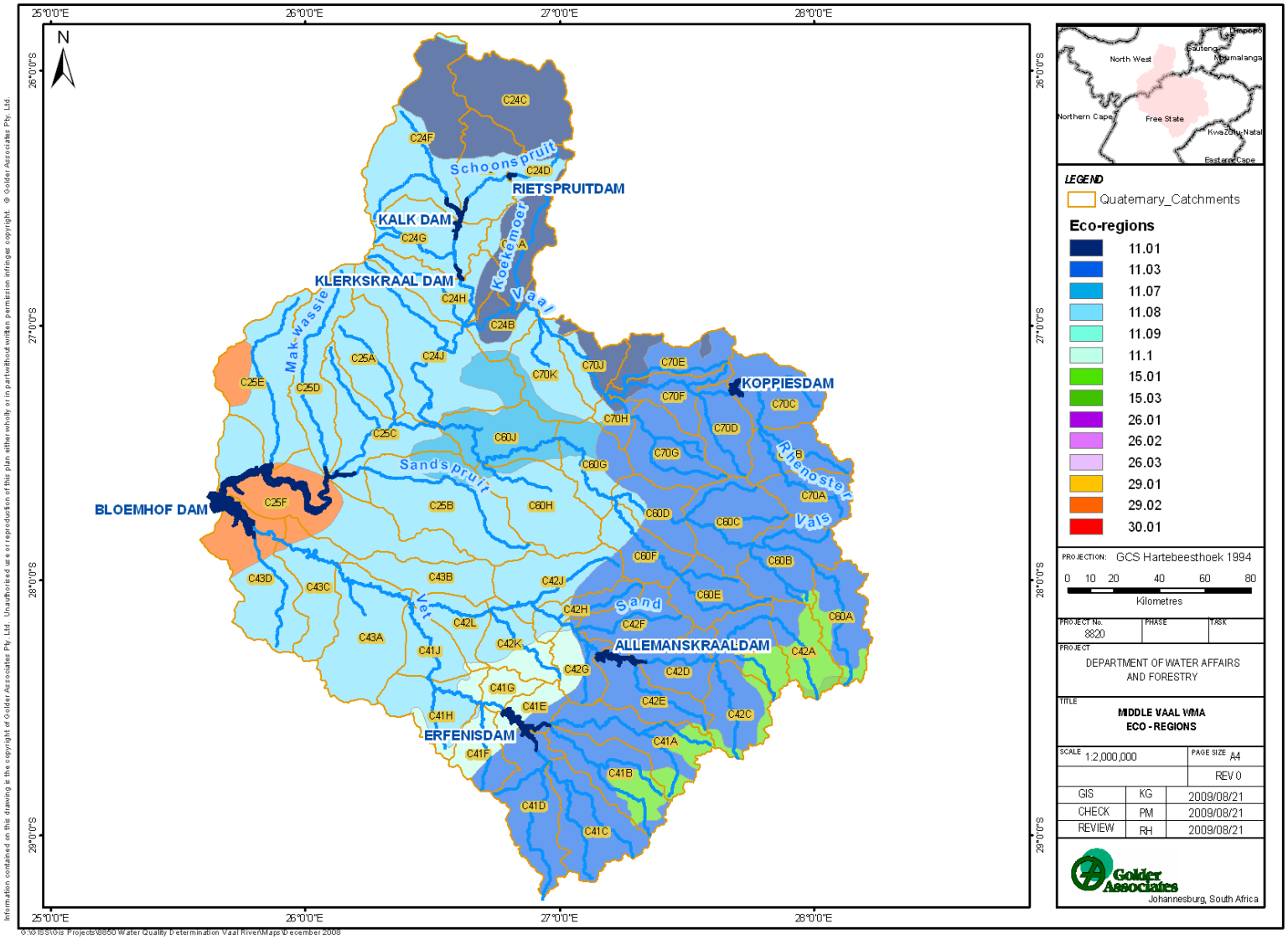

Figure 3: Eco-regions of the Middle Vaal WMA

Table 3: Geomorphological Zonation of River Channels (adapted Rowntree and Wadeson, 1999)

Longitudinal zone	Characteristic channel features	
	Zone class	Description
Mountain stream	B	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Transitional	C	Moderately steep stream dominated by bedrock or boulder. Reach types include plain-bed, pool-rapid or pool riffle. Confined or semi-confined valley floor with limited flood plain development.
Upper Foothills	D	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plain-bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow flood plain of sand, gravel or cobble often present.
Lower Foothills	E	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Flood plain often present.
Lowland river	F	Low gradient alluvial fine bed channel, typically regime reach type. May be confined, but fully developed meandering pattern within a distinct flood plain develops in unconfined reaches where there is an increased silt content in bed or banks.

3.2.3 Land cover

Land cover and land use information of the WMA is used to determine homogeneity of impacts and used in the decision-making regarding delineation of the RUs. The land cover of the Middle Vaal WMA is dominated by natural grassland, cultivated land, urban/built up areas and goldmines in the riparian and adjacent zones (see Figure 4).

3.2.4 System Operation

An overview of system management is required to ensure an understanding of the system operation and to interpret biological responses. System operation infrastructure is also often the logical endpoint of a RU. A description on the present operation which includes present uses, abstractions, curtailments *etc*. and operational structures (formal and informal) if any, that could impact on the characteristics of the river within the system must be understood.

The surface flow of the Vaal River, most of which originates in the Upper Vaal WMA, represents the bulk of the surface water in the Middle Vaal WMA. The surface water flows that originate within the WMA are highly seasonal and intermittent. The Vaal River is fed by a number of tributaries of which the most significant are the Renoster, Schoonspruit, Vals and Vet Rivers. Vlei areas occur along the lower Vet River and in the upper Schoonspruit catchment. The surface water occurring in the WMA has been developed to its potential and all water is being fully utilised. There are several large dams that have been developed in the WMA (Table 4).

Most of the major tributaries of the Middle Vaal WMA support irrigation schemes. The Sand-Vet Irrigation Scheme within the Sand-Vet Government Water Scheme (GWS) is the most important in the Middle Vaal WMA. Other significant irrigation schemes in this WMA are the Schoonspruit and Rhenoster GWS.

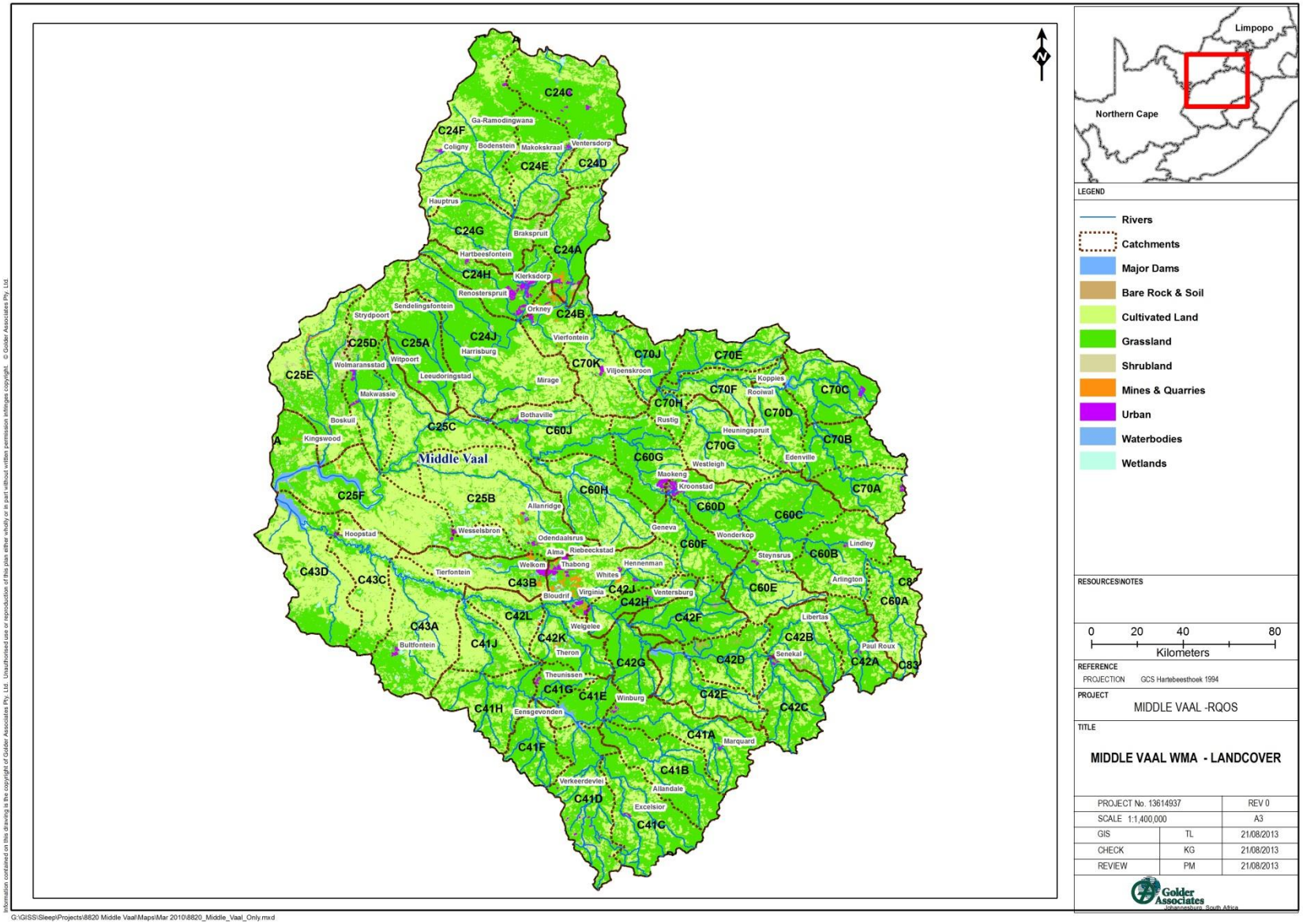

Figure 4: Land cover of the Middle Vaal WMA

Table 4: Major Dams in the Middle Vaal WMA (DWAF, 2006)

Dam name	Quaternary catchment	River	Purpose
Bloemhof	C91A	Vaal	Irrigation
Allemanskraal	C42E	Sand	Irrigation
Bloemhoek	C60D	Jordaan Spruit	Domestic
Erfenis	C41E	Vet	Irrigation
Johan Neser	C24G	Schoonspruit	Irrigation
Klipplaatdrift	C25A	Vaal	
Koppies	C70C	Renoster	Irrigation
Marquard	C41A	Laai Spruit	Domestic
Rietspruit	C24D	Schoonspruit	Irrigation
Three Sisters	C42F	Sand	
Uniefees	C70C	Eland Spruit	Domestic

The system operation is summarised below:

- **Vaal River inflow from Upper Vaal WMA (C24A) – at Vermaasdrift**: The Middle Vaal WMA is dependent on the Upper Vaal WMA for meeting the bulk water requirements of its mining, industrial and urban sectors in the Klerksdorp-Orkney and Welkom-Virginia areas. Large quantities of water are transferred into the WMA to augment local water resources. The North West Goldfields, therefore urban and bulk water requirements account for 40% of total requirements. The main urban centres are Klerksdorp, Orkney and Stilfontein in the NW Goldfields and Odendaalsrus in the Free State. The requirements of Stilfontein, Buffelsfontein, Vaal Reefs and Hartebeesfontein Gold Mines make up the bulk requirements in the area. Effluent returns from these towns and mines increase the water resources of the area significantly. This area also exports water from the Vaal River to a number of adjacent key areas, the most significant being Sedibeng Water export of water at Balkfontein to the Free State Goldfields in the Vet key area.

  The local water resources within the WMA are used by smaller towns (Bothaville and Wolmaranstad) and for irrigation. Some small transfers also occur from Vaal Dam to Heilbron in the Middle Vaal WMA and out of Erfenis Dam to the Upper Orange WMA. Water is also transferred via the Vaal River through this WMA to Bloemhof Dam, from the Upper Vaal WMA to the Lower Vaal WMA. Management of water quality and quantity in the Middle Vaal WMA is therefore integrally linked to both the Upper and Lower Vaal WMAs. Notable abstractions in the river reach between Vaal Barrage and Bloemhof Dam include Midvaal Water, Sedibeng Water and abstractions for irrigation. These abstractions are supported with releases from Vaal Barrage (backed by Vaal Dam). The releases from Vaal Barrage are driven by either these downstream water requirements or through excess water in the Vaal Barrage (spills).

Water stored in Bloemhof Dam is used to supply the downstream irrigation and urban users and only if Bloemhof Dam is empty will water be released from Vaal Dam to support those demands. Users along the Middle Vaal Reach (between Vaal Barrage and Bloemhof Dam) are supplied with incremental run-off supplemented from Vaal Barrage and if required from Vaal Dam. The objective is to only release sufficient water to satisfy the requirements of the users in the reach. In addition, releases are occasionally made from Vaal Dam for blending purposed. These releases are mostly captured in Bloemhof Dam for subsequent supply to the downstream users.

The water entering Middle Vaal WMA from the Upper Vaal WMA brings with it a large contribution of urban, industrial and mining return flows from the highly industrialised and urbanised areas within the Upper Vaal WMA. These carry with it high salinity levels and high nutrient concentrations which are "transferred" into the Middle WMA. As a consequence these high salinity levels need to be managed through dilution with fresh water from Vaal Dam to ensure water of an acceptable quality reaches the Middle Vaal WMA.

- **Vaal River from Vaal Barrage to downstream of the confluence with the Schoonspruit:**

  Three conditions or events influence the flow in this reach. Firstly, releases are made from Vaal Barrage (source Vaal Dam) to supply urban and industrial demands as well as riparian irrigation. The releases to these users are dependent on the run-off from the incremental catchments and are adjusted on a short term basis. Due to the limiting storage capacity at the intakes of these users, no flexibility exists in terms of the short term release rate.

  Secondly, during prolonged droughts additional releases are made from Vaal Dam for users downstream of Bloemhof Dam. These releases can be reasonably flexible with respect to the discharge rate and pattern within a monthly period due to the buffering capacity of Bloemhof Dam. The governing rule for these releases (in terms of seasonal and annual timescales) is to only release sufficient water to satisfy the demand.

  A third condition, to achieve specific water quality blending objective (the additional release of Vaal Dam water to maintain the TDS concentration in Vaal Barrage at 600 mg/l) may cause additional "spills" over Vaal Barrage. This is necessary due to the high salinity (TDS) content of the underground mine water that is pumped out of the gold mines into the river system and surface runoff from the highly urbanised areas in the incremental catchment of the Vaal Barrage. The flow rate into this reach is also flexible over the short term.

  Goldfields Water and MidVaal Water Company withdraw significant amounts of water from the Vaal River within this reach.

  The Pilgrims Estate weir (C2H007) which also influences flow in the Middle Vaal River is located just outside Orkney. The weir captures the inflows from the Koekemoerspruit and Vierfontein Spruit, and supports irrigation upstream of the Schoonspruit and Koekemoerspruit catchments. The MidVaal Water Company abstraction is at the Pilgrims Estate weir.

- **Vaal River from Schoonspruit confluence to Bloemhof Dam wall:**

  The system operation of 'Vaal Barrage to Schoonspruit reach' applies to this reach as well with the addition of run-off from the incremental catchment. It is important to note that developments in the form of small dams and irrigation schemes along the tributaries contributing to this reach do reduce the run-off to the Vaal River.

  The Klipplaatdrift weir (C2H061) is situated approximately 60 km downstream of the Pilgrims

Estate weir (at Balkfontein). Sedibeng Water abstracts it water at the Klipplaatdrift weir. There is an operational problem at the Balkfontein abstraction point as storage at the Balkfontein weir is too low. Consequently releases from the Vaal Dam need to coincide with actual water requirements in this catchment to ensure that the weir does not overflow or that water shortages do not occur. Sedibeng Water also enjoys a conditional water use from Allemanskraal when the dam is overflowing, provided that the Reserve requirements are catered for. This water is cheaper and of a better quality than water from the Vaal River (DWAF, 2004).

- **Renoster (C70):** The Renoster River has its origin south of Petrus Steyn in the South Eastern Free State. It includes the C70 tertiary catchment (C70A to C70K). The major town influencing the Renoster River is Petrus Steyn. The Rhenoster catchment is rural in nature and has significant controlled irrigation and rural requirements (87 % of total requirements). Heilbron and Viljoenskroon are the most significant urban centres in the area. Water is imported from the Upper Vaal WMA (Vaal Dam) to supply the needs of Heilbron. This catchment area does not contribute to the yield of the Vaal River. The potential for water resources development within the key area is mostly limited to the exploitation of groundwater.

  Only one dam exists, namely Koppies Dam, which was constructed mainly for irrigation purposes and completed in 1912. The presence of a large number of weirs (61), road bridges and roads has resulted in a large to serious impact on the Renoster River. Koppies Dam provides flow regulating capability. The yield balance situation is such that the water available from the dam is fully utilised. There is also significant water use from the river downstream of the dam to the extent that there is no excess water available. The Voorspoed Mine has purchased water rights from irrigators that were supplied from Koppies Dam as part of the Koppies Government Water Scheme.

  Large areas of the river are inundated and this has a serious impact on the flow, bed and channel of the river. The riparian zone is also impacted on by these obstructions in the river as the wetted and dry riparian zones of the river are altered. The many abstraction pumps present also indicate that there is a large volume of water abstracted from the river although not many irrigated lands were visible.

- **Koekemoerspruit (C24A):** The Koekemoerspruit catchment is highly altered by catchment development. The river falls within the C24A quartenary catchment. The Koekemoerspruit flows through the Hartebeesfontein and Stilfontein mines and is upstream of Klerksdorp and the Midvaal Water Company. Catchment development has led to severe deterioration in water quality. Major impacts on water quality include mining pollution, urban run-off, sewage effluent and irrigation return flows. The water quality issues in the catchment have an impact on the water abstracted by MidVaal Water. There have been concerns that water is disappearing from the Koekemoerspruit however this has been difficult to prove due to rapidly changing flows in the river.

  The Buffelsfontein weir is also used to monitor the water quality of the discharges from the goldmines in the area, and whether the Margaret shaft water is entering the Vaal River. However this has not yet been proven.

- **Schoonspruit (C24C-H):** As with the Koekemoerspruit, the Schoonspruit catchment is also characterised by intensive development. The Schoonspruit catchment comprises of six quaternary catchments C24C, C24D, C24E, C24F, C24G and C24H. Quaternary C24C and parts of C24E and C24F are considered as endoreic areas, as the surface runoff generated in

these areas flow to localised pans in the area and therefore do not contribute to the stream flow in the Shoonspruit and its tributaries. The Schoonspruit Eye forms the origin of the Schoonspruit in the southern part of quaternary catchment C24C. Just downstream of the Schoonspruit Eye a diversion weir was constructed to divert water into the Schoonspruit Canal. The diversion weir (C2H064) is also used as a gauging weir to measure excess water that is not diverted into the canal but spills over the weir back into the mainstream of the Schoonspruit. The Schoonspruit canal supplies water to Ventersdorp as well as to the whole Schoonspruit Irrigation Scheme. The Right Bank Canal conveys the water to the Ventersdorp Municipality off take and further along the canal at Kalk Dam, the Municipality also abstracts water for agriculture use in the town.

At the Kalk Dam, there is a structure that can reject excess water into the Schoonspruit as well as allowing water to flow underneath the Schoonspruit by means of a siphon to a canal. This canal supplies water for irrigation up to the Rietspruit Dam as well as supplies water by means of the Elandskuil siphon to the Elandskuil Dam and canal on the Right Bank of the Schoonspruit. All the excess water flows into the Rietspruit Dam. The Elandskuil Dam supplies water for irrigation and is considered more as a balancing dam. The Rietspruit Dam captures runoff from the Rietspruit catchment and is used to supply water for irrigation by means of a canal system (DWAF, 2006).

Significant irrigation developments started on the dolomitic aquifer recharge areas in the late nineteen eighties. Irrigation water for these new developments was obtained from the dolomitic aquifers through boreholes. To be able to protect the resource the minister proclaimed the Ventersdorp Eye subterranean Government Water Control Area (G.W.C.A) in June 1995.

The Klerksdorp Irrigation Scheme is located downstream of the Schoonspruit Irrigation Scheme and originates on the farm Witpoort and stretches to the Vaal River. Abstraction of water takes place at five points in and around Johan Neser Dam. The irrigation scheme includes weirs, directing pumping from the dam and river, a canal system and a 400 mm pipeline from the Johan Neser Dam to supply irrigation developments.

Informal or diffuse irrigation also takes place within the tributary sub-catchments of the Schoonspruit. Water is abstracted directly from the streams or from farm dams located in the tributary sub-catchment. Urban/Industrial return flows from Klerksdorp, Hartbeesfontein and Orkney enter the lower Schoonspruit catchment downstream of Johan Neser Dam. Return flows from Ventersdorp is relatively small and enters the Schoonspruit downstream of Kalk Dam.

- **Vals River (C60):** The Vals River which includes the C60 tertiary drainage region of the Vaal River catchment has its origin in the vicinity of Bethlehem from where it flows past Lindley in the north-westerly direction to Kroonstad and on to Bothaville from where it flows into the Vaal River. Various tributaries enter the Vals River of which the Elandspruit is the largest. While the Vals River catchment is rural in nature, it has significant urban requirements (73 % of total water requirements). The urban requirements are dominated by the requirement of Kroonstad Municipality. Water is imported from the Vaal River by Sedibeng Water to supply the needs of the Bothaville local municipality. Treated sewage and storm water returns from Kroonstad in particular contribute significantly (33 % of total resource) to the water resources of the Vals key area. All irrigation in the Vals catchment is regarded as diffuse and is not significant. The catchment does not contribute to the yield of the Vaal River. This river system does not have storage regulation capability with release capabilities, with the result that high flow control and

management is not possible.

Serfontein Dam is the only large Dam in the catchment on the Vals River and it is located near Kroonstad. It has a small storage relative to the runoff. The Serfontein Dam has a capacity of 4.200million m^3 and a surface area of 1.58 km^2. Seasonal water releases are made from the dam.

Water quality deterioration as a result of Kroonstad, Lindley and Bothaville Sewage Works runoff as well as runoff from irrigated and drylands has a serious to critical impact on the Vals River. Prolific growth of algae in the lower reach of the river has been observed.

The overall modification to bed, channel and flow in the Vals River is moderate to large due to the presence of several weirs, roads through the river and road bridges over the river, as well as Serfontein Dam. Some sand mining occurs in the river and these lead to bank erosion and siltation of the river.

- **Sandspruit (C25B):** The Sandspruit is located in quartenary catchment C25B of the Vaal River System. It is an ephimeral river that flows only during certain times during the year. There are no structures, weirs or dams.
- **Makwassie (C25D):** As with the Sandspruit the Makwassie is also an ephimeral river, with no flow regulation in the catchment.
- **Vet River (C40):** The Vet River catchment includes the secondary drainage (C4) of the Vaal River catchment. The Sand River is a major tributary of the Vet River. The river system includes two major dams, Erfenis on the Vet River and Allemanskraal Dam on the Sand River. The available water resources in this river system are fully utilised. Allemanskraal Dam (located in quaternary C42E) on the Sand River and Erfenis Dam (located in quaternary C41E) on the Vet River have flow release regulating capabilities.

  The water resources of this catchment area are augmented by transfers from Vaal River by Sedibeng Water for urban and bulk use in the Free State Goldfields and by the upstream yields of Erfenis and Allemanskraal catchment areas. The mining and urban water requirements of the Free State Goldfields dominate the water requirements of this catchment. The main urban centres are Welkom and Virginia and the main mines are Harmony, President Steyn, African Rainbow Minerals and Bambanani Gold Mines. Returns flows from these users contribute about 10 % to the water resources of the catchment.

  Irrigation water requirements for controlled irrigation are significant in the Vet River catchment and are the most important in the Middle WMA as a whole. Approximately 122 km2 is scheduled for irrigation in three areas, namely Sand-Vet GWS (Sand), Sand-Vet GWS (Vet) and Vet River GWS. Actual irrigation requirements are significant therefore Vet River catchment does not contribute to the yield of the Lower Vaal WMA.

  The Allemanskraal Dam and Erfenis Dam catchments are rural in nature. In the Allemanskraal catchment area consumptive requirements by urban and rural users make up the rest of the requirements, with irrigation water requirements not being significant. Senekal is the most important urban centre in the area. The upper reaches of this catchment do contribute to the downstream yield of the Sand River.

  There is an export of water from Erfenis Dam to Brandfort local municipality in the Upper Orange WMA. Irrigation water requirements are also not significant in the Erfenis Dam catchment. Winburg and Marquard are the most important urban centres in the catchment

area.

- **Bloemhof Dam (C25, C43):** Bloemhof Dam was built in 1970 and helped to relieve Vaal Dam of part of the downstream water demands. Bloemhof Dam is the most downstream regulating storage in the subsystem with the function of supplying the water requirements in the Low Vaal Subsystem as their primary resource. The releases from the dam are made in accordance with a daily schedule of water requirements that are updated on a weekly basis. Since the water requirements supplied from Bloemhof Dam is more than the supply capability (incremental yield) of the dam, releases are made from Vaal Dam (via Vaal Barrage) once the water level in Bloemhof Dam reaches its minimum operating level.

  Various sub-catchments contribute to the flow into Bloemhof Dam with each having various dams and water abstractions all impacting on the supply capability of the dam. There are no release obligations from these sub-catchments with the result that only spills from these dams and unused runoff flows into Bloemhof Dam.

  The requirements of this catchment area are dominated by non-consumptive requirements. Consumptive requirements by urban and rural users are small in comparison, approximately, 3%. Wolmaransstad and Wesselsbron are the most important urban centres in the catchment area.

  There is no significant irrigation in this area. The potential for water resources development in this area is controlled by requirements in the Upper Vaal WMA and the upstream Middle Vaal River catchment area and by the scheduled irrigation requirements of the downstream Lower Vaal WMA.

3.2.5 Water quality sub-units

Water quality sub-units define areas of homogenous water quality. The land use defines the anthropogenic influences on water quality and provides a good indicator of which water quality variables would change over time. A water quality sub-unit is a length of river for which a single description of water quality can be given. This may be determined by eco-regions, dams, tributaries, towns, point sources of pollution etc. Changes in water quality may be natural e.g. input of water from tributaries, or man-made, e.g. abstractions and discharges, towns, tributaries, industries, sewage treatment works etc. All these factors therefore can cause changes in water quality and define sub-units.

Water quality sub-units may not coincide with the RUs for flow, but where possible they should be integrated. This is the start of the integration process between quantity and quality, and may be important for setting RQOs. The water quality delineation of the study area, Middle Vaal WMA (WMA 9) was undertaken during the Reserve study and confirmed during this process to identify water quality changes. Table 5 indicates a water quality delineation using the water quality information and data available.

Table 5: Water Quality sub-units of the Middle Vaal WMA

Water Quality Subunit Number	Quaternary Catchment(s)	Major River/Dam unit	Reason: Water Quality Issues
1	C70A, C70B, C70D, C70E, C70F, C70G, C70H, C70J, C70K	Rhenoster/Renoster spruit	Salinity and nutrients are relatively low - however, visual appearance of river is not good. Water appears milky turbid and there is algal growth on rocks. Agricultural impact is high (Koppies irrigation scheme).
2	C70C	Koppies Dam	Salinity and nutrients are relatively low. Water appears milky turbid and there is algal growth on rocks. Agricultural impact is high (Koppies irrigation scheme).
3	C24A	Koekemoerspruit/ Kromdaaispruit (before confluence); and Koekemoerspruit (downstream confluence)	Extremely high salinity (high sulphate) and very high nutrient concentrations. Spruit shows severe signs of eutrophication.
4	C24B	Vaal River (downstream Mooi River to upstream Schoonspruit)/ Vierfontein; and Vaal River (downstream Koekemoerspruit to upstream Schoonspruit)	High TDS and high DOC, increasing. High phosphates and inorganic nitrogen. High potential for algal growth. Microbiological contamination is a problem due to sewage pollution. Vierfonteinspruit - strong algal growth/high salt levels (limited data)
5	C24C, C24D, C24E	Upper reaches Schoonspruit/ Rietspruit (Rietspruit dam)	Agricultural runoff (nutrients and sediments). Dam - channel supplies water to farmers
6	C24F	Taaibosspruit (and Monamaladi)	Agricultural impact. Ventersdorp eye - extraction. Area includes piggeries which have an impact.
7	C24G	Johan Neser Dam	
8	C24G	Buisfonteinspruit	Agriculture
9	C24H	Schoonspruit (below dam upstream Jagspruit confluence)	Poor water quality. Extremely high salinity and very high nitrogen and phosphate concentrations.
10	C24H	Jagspruit	Impacts from Gold and uranium mining. Increasing impact - slimes dams. Downstream agricultural uses impact on river.
11	C24J	Vaal River where - Regina to Klipplaatdrift?	High Salinity, high nutrients and increasing. High potential for algal growth
12	C60A, C60B, C60C,C60D	Vals River (Upper reaches)	Downstream Kroonstad impacts from sewage works (Kroonstad, Lindley and Bothaville). Agricultural activities in lower reaches of catchment also have negative impacts.
13	C60E, C60F	Elandspruit Tributary	
14	C60D	Serfontein Dam	
15	C60G, C60H, C60J	Vals River	Nutrient concentrations are high and increasing. High levels of salinity also recorded.
16	C25A, C25B,C25C,C25D , C25E, C25F	Vaal River to Bloemhof Dam	High salinity and nutrients - upstream impacts (from Barrage downstream). Area also has a large amount of diamond digging. Agricultural activities also impact on river.
17	C42A, C42B, C42C, C242D	Sand River (upper reaches)	No real issues at present. Agriculture and cattle farming are key activities in catchment.

Water Quality Subunit Number	Quaternary Catchment(s)	Major River/Dam unit	Reason: Water Quality Issues
18	C41A, C41B, C41C, C41D	Vet River (upper reaches)	Agricultural impact on river. (Two biomonitoring sites in catchment - on Vet and Klein Vet).
19	C41E	Erfenis Dam	Extraction from dam for irrigation
20	C42E	Allemanskraal Dam	Extraction from dam - canal - Sand Vet irrigation scheme.
21	C42F, C42G,C42H, C42J, C42K, C42L	Sand River (below Allemanskraal dam before confluence)	Large gold mines present in catchment. Also has a fair amount of agricultural activities in area. Impact negatively on Sand River. (WQOs at Bloudrif on Sand). High nutrients with filamentous algal and macrophyte growth.
22	C41F, C41G, C41H, C41J	Vet River (below Erfenis dam before confluence)	Impact from irrigation. High return flows to Vet river.
23	C43A, C43B, C43C, C43D	Vet River (downstream confluence with Sand)	Fairly high salinity. Impact from Hoopstad sewage treatment plant and agricultural activities. Fairly high phosphates.
24	C25F, C43D	Bloemhof Dam	TDS inversely correlated with dam levels. Algal blooms/water hyacinth. Relatively low phosphates ascribed to biogenic uptake.

3.2.6 Ecological condition

As RU definition is to a large extent based on the ecological condition and characteristics of the water resource, it is important to understand the ecological requirements and specifications of the surface water resources in the Middle Vaal WMA. The ecological condition of the 8 IUAs as classified in terms of the Water Resource Classification study for the Middle Vaal WMA is summarised below.

The Middle Vaal WMA includes 4 EWR sites and 26 biophysical nodes. The summary table of the eco-classification at the EWR sites and biophysical nodes per IUA in the Middle Vaal WMA is provided in Table 6 (DWA, 2012). The management classes per IUA are also included in Table 6 (DWA, 2012).

Table 6: Summary of Eco-classification at EWR sites and biophysical nodes and the IUA Management Classes in the Middle Vaal WMA

Node name	PES	REC	EIS	EI	Gross catchment area (km^2)	Management Class
IUA MA Renoster River						
MA.1	C	C	moderate	moderate	613	II
MA.2	B/C	B/C	moderate	moderate	881	
MA.3	C	C	moderate	moderate	81	
MA.4	C	C	low	low	2413	
MA.5	C/D	C/D	low	low	422	
MA.6	C	C	low	low	4092	
MA.7	C	C	low	moderate	1152	

Node name	PES	REC	EIS	EI	Gross catchment area (km^2)	Management Class
MA.8	C	C	low	low	5868	
IUA MB Vals River						
MB.1	C	C	low	low	860	III
MB.2	C	C	low	moderate	349	
MB.3	C	C	low	low	4898	
EWR14	C/D	C/D	moderate	moderate	5930	
IUA MC Schoonspruit						
MC.1	C	C	low	low	1350	III
MC.2	C	C	low	moderate	2020	
MC.3	C/D	C/D	low	low	2694	
MC.4	C/D	C/D	low	low	3503	
MC.5	D/E	D	low	low	839	
MC.6	D	D	low	low	499	
IUA MD1 Upper Sand River						
MD1.1	C	C	low	low	2215	III
IUA MD2 Lower Sand River						
MD2.1	C	C	moderate	**low**	3974	III
MD2.2	C	C	moderate	**low**	734	
MD2.3	C	C	moderate	**low**	7555	
IUA ME1 Upper Vet River						
ME1.1	C	C	low	moderate	2113	II
ME1.2	C	C	low	low	2083	
ME1.3	B/C	B/C	low	moderate	159	
IUA ME2 Lower Vet River						
ME2.1	C	C	low	moderate	5551	III
EWR15	C/D	C/D	moderate	moderate	16040	
IUA MF Vaal River from Renoster to Bloemhof Dam						
MF1	C	C	low	moderate	864	III
EWR12	D	D	moderate	moderate	62305	
EWR13	C/D	C/D	moderate	moderate	70809	

3.2.7 Groundwater units

The borehole yield classification for the Middle Vaal WMA (Figure 5) shows dolomite aquifer systems in the northern limb of the WMA. These dolomite aquifer systems are characteristically large systems with high permeabilities, thus they receive significant recharge from rainfall and represent large flow systems. They are classified as significant groundwater resources and require special management criteria due to the high abstractions which may impact on downstream resources and users.

In the remaining part of the Middle Vaal Catchment, the aquifer systems are Ventersdorp Lava and Karoo sedimentary type aquifer systems which are localised systems and are classified as Insignificant-Minor-Moderate systems with much lower recharge rates and production yields.

3.2.8 Freshwater Ecosystem Priority Areas

The Freshwater Ecosystem Priority Areas (FEPAs) identified through the National Freshwater Ecosystem Priority Areas Project of the Water Research Commission (WRC, 2011) within the Middle Vaal WMA were considered and assessed for RU delineation. FEPAs have been identified as those areas that are important for sustaining the integrity and continued functioning of their related ecosystems. The FEPAs of importance as identified in the Middle WMA are shown in Figure 6 (WRC, 2011). FEPAs are present in the Schoonspuit, Rhenoster, Vals, Sand and Vet catchment areas. The type of FEPAs and their associated quartenary catchment are listed below in Table 7.

Table 7: FEPAs within the Middle Vaal WMA (WRC, 2011)

FEPA ID	FEPA TYPE	Quaternary Catchment(s)	IUA
1661	Phase 2: River Ecosystem	C24G	Schoonspruit (MC)
2023, 2024, 2039, 2061, 2088	River Ecosystem, Wetland Ecosystem	C70E, C70J	Renoster (MA)
2208, 2238, 2293	Wetland Ecosystem, wetland clusters, River Ecosystem	C70G, C70H	Renoster (MA)
2183, 2233, 2241	Wetland Ecosystem, River Ecosystem, Fish species (Barbus anoplus)	C70C	Renoster (MA)
2323, 2324, 2393	Wetland Ecosystem, River Ecosystem, Wetland clusters, Fish species (Barbus, anoplus)	C70A, C70B	Renoster (MA)
2607, 2782, 2805	Wetland clusters, Fish species (Barbus, anoplus), wetland ecosystem	C60A	Vals (MB)
2507, 2564, 2471	River Ecosystem	C60C, C60D	Vals (MB)
2262, 2280, 2286, 2318	River Ecosystem, Wetland Ecosystem	C60G, C60J	Vals (MB)
2724, 2756	River Ecosystem	C42F	Lower Sand (MD2)

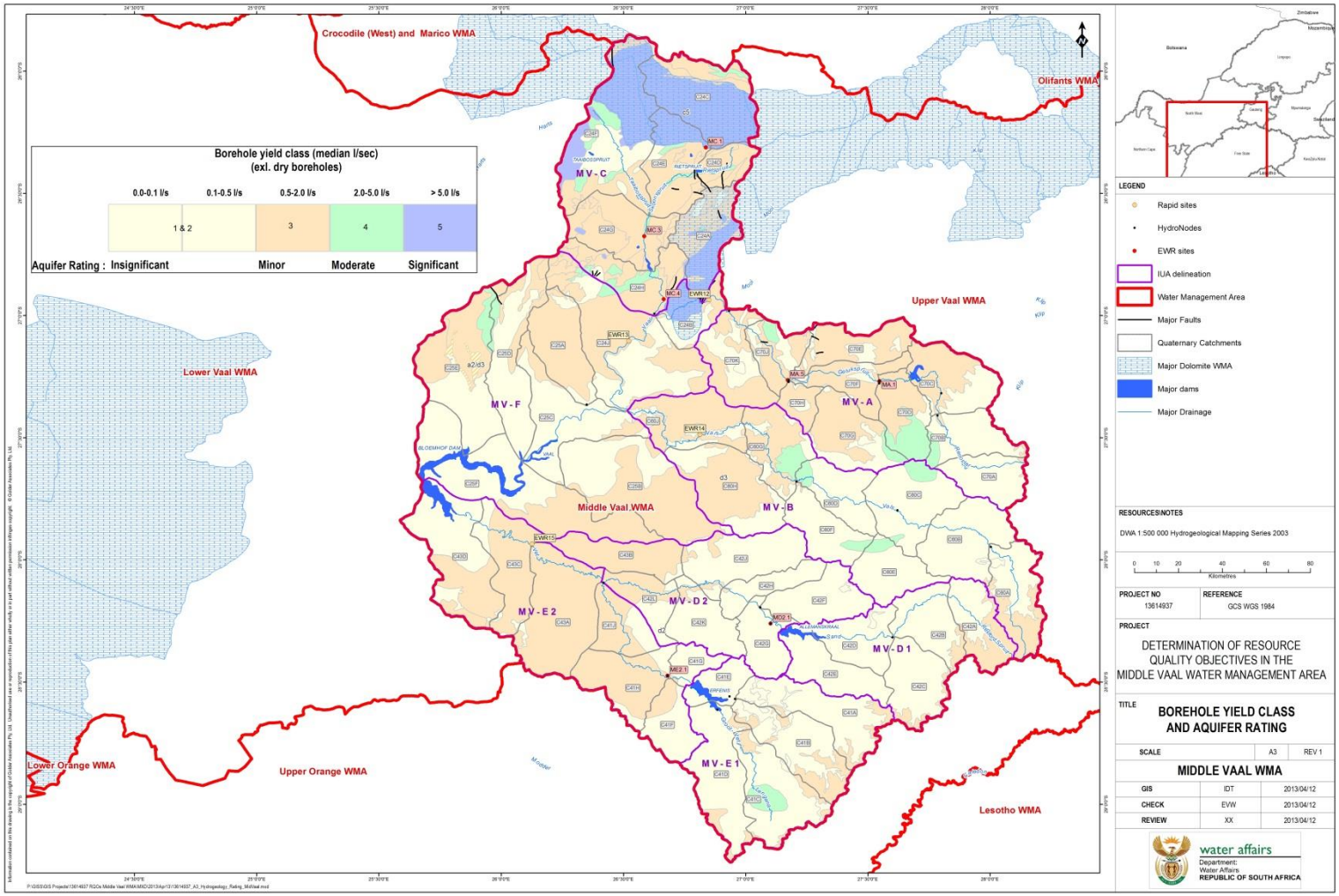

Figure 5: Borehole Yield Class and Aquifer Rating in the Middle Vaal WMA

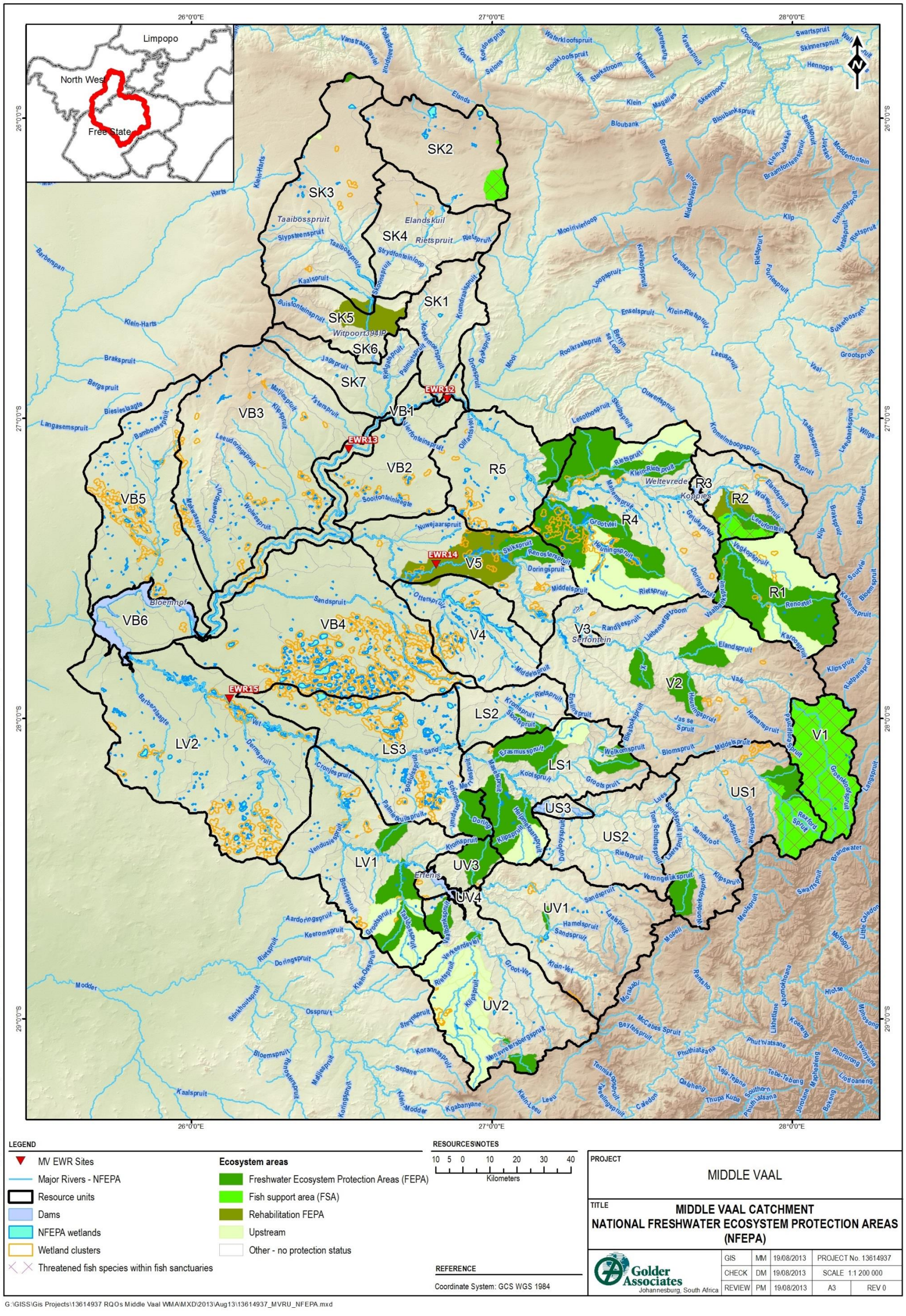

Figure 6: FEPAs in the Middle Vaal WMA

FEPA ID	FEPA TYPE	Quaternary Catchment(s)	IUA
2628, 2659, 2741	River Ecosystem, Wetland Ecosystem	C42H, C42J	Lower Sand (MD2)
3107	River Ecosystem	C42C	Upper Sand (MD1)
2802, 2881, 2857, 2947, 2956, 2989	River Ecosystem, Wetland Ecosystem	C42G, C42K	Lower Sand (MD2)
3227, 3295	River Ecosystem	C41B	Upper Vet (ME1)
3793, 3799	River Ecosystem	C41C	Upper Vet (ME1)
3299	River Ecosystem, Wetland Ecosystem	C41D	Upper Vet (ME1)
3184	River Ecosystem	C41D	Upper Vet (ME1)
2989	River Ecosystem, Wetland Ecosystem	C41E	Upper Vet (ME1)
3237, 3243, 3198, 3190, 3078	River Ecosystem, Wetland Ecosystem	C41F	Lower Vet (ME2)
2948	River Ecosystem	C41H	Lower Vet (ME2)

3.3 RESOURCE UNITS DELINEATION RESULTS

Based on the consideration and integration of the aspects discussed above and based on discussions with the stakeholders in the WMA, thirty one river and six dam RUs in the Middle Vaal WMA have been delineated. The RUs are shown in Figure 7 below. The RUs per IUA are described in the sections that follow.

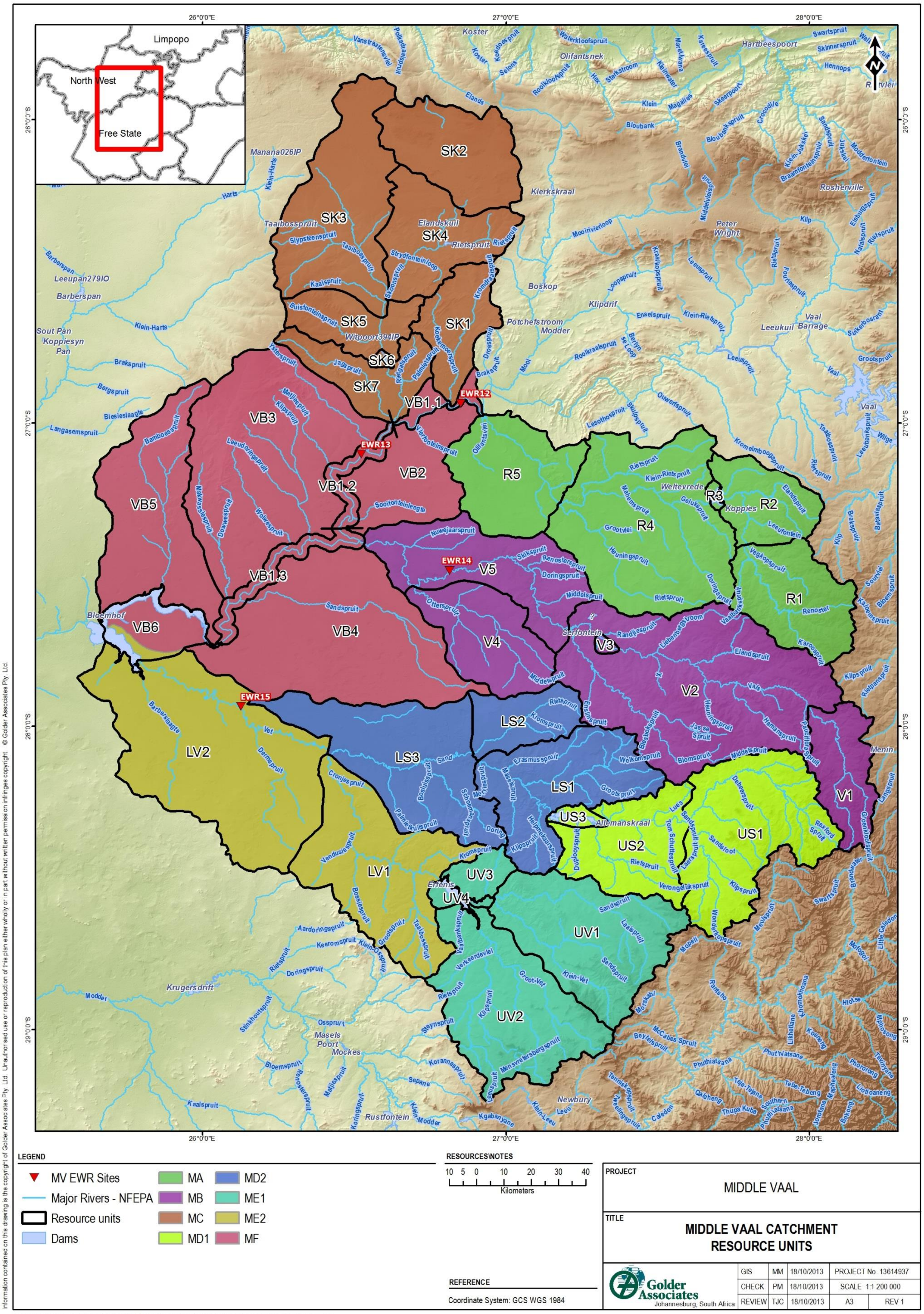

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Figure 7: RUs delineated in the Middle Vaal WMA

3.3.1 IUA MA: Renoster River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Renoster IUA is delineated into 5 RUs (R1 to R5). The RUs are shown in Figure 8 and the rationale for their selection is defined in Table 8. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 1: RENOSTER RIVER		
R1	From origin to Vaalbankspruit and Vegkopspruit tributary confluences	C70A, C70B
R2	Downstream Vaalbankspruit and Vegkopspruit tributary confluences to Koppies Dam	C70C
R3	Koppies Dam	C70C
R4	Downstream Koppies Dam to confluence with the Heuningspruit	C70E, C70D, C70F, C70G, C70H,
R5	Downstream Heuningspruit confluence to confluence with the Vaal River	C70J, C70K

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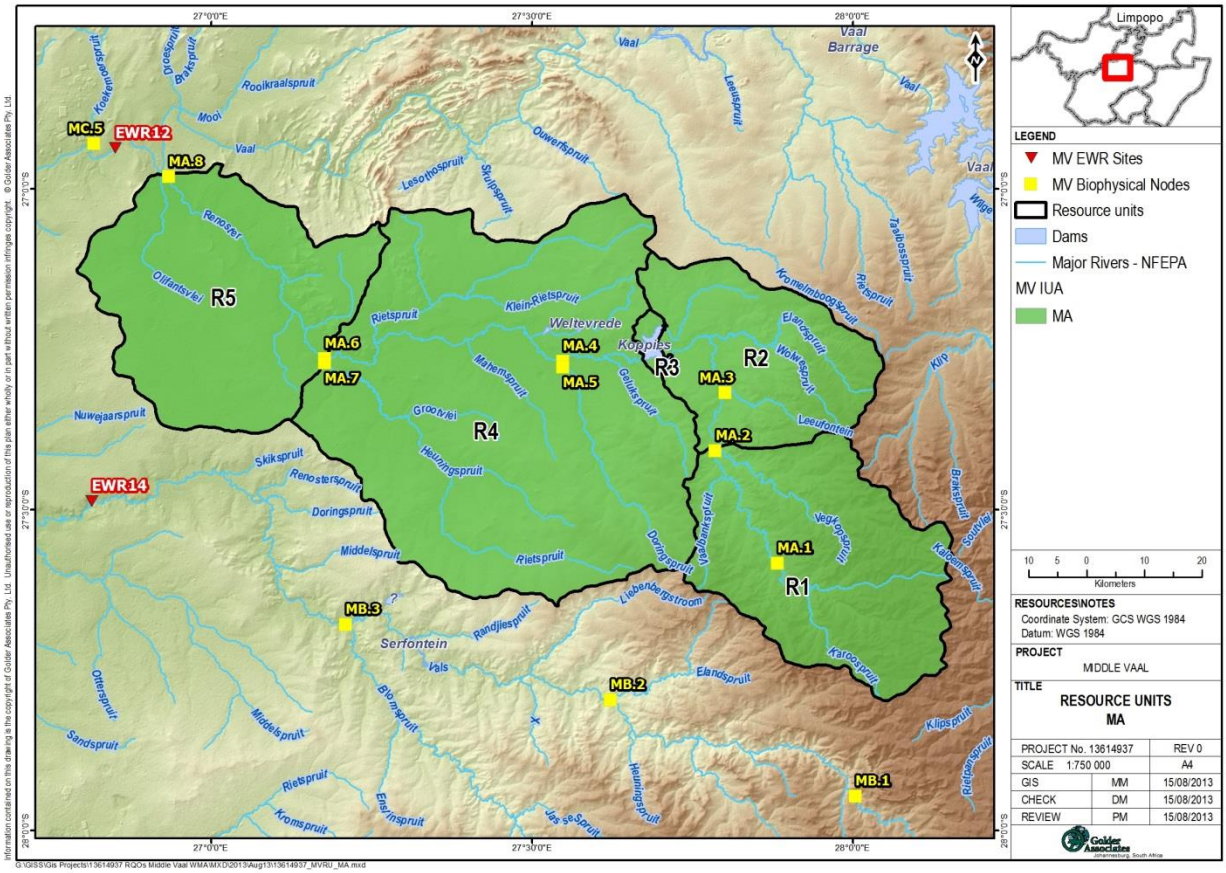

Figure 8: RUs delineated within IUA 1 Renoster River catchment

Table 8: RU delineation description of the Renoster IUA (IUA: MA)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
R1 From origin to Vaalbankspruit and Vegkopspruit tributary confluences	Highveld	Mostly natural clay grass land and central Free State Grassland. Some cultivated land.	The RU includes the headwaters of the Renoster river, and the Vegkopspruit, Vaalbankspruit and Karoospruit tributaries. The land use includes cultivated areas, however the area is largely undeveloped. The town of Petrus Steyn is located in the RU. The RU includes 2 biophysical nodes (MA.1 and MA.2) that have an EC of C. The headwaters of the Rhenoster river has a PES of C. There are no areas of high ecological importance however upper catchment area is considered a vulnerable ecosystem. The RU does include river FEPAs.	C70A, C70B
R2 Downstream Vaalbankspruit and Vegkopspruit tributary confluences to Koppies Dam	Highveld	Mostly natural clay grass land, and central Free State Grassland, marginal Karriod shrubland. Some cultivated land.	The RU coincides with a logical break in the system – Koppies Dam. Land use is also similar (irrigated agriculture). The area also includes bentonite mining. The town of Heilbron is located in the RU. Tributaries include the Elandspruit, Leeufontein and Wolwespruit. The RU has one biophysical node (MA.3). The reach has a moderate priority rating (EC of C). However , the Elandspruit tributary has a PES of D.	C70C
R3 Koppies Dam	Highveld	Mostly natural central Free State Grassland. Some cultivated land.	The RU is Koppies Dam. The dam is delineated as a unit. The dam supports the irrigation scheme and includes weirs and canals. The dam provides flow regulating capability. The yield balance situation is such that the water available from the dam is fully utilised. There is also significant water use from the river downstream of the dam to the extent that there is not excess water available. The land use is irrigated agriculture and recreational fishing around the dam. The reach has a moderate priority rating.	C70C
R4 Downstream Koppies Dam to confluence with the Heuningspruit	Highveld	Central Free State Grassland and Vaal-Vet sandy Grassland. Cultivated land.	This reach of the Rhenoster river downstream Koppies Dam to the confluence of the Heuningspruit and Rietspruit is delineated as R4. The land use, associated impacts and water use in the area warrants the catchment being delineated as a RU. In addition a river node is present at the downstream point. The towns of Koppies and Edenville are located in this RU. Major tributaries are the Heuningspuit, Rietspruit, Grootvlei and Mahemspruit. The RU includes some mining areas in catchments C70G and C70H and includes irrigated agriculture as a major water use. The RU has 3 biophysical nodes MA.4 (EC of C), MA. 5 (EC of C/D) and MA.6 (EC of C). Quartenary catchment C70D does include some moderately yielding boreholes (2-5 l/s). The RU has extensive areas of floodplain wetlands and some salt pans which have been identified as a priority wetland area. This area is also a FEPA.	C70D, C70E, C70F, C70G, C70H
R5 Downstream Heuningspruit confluence to confluence with the Vaal River	Highveld	Majority of Vaal-Vet sandy Grassland and some areas Highveld grassland, Free State grassland and mountain bushveld. Cultivated land.	R5 includes the Renoster River from below the confluence of the Heuningspruit to the confluence with the Vaal River. The Olifantsvlei is the major tributary in the RU. The town of Viljoenskroon is located in the RU which has some water quality impact on the river. These lower reaches (C70J and C70K) display some difference in Eco-region level. The RU has one biophysical node MA.7 (EC of C). The node has a moderate ecological importance. Quartenary catchment C70J does include a small area of some moderately yielding boreholes (2-5 l/s). The presence of the biophysical nodes, similar land use and eco-region character make this a logical RU.	C70J, C70K

3.3.2 IUA MB: Vals River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Vals River IUA is delineated into 5 RUs (V1 to V5). The RUs are shown in Figure 9 and the rationale for their selection is defined in Table 9. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 2: VALS RIVER		
V1	Origin of Vals River to Pauciflora Spruit confluence	C60A
V2	Downstream Pauciflor Spruit confluence to Kroonstad	C60B, C60C, C60D, C60E, C60F
V3	Serfontein Dam	C60D
V4	Middelspruit Tributary catchment	C60H
V5	From the Kroonval weir to the Vaal River confluence	C60G, C60J

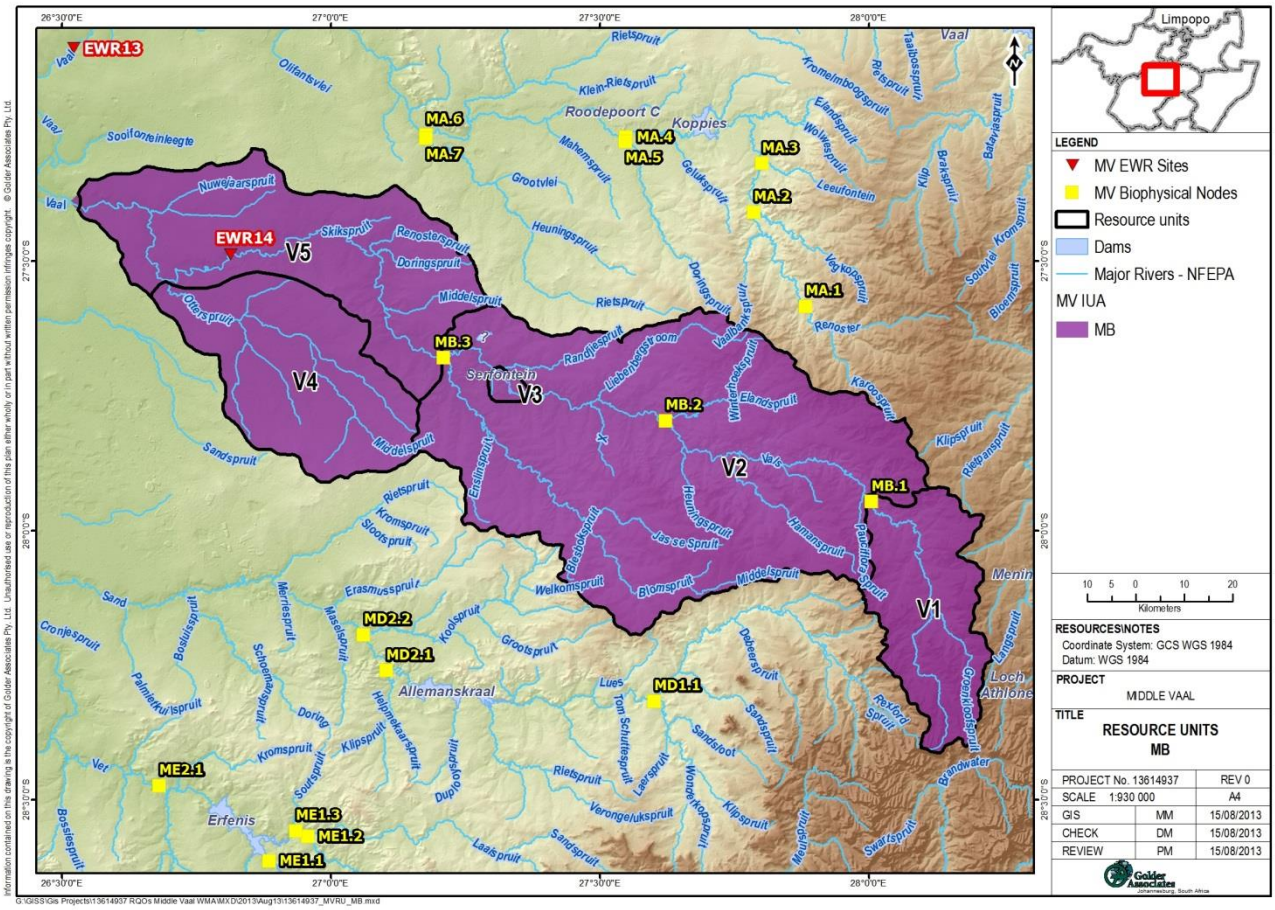

Figure 9: RUs delineated in the IUA 2 Vals River Catchment

Table 9: RU delineation description of the Vals IUA (IUA: MB)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
V1 Origin of Vals River to Pauciflora Spruit confluence	Highveld	Mostly natural eastern Free State clay grass land. Largely cultivated land.	The RU includes the origin of the Vals River in the vicinity of Bethlehem to the just upstream of the Pauciflora Spruit confluence. The only major tributary is the Groenkloofspruit. The land use includes irrigated agriculture with mainly grassland areas. The RU includes 1 biophysical node (MB.1) which has an EC of C. There are no areas of high ecological importance. The area does include a FEPA fish support area. The presence of the biophysical node and the fish support area warranted the delineation of C60A as an RU.	C60A
V2 Downstream Pauciflor Spruit confluence to Kroonstad	Highveld	Mostly central Free State Grassland and some Vaal-Vet sandy Grassland. Some cultivated land.	RU V2 includes the Vals river from the Pauciflora Spruit confluence to the Kroonval weir at Kroonstad. The weir forms a break in the system and creates delineation between the upper and lower reaches of the Vals river system. In addition the land use impacts in the vicinity of Kroonstad and the presence of a biophysical node (MB.3) in the vicinity of the weir also make this a logical break. This RU is largely rural in nature. In addition to Kroonstad, the towns of Lindley and Steynrus are also located in the RU. The wastewater treatment works of the towns impact on the Vals River. Land use is large dry commercial agriculture with some irrigation. A second node MB.2 is present at Elandspruit confluence. The ecological importance rating is moderate. Both nodes MB.2 and MB.3 have an EC of C. Major tributaries include the Elandspruit and Blomspruit. Reaches within the Elandspruit, Heuningspruit and a minor tributary in C60 are identified as FEPAs.	C60B, C60C, C60D, C60E, C60F
V3 Serfontein Dam	Highveld	Central Free State Grassland. Some cultivated land.	The RU is Serfontein Dam. The dam is delineated as a unit. The dam has a small storage relative to the runoff. Seasonal water releases are made from the dam. The yield balance situation is such that there are deficits in supply as was recently experienced in restrictions to the town of Kroonstad.	C60D
V4 Middelspruit Tributary catchment	Highveld	Largely Highveld alluvial vegetation and some Vaal-Vet sandy Grassland. Areas of cultivated land.	The catchment area of the Middelspruit tributary is delineated as a RU V4. The area is largely rural in nature. It includes the Otterspruit as a tributary. Extensive wetland systems occur along the upper reaches of the Otterspruit and its associated tributaries. Pan systems also occur along the drainage divides in this area. The Otterspruit wetland system renders this an important water resource in the study area. The wetlands associated with this system are considered to have a high ecological importance and sensitivity. This warranted the delineation of this area as a RU.	C60H
V5 From the Kroonval weir to the Vaal River confluence	Highveld	Largely central Free State Grassland and Vaal-Vet sandy Grassland. Some areas of Highveld alluvial vegetation. Cultivated land.	V5 includes the Vals River from below the Kroonval weir at Kroonstad to the confluence with the Vaal River. These lower reaches of the Vals River are delineated as a RU. The Nuwejaarspruit and Skikspruit are the major tributaries in the RU. Bothaville is located in the RU alongside the Vals river close to the Vaal river confluence. The RU is impacted by the town of Kroonstad and upstream activities. Quaternary catchment C60G does include a small area of some moderately yielding boreholes (2-5 l/s). The RU has one EWR site (EWR 14) with an EC of C/D. The site has a moderate ecological importance rating. The lower reaches of the Vals River in this RU in quartenary catchment C60J - from Kroonstad to the confluence of the Otterspruit has been identified as rehabilitation FEPA.	C60G, C60J

3.3.3 IUA MC: Schoonspuit

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Schoonspruit IUA is delineated into 7 RUs (SK1 to SK7). The RUs are shown in and the rationale for their selection is defined in Table 10. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 3: SCHOONSPRUIT		
SK1	From origin of Koekemoerspruit to confluence with Vaal River	C24A
SK2	Schoonspruit eye	C24C
SK3	Taaibospruit tributary catchment	C24F
SK4	From Schoonspruit eye to Kaalspruit confluence	C24D, C24E
SK5	Schoonspruit - Kaalspruit and Buisfonteinspruit tributary catchment	C24G
SK6	Johan Neser Dam	C24G
SK7	From Johan Neser Dam to confluence with the Vaal River	C24H

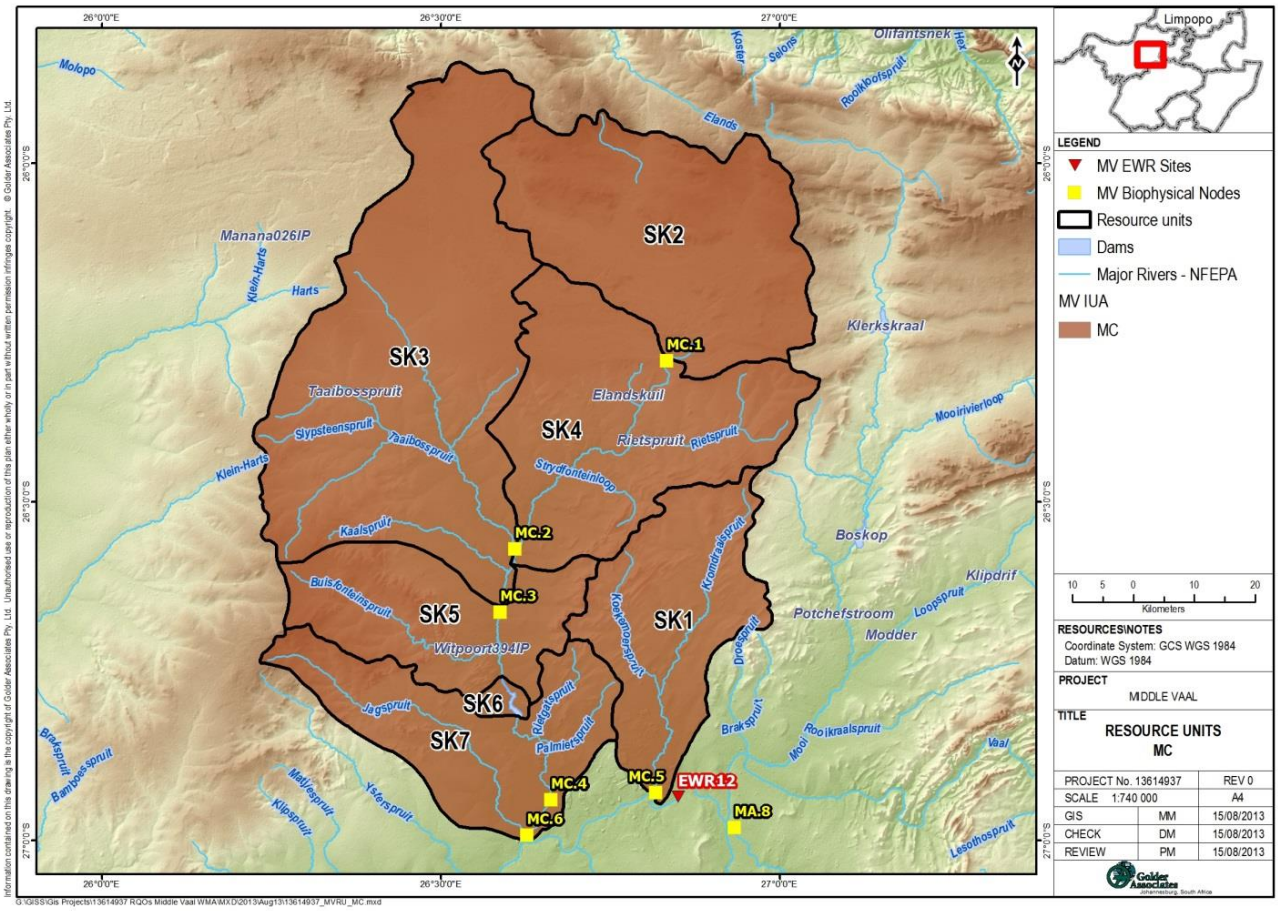

Figure 10: RUs delineated in the IUA 3 Schoonspruit Catchment

Table 10: RU delineation description of the Schoonspruit IUA (IUA: MC)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
SK1 From origin of Koekemoer spruit to confluence with Vaal River	Highveld	Rand Highveld grassland, Vaal Reefs Dolomite Woodland, Vaal-Vet Sandy grass land. Cultivated land in upper reaches.	The Koekemoerspruit catchment (C24A) – origin of river to confluence of the Vaal River is delineated as a RU SK1. There are no characteristic features, significant changes or physical structures in the surface water system to define more than one RU. Land use includes agriculture and mining. The catchment includes one biophysical node (most downstream point) (MC.5). The node has a low priority rating with a PES of D to D/E. Significant water quality improvement is required in this RU. The RU includes a major dolomite aquifer system and is identified as a groundwater priority area.	C24A
SK2 Schoonspruit eye	Highveld	Carletonville Dolomite Grassland. A few Highveld salt pans. Some cultivated land.	The Schoonspruit Eye forms the origin of the Schoonspruit in the southern part of quaternary catchment C24C. Catchment area C24C is delineated as RU SK2. The Schoonspruit eye is of major ecological importance and needs to be protected. This warranted the delineation of the RU. The RU includes biophysical node, MC.1, with an EC of C. The town of Ventersdorp is located in the RU. Irrigation is a major water use in the RU.	C24C
SK3 Taaibospruit tributary catchment	Highveld	Vaal-Vet Sandy grass land and Carletonville Dolomite grassland. Some cultivated land.	The Taaibospruit tributary catchment is delineated as an RU (C24F). This is so due to its priority rating in terms of the dolomitic aquifer system and the associated wetland systems (peatlands). The Kaalspruit tributary is also included in this RU. The town of Coligny is located here. Land use includes agriculture (irrigated) and diamons mining. The RU includes one biophysical node. MC.2 with a moderate ecological importance rating and a EC of C.	C24F
SK4 From Schoonspruit eye to Kaalspruit confluence	Highveld	Largely Vaal-Vet Sandy grass land with some Carletonville Dolomite grassland and highveld alluvial vegetation. Areas of cultivated land.	The upper reaches of the Schoonspruit in this RU is highly modified with the dam and canal systems. The RU coincides with a logical break in the system – Kalk Dam. Land use is also similar (irrigated agriculture). Ventersdorp abstracts water for the town's supply and for irrigation. There are impacts from the wastewater treatment works of the town. Low flow in the river is being experienced. The dolomitic aquifer serves as a source of water.	C24D, C24E
SK5 Schoonspruit - Kaalspruit and Buisfontein-spruit tributary catchment	Highveld	Largely central Free State Grassland and Vaal-Vet sandy Grassland. Some areas of Highveld alluvial vegetation. Cultivated land.	SK5 includes the Schoonspruit River from the Taaibosspruit confluence to Johan Neser Dam. This lower reach of the Schoonspruit, above the dam is delineated as one RU. The only significant change that occurs along these lower reaches below the Dam is an increase in urban/built up areas. There is some irrigated agriculture in this reach of the river.	C24G
SK6 Johan Neser Dam	Highveld	Waterbody – dominated by Vaal-Vet Sandy Grassland. Some cultivated land.	The RU comprises Johan Neser Dam. The dam is delineated as a unit. The dam supports the Klerksdorp irrigation scheme and includes weirs, canals, direct pumping and a pipeline. It belongs to the water user association. Land use is irrigated agriculture and there is some recreational use around the dam. The reach has a low priority rating. The EC is a C/D category.	C24G

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
SK7 From Johan Neser Dam to confluence with the Vaal River	Highveld	Vaal-Vet Sandy Grassland and Klerksdorp thornveld. Some cultivated land.	This lower reach of the Schoonspruit, below the dam is delineated as RU SK7. The significant change that occurs along these lower reaches is an increase in urban/built up areas. The RU includes the towns of Klerksdorp and Orkney. There is an increase in return flows from these areas into the Schoonspruit. The RU has a high occurrence of urbanisation and water quality problems. The major tributaries in the RU include the Jagspruit and Palmietspruit. The rivers in the RU are highly impacted and are in a D or D/E ecological category. The ecological importance is rated as low. The RU has two biophysical nodes present, MC.4 and MC.6. Improvements are required to address the low ecological categories.	C24H

3.3.4 IUA MD1: Upper Sand River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Upper Sand River IUA is delineated into 3 RUs (US1 to US3). The RUs are shown in Figure 11 and the rationale for their selection is defined in Table 11. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 4: UPPER SAND RIVER		
US1	Origin of Sand River to confluence of the Klipspruit	C42A, C42B, C42C
US2	Downstream Klipspruit confluence to Allemanskraal Dam	C42D, C42E
US3	Allemanskraal Dam	C42E

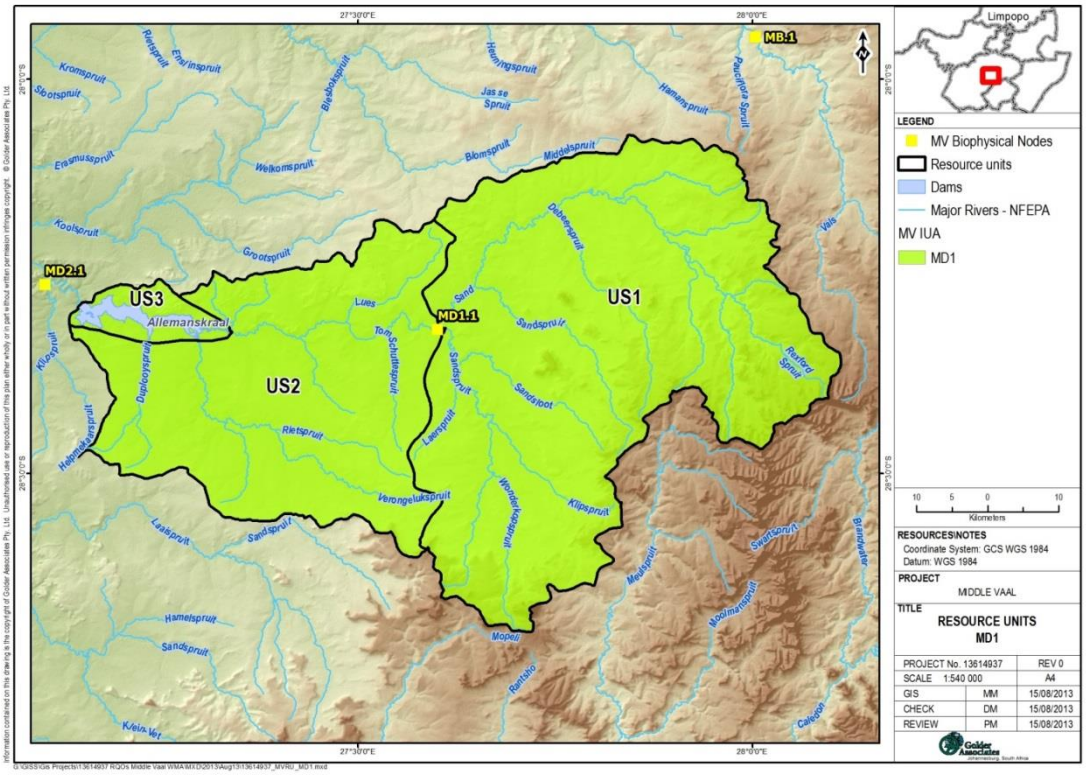

Figure 11: RUs delineated in the IUA Upper Sand River

Table 11: RU delineation description of the Upper Sand IUA (IUA: MD1)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
US1 Origin of Sand River to confluence of the Klipspruit	Highveld	Predominantly Eastern Free State Clay Grassland. Some cultivated land.	RU US1 includes the origin of the Sand River to the Klipspruit confluence (just downstream Senekal). The RU includes some irrigation, while dryland agriculture is the main land use. Tributaries include the Rexfordspruit, Debeerspruit, Sandspruit and Klipspruit. Senekal is the only major town in the RU. Region has a low priority rating and an ecological category of C. The RU has flow related impacts due to abstraction in the upper reaches and water quality impacts around Senekal. There is one biophysical node just at the outlet of the RU. The Rexfordspruit tributary catchment is a FEPA fish support area, and a tributary catchment of the Wonderkopspruit (C42C) is a FEPA.	C42A, C42B, C42C
US2 Downstream Klipspruit confluence to Allemanskraal Dam	Highveld	Predominantly Eastern Free State Clay Grassland and some Central Free State Grassland. Includes areas of cultivated land.	RU comprises the area from the Klipspruit confluence to Allemanskraal Dam. Dryland agriculture is the main land use. Reach has water quality impacts related to Senekal. Area includes the Willem Pretorius Game Park in area around Allemanskraal Dam. Most of the area is potentially in a C ecological category. Ecological importance is low.	C42D, C42E
US3 Allemanskraal Dam	Highveld	Waterbodies – dominated by natural grassland - Central Free State Grassland as riparian vegetation.	Allemanskraal Dam is delineated as a RU US3. Dam supports irrigation and some urban and bulk water users further downstream. Forms part of the Sand Vet GWS and serves as a source of water for Virginia. It regulates flow in the Sand River. Ecological importance is low. The ecological category is a C.	C42E

3.3.5 IUA MD2: Lower Sand River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Lower Sand River IUA is delineated into 3 RUs (LS1 to LS3). The RUs are shown in Figure 12 and the rationale for their selection is defined in Table 12. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 5: LOWER SAND RIVER		
LS1	Allemanskraal Dam to Merriespruit confluence	C42F, C42G, C42H,
LS2	Rietspruit tributary catchment	C42J
LS3	Downstream Rietspruit confluence to confluence with the Vet River	C42K, C42L, C43B

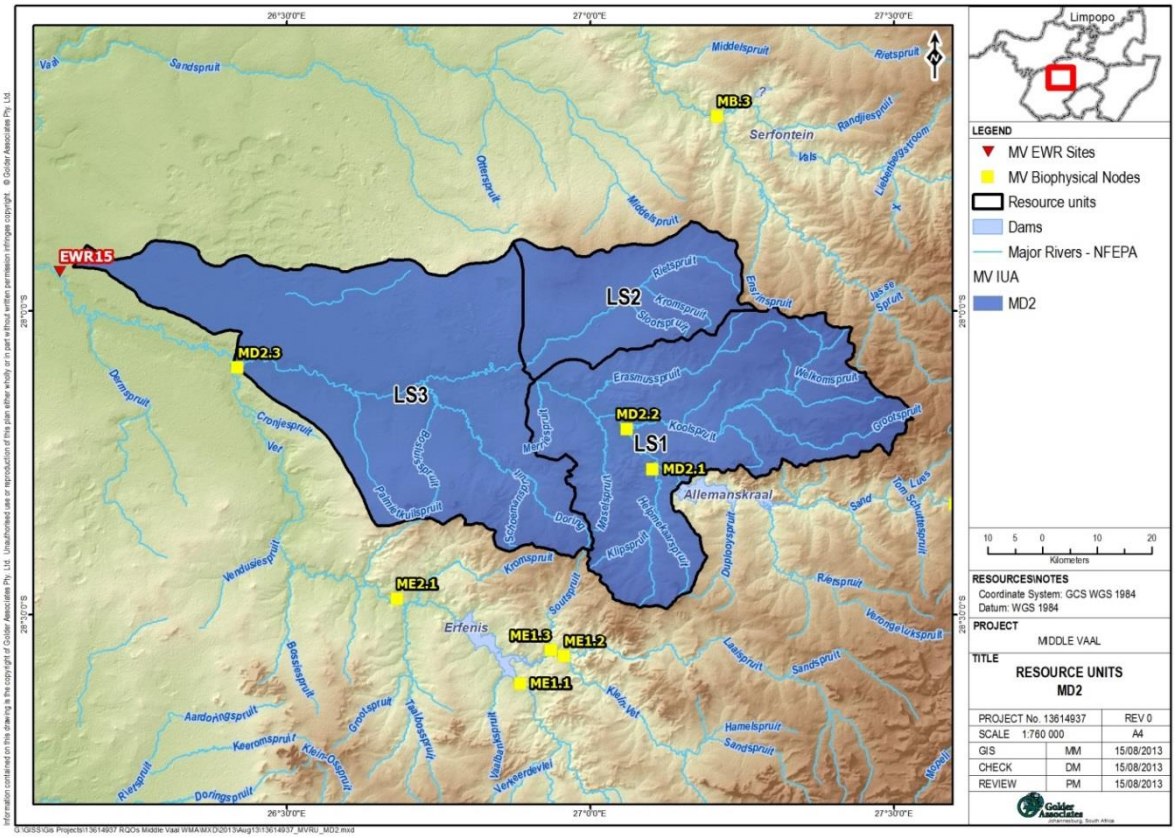

Figure 12: RUs delineated in the IUA Lower Sand River

Table 12: RU delineation description of the Lower Sand IUA (IUA: MD2)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
LS1 Allemanskraal Dam to Merriespruit confluence	Highveld	Predominantly Central Free State Clay Grassland. Some areas of Highveld alluvial vegetation and grassy shrubland. Some cultivated land.	RU LS1 comprises the lower Sand River from Allemanskraal Dam to the confluence with the Merriespruit. Tributaries include Klipspruit, Koolspruit, Maselspruit and Erasmusspruit. Only major town is Ventersburg. The RU includes irrigation agriculture as the main land use. Region has a moderate EIS rating. The RU has impacts related to abstraction. There are two biophysical nodes in the RU (MD2.1 and MD2.2) in a C EC. Most of the area is however in D EC. Sub-catchments of the Klipspruit, Maselspruit, Erasmuspruit and Welkomspruit are FEPAs.	C42F, C42G, C42H,
LS2 Rietspruit tributary catchment	Highveld	Predominantly Vaal Vet Sandy Grassland and some Highveld Alluvial vegetation. Includes some cultivated land, mining and urban areas.	RU comprises the Rietspruit tributary catchment. The catchment is delineated as a RU due to mining and urbanisation related impacts. Area is also impacted by return flows from the urban centres, bulk water users and irrigation. The RU includes the major towns of Virginia, Welkom, Henneman and Riebeeckstad. Water quality is impacted by the mining activities in the Welkom and Virginia. Most of the area is considered to be in D EC. The Slootspruit tributary has been identified as a FEPA	C42J

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
LS3 Downstream Rietspruit confluence to confluence with the Vet River	Highveld	Vaal Vet Sandy Grassland and some Highveld Alluvial vegetation. Cultivated land. Some mining and urban area (C43B).	Resource unit is delineated from Merriespruit and Rietspruit confluences to the confluence of the Sand with the Vet River. Area is impacted by return flows from the urbanisation, abstraction, agricultural activities and irrigation from the upstream catchments. A portion of Welkom does fall within this RU (C43B). Catchment area has a low to moderate ecological importance rating. There is a biophysical node located at the outlet of the RU (MD2.3). The node has a C ecological category. The RU includes a significant area of salt pans towards the northern part of the C43B catchment area. This area has been identified as a priority wetland area of the Middle Vaal WMA and a FEPA wetland cluster.	C42K, C42L, C43B

3.3.6 IUA ME1: Upper Vet River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Upper Vet IUA is delineated into 4 RUs (UV1 to UV4). The RUs are shown in Figure 13 and the rationale for their selection is defined in Table 13. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 6: UPPER VET RIVER		
UV1	Klein Vet and Laaispruit tributary catchments	C41A, C41B
UV2	Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	C41C, C41D
UV3	Soutspruit tributary catchment	C41E
UV4	Erfenis Dam	C41E

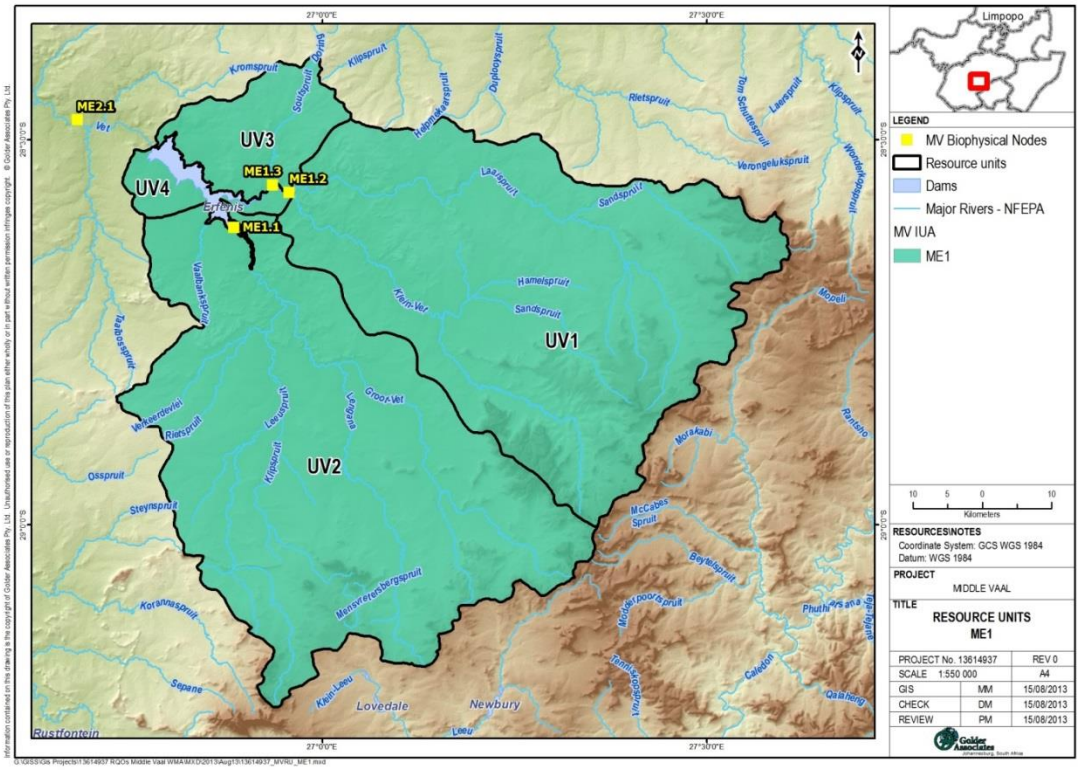

Figure 13: RUs delineated in the IUA Upper Vet River

Table 13: RU delineation description of the Upper Vet IUA (IUA: ME1)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
UV1 Klein Vet and Laaispruit tributary catchments	Highveld	Predominantly Eastern and Central Free State Grassland. Some areas of montane grassy shrubland. Some cultivated land.	RU UV1 comprises the Klein Vet and Laaispruit tributary catchment areas. The towns of Winburg and Marquard are located in the RU, with the majority of the area being rural in nature. Land use is mainly agriculture. Flow modification is the main impact due to farm dams and erosion. There is a biophysical node in the RU (ME1.2) in a C EC. Most of the area has a low ecological importance rating. A FEPA is present on a minor tributary of the Hamelspruit.	C41A, C41B
UV2 Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	Highveld	Predominantly Eastern and Central Free State Grassland. Cultivated land.	The Groot Vet River catchment to Erfenis Dam is delineated as a RU. The dam forms the lower delineation boundary of the unit. The region is also rural in nature and includes irrigated agriculture as major land use. Flow modification is the main impact due to farm dams and erosion. Small towns in the RU include Excelsior and Verkeerdevlei. Region has a moderate ecological priority rating. Most of the area is considered to be in C EC. There is a biophysical node in the RU (ME1.1) in a C EC. The RU has two small FEPAs. Quartenary catchment C41C does include a small area of some moderately yielding boreholes (2-5 l/s).	C41C, C41D
UV3 Soutspruit tributary catchment	Highveld	Predominantly Central Free State Grassland. Small area of cultivated land.	The Soutspruit catchment area is delineated as RU UV3 as it is less impacted and is in a better ecological condition. Area is largely rural in nature. Catchment area has a moderate ecological importance rating. There is a biophysical node located at the outlet of the RU (MD1.3) in B/C ecological category. The Soutspruit is identified as a FEPA.	C41E
UV4 Erfenis Dam	Highveld	Central Free State Grassland. Some cultivated land.	Erfenis Dam is delineated as a resource unit. Dam supports irrigation and some urban and bulk water users. Forms part of the Sand Vet Government Water Scheme.	C41E

3.3.7 IUA ME2: Lower Vet River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Lower Vet IUA is delineated into 2 RUs (LV1 and LV2). The RUs are shown in Figure 14 and the rationale for their selection is defined in Table 14. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 7: LOWER VET RIVER		
LV1	Erfernis Dam to confluence with Sand River	C41F, C41G, C41H, C41J
LV2	Downstream Sand River confluence to Bloemhof Dam	C43A, C43C, C43D

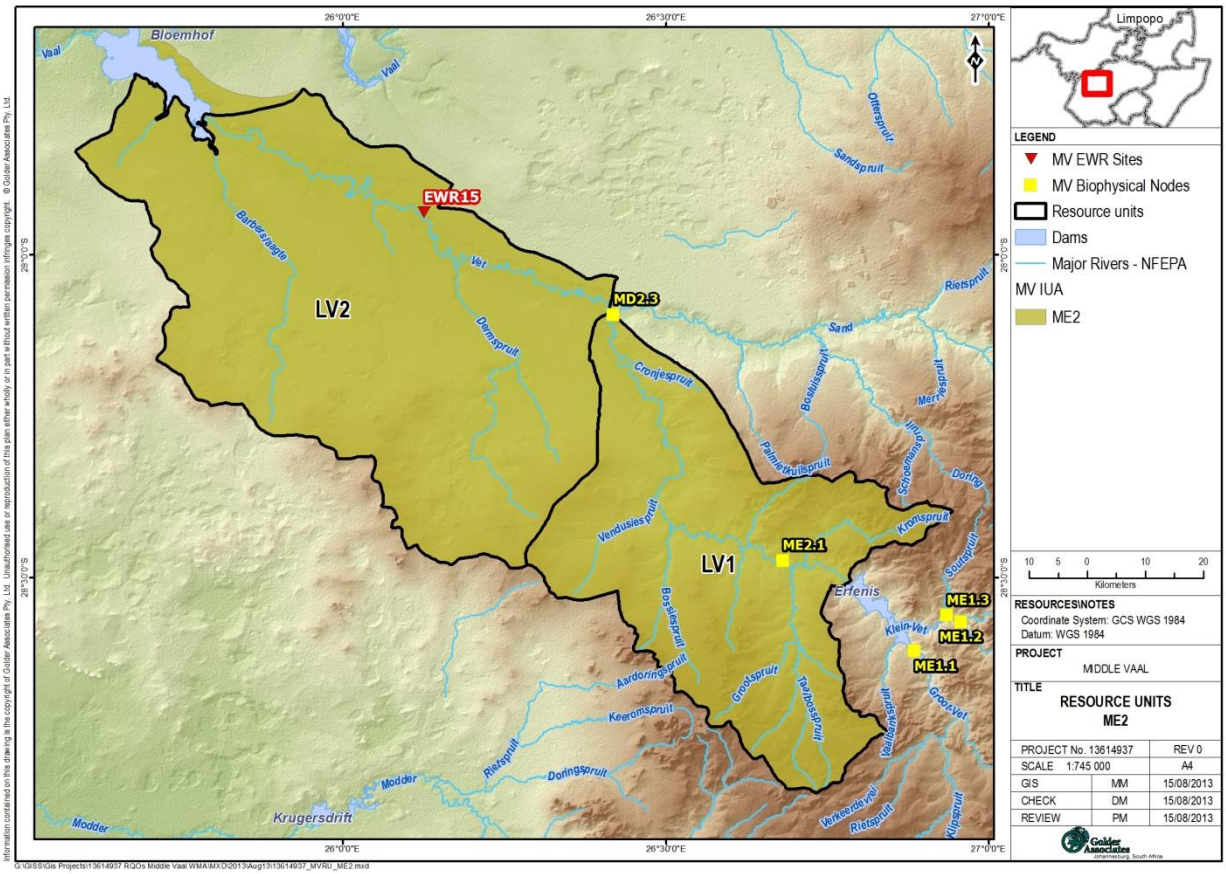

Figure 14: RUs delineated in the IUA Lower Vet River

Table 14: RU delineation description of the Lower Vet IUA (IUA: ME2)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
LV1 Erfernis Dam to confluence with Sand River	Highveld	Predominantly Central Free State and Vaal Vet Sandy Grassland. Some areas of Highveld Alluvial vegetation. Cultivated land	RU LV1 extends from Erfenis dam to confluence with the Sand River. The major tributary is the Taaibosspruit. The region is rural in nature. No significant changes in land use occur - irrigated agriculture as major land use. The RU include does include two Eco-regions. Reach has a moderate ecological importance rating. The town of Theunissen is located in the RU. Flow modification, alien vegetation and agricultural lands are the major impacts. There is a biophysical node in the RU (ME2.1) in a C EC. Areas of the Taaisbospruit quartenary catchment have been identified as FEPAs.	C41F, C41G, C41H, C41J
LV2 Downstream Sand River confluence to Bloemhof Dam	Highveld	Western Free State and Vaal Vet Sandy Grassland and Thornveld bush. Large areas of cultivated land.	RU includes Vet River from confluence with Sand River to inflow into Bloemhof Dam. Catchment area is dominated by irrigated agriculture. Area has a moderate ecological importance rating. The major towns in the RU are Hoopstad and Bultfontein, but as in the Upper Vet the population is sparse. Irrigation agriculture is the major land use. Flow modification, alien vegetation and agricultural lands are also the major impacts. The RU includes EWR site EWR15. The site is in a C/D EC.	C43A, C43C, C43D

3.3.8 IUA MF: Middle Vaal River

Based on the biophysical characteristics, the system characteristics, management and operation and ecological condition the Middle Vaal IUA is delineated into 6 RUs (VB1 and VB6). The RUs are shown in Figure 15 and the rationale for their selection is defined in Table 15. The RUs are as follows:

RU	Delineation area	Quartenary Catchment
IUA 8: Vaal River		
VB1.1	Vaal River mainstem: Vermaasdrift to upstream Schoon spruit confluence	C24B
VB1.2	Vaal River mainstem: From the Schoonspruit confluence to just upstream Vals River confluence	C24J
VB1.3	Vaal River mainstem: From Vals River confluence to Bloemhof Dam	C25C, C25F
VB2	Tributary catchments (Vierfonteinspruit and 24J –south of Vaal River)	C24B, C24J
VB3	Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassiespruit tributary catchments	C24J, C25A, C25C, C25D
VB4	Sandspruit tributary catchment	C25C, C25B, C25F, C43B
VB5	Bamboespruit tributary catchment	C25E
VB6	Bloemhof Dam	C25E, C25F, C43D

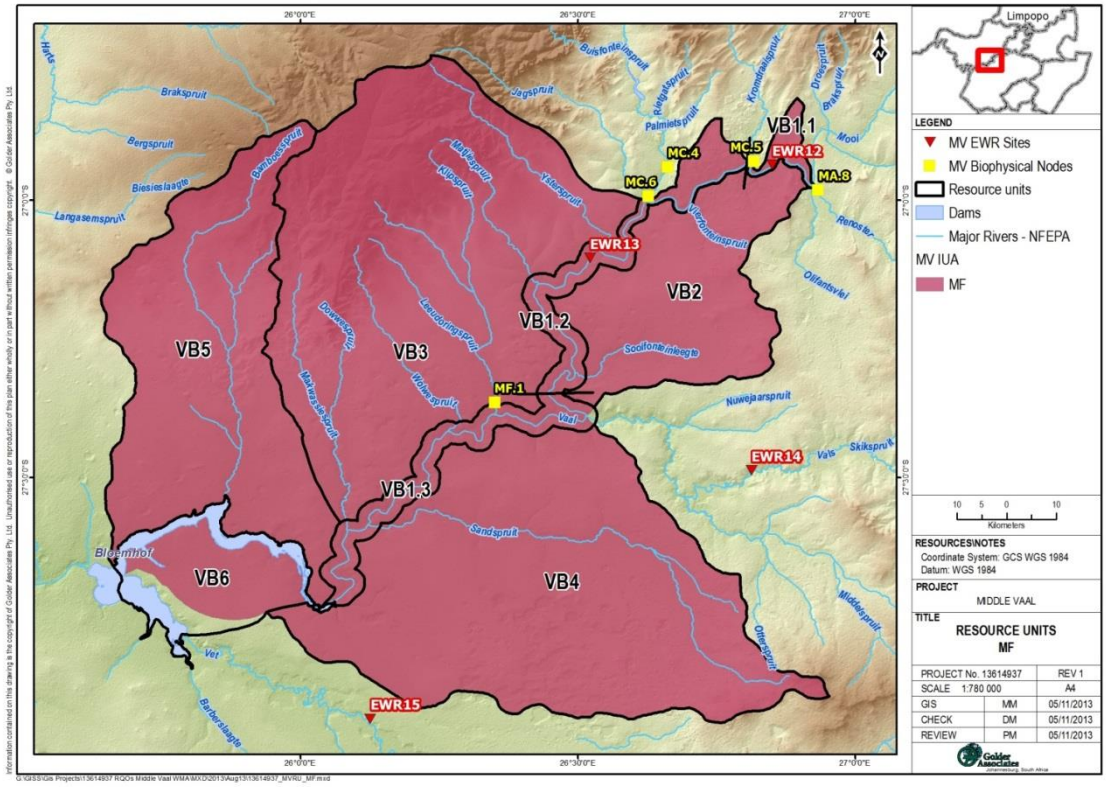

Figure 15: RUs delineated in the IUA Middle Vaal

Table 15: RU delineation description of the Middle Vaal River (IUA: MF)

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
VB1.1 Vaal River main stem from Vermaasdrift to upstream Schoon spruit confluence	Highveld	Predominantly Vaal-Vet Sandy Grassland. Some cultivated land, mining and urban area.	The middle Vaal River from its inflow at the Upper Vaal WMA to just upstream the Schoonspruit confluence has been delineated as RU VB1.1. This unit was delineated to manage the water quality influences to the abstraction point of the bulk water user, a significant use in the catchment. Much of the water use, impacts and activity occur from the Upper Vaal WMA through this reach of the Vaal River. The Middle Vaal river is considered a "workhorse" river. The area is characterised by mining, dryland agriculture and irrigation, and bulk water use. Major impacts include flow modification and water quality impacts of mining and treated wastewater from urban areas. The ecological importance of the river is characterised as moderate. The RU includes a EWR site (EWR12). EWR 12 a D ecological category.	C24B
VB1.2 Vaal River main stem from the Schoonspruit confluence to just upstream Vals River confluence	Highveld	Predominantly Vaal-Vet Sandy Grassland. Some cultivated land with smallholdings.	The Vaal River from the confluence of the Schoonspruit to just upstream the confluence of the Vals River is been delineated as RU VB1. This delineation serves to manage the water use, impacts and activity occur along of the middle Vaal River in the IUA and to manage the water quality influences to the abstraction point of the second bulk water user, a major use in the catchment. This reach of the middle Vaal River area is characterised by dryland and irrigated agriculture. Major impacts include flow modification and water quality impacts of the upper reaches of the Vaal River (including the Upper Vaal WMA). The ecological importance of the river is characterised as moderate. The RU includes one EWR site (EWR 13) which has an C/D ecological category.	C24J
VB1.3 Vaal River main stem from Vals River confluence to Bloemhof Dam	Highveld	Predominantly Vaal-Vet Sandy Grassland. Some cultivated land, predominantly dryland, with smallholdings.	The Vaal River from the confluence of the Vals River to Bloemhof Dam forms RU VB 1.3. This catchment area is dominated by dryland agriculture, grasslands and with some irrigated areas. The Vaal River in this RU is impacted by the river flow modification due to system operation and the water quality impacts of upper reaches of the Vaal River and by the tributaries in the catchment. The ecological importance of the river is characterised as moderate and is considered a hardworking river. It includes one biophysical node MF.1 which has a REC of C.	C25C, C25F
VB2 Tributary catchments (Vierfontein-spruit and 24J – south of Vaal River)	Highveld	Predominantly Vaal-Vet Sandy Grassland. Some cultivated land, mining and urban area.	The Vierfontein tributary catchment area and the area C24J south of the Vaal River are delineated as RU VB2. The only significant land use is coal mining in the catchment. The RU also includes some areas of irrigation and dryland agriculture. The RU comprises the incremental catchment area between the Renoster and Vals River IUAs and the Vaal River. The water quality of the middle Vaal River and dolomitic aquifer system is potentially impacted by the land-use activities in the catchment.	C24B, C24J
VB3 Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassie-spruit tributary catchments	Highveld	Predominantly Central Free State Grassland and some thornveld bush area. Areas of cultivated land.	The Makwassie, Ysterspruit, Matjiespruit, Klipspruit, and Wolwespruit catchments to their confluences with the Vaal River are delineated as RU VB3. There are no characteristic features or significant changes to define more than one RU. Land use is also similar with limited activity. Areas are largely rural in nature. RU includes towns of Makwassie, Wolmeransstad, Wipoort and Leeudoringstad,	C24J, C25A, C25C, C25D

RU	Eco-Region Level 2	Land cover/ vegetation	Description/Rationale	Quartenary catchment
VB4 Sandspruit tributary catchment	Highveld	Predominantly Free State and Vaal Vet Sandy Grassland. Some areas of Highveld Alluvial vegetation and thornveld bush. Cultivated land	The Sandspruit catchment and an area of C43B are delineated as one RU. The RU includes the incremental Vaal catchment between the Vals and Vet River catchments. Land use is limited to agriculture. The towns of Odendaalrus, Allanridge and Wesselsbron are located in the RU. The RU is significant as it incorporates the Wesselbron cluster as a priority wetland area in the RU.	C25C, C25B, C25F, C43B
VB5 Bamboes-spruit tributary catchment	Highveld	Thornveld bush, western Highveld sandy grassland, Vaal-Vet sandy grassland. Cultivated land.	The Bamboesspruit tributary catchment is delineated as RU VB5 as it includes an extensive cluster of pans occurring along the watershed divide to the west of the Bamboesspruit. This Has been identified as a priority wetland area.	C25E
VB6 Bloemhof Dam	Highveld	Highveld Alluvial vegetation, thornveld bush, some grassland. Dominated by waterbodies. Cultivated land	The Vaal river is logically delineated at the end of the WMA by Bloemhof Dam. This RU comprises the Dam, and is inundated with water. Bloemhof Dam serves as a critical point in the system from an operation point of view in the Vaal River System. Water is released to supply downstream irrigation and urban users.	C25E, C25F, C43D

4 RESOURCE UNIT PRIORITISATION

While the WRCS proposes RQOs for each resource unit, this may not always possible due the potentially large number of RUs that could be delineated for a catchment. A rationalisation process has therefore been developed as part of the RQO Determination Procedure (DWA, 2011) in order to prioritise and select the most useful RUs for RQO determination. The prioritisation of resource units forms Step 3 of the RQO determination process (Figure 16), and has been defined specifically prioritise and select RUs that are then taken through stakeholder consultation process to confirm priority.

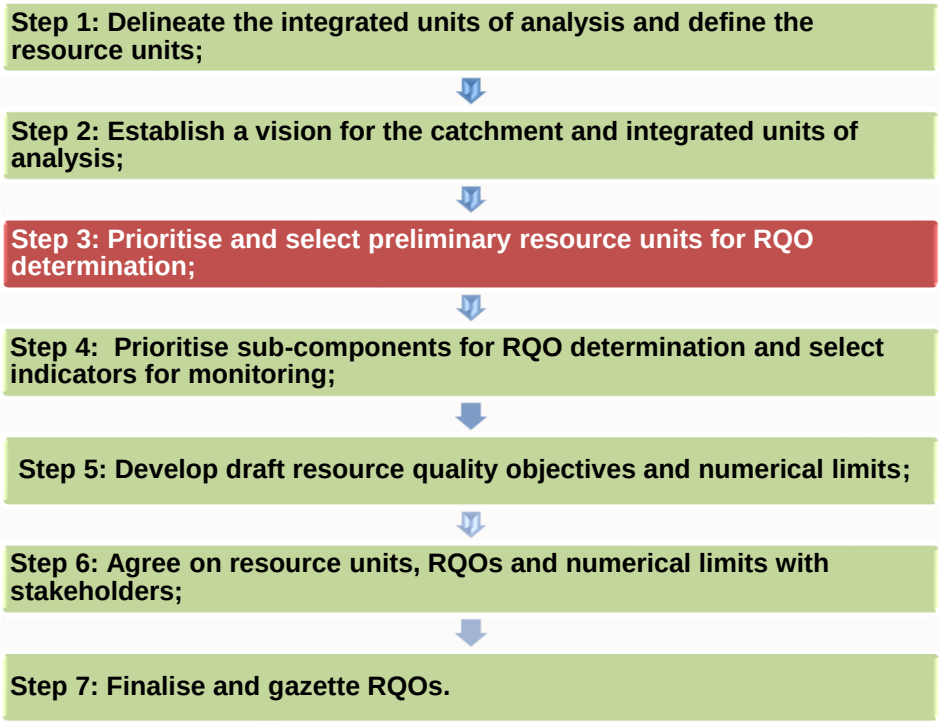

Figure 16: RQO Determination Process

The rationalisation process for RU selection and prioritisation is based on a decision support tool that has been developed to guide and support the process. The 'Resource Unit Prioritisation Tool' incorporates a multi criteria decision analyses approach to assess the importance of monitoring each RU as part of management operations to identify important RUs.

The criteria assessed per RU include:

- Position of RUs within an IUA;
- Importance of the RU to users;
- Threat posed to water resource quality for users;
- Threat posed to water resource quality for the environment;
- Ecological considerations;
- Practical Constraints, and

- Management Considerations.

Standardised rankings and weightings are proposed for each of the seven criteria above used in the prioritisation process by application of the tool. The RU Prioritisation Tool consists of a simple scoring system where a score of 0, 0.5 or 1 is assigned to the criteria to assess conformance to the guidelines supporting criterion. The rating scores then through ranking, relative weighting and multiplication allows for the relative prioritisation of RUs to be determined, by producing a prioritisation score – the priority rating of the RU (DWA, 2011). The priority rating scores the RUs relative to each other and considers the summary scores for the criteria This provides an integrated measure to inform the selection of RUs. However these values maybe altered if strong motivation exists and may be adjusted to suite the current context. The process also requires that a rationale is provided for the selection of priority RUs as in some cases low and moderate rated RUs may be selected over higher rated ones (DWA, 2011).

This tool maybe applied using desktop information however local knowledge and good understanding of the catchment is required to obtain the desired results.

4.1 RESOURCE UNIT PRIORITISATION BASED ON ASSESSMENT CRITERIA

As described above the Resource Unit Prioritisation Tool incorporates seven criteria that are scored, ranked, weighted, rated and assessed. The criteria assessed to prioritise the RUs are described in Table 16 below.

Table 16: Criteria of the Resource Unit Prioritisation Tool (DWA, 2011)

Criterion	Description and Reasoning	Sub-criteria rated (0: low, 0.5: moderate or 1:high) per criterion per RU
Position of RU within IUA	This is the first criterion that is considered within the RU Prioritisation Tool. Resource Units on large main stem 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 (including the gazetted IUA Class) for the upstream catchment. These RU thus receive high prioritisation in the Tool. It is important to note that estuaries will always be prioritised in this way (DWA, 2011).	• Resource Units located on large main stem river at the downstream end of the IUA (IUA outlet node)
Assessment of the importance of each Resource Unit to users	This is the second criterion assessed and considers both current and future use. The tool assesses a number of sub-criteria relevant to different user considerations.	• Resource units which provide important cultural services to society • Resource units which are important in supporting livelihoods of significant vulnerable communities • Resource units which are important in meeting strategic requirements and international obligations

Criterion	Description and Reasoning	Sub-criteria rated (0: low, 0.5: moderate or 1:high) per criterion per RU
		• Resource units that provide supporting and regulating services • 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)
Level of threat posed to the water resource quality for users	This assessment considers the risk of the water resources to the users. Resource units which are threatened or are likely to be threatened by current or future activities should be monitored (most likely to be impacted by high risk activities)	• Level of threat posed to users
Ecological importance	This criterion is assessed to identify resource units that are important from an ecological perspective. A range of attributes relative to the water resource are considered.	• Ecological Importance and Sensitivity Categories (EIS) • Present Ecological State (PES) and Nested Ecological category (NEC) • National Freshwater Ecosystem Priority Areas • Priority habitats/species identified in provincial conservation plans
Threat posed to the water resource quality for the environment	This criterion is assessed to identify RUs which are threatened or are likely to be threatened by current or future activities that should be monitored due to the risk posed to the ecological elements of the water resource. This considers those RUs most likely to be impacted by high risk activities.	• Level of threat posed to the ecological components of the resource unit
Management considerations	This criterion requires the assessment of RUs where management actions should be prioritised. This applies to RUs or reaches where it is necessary to monitor the effectiveness of measures implemented to improve status quo.	• Resource Units with PES lower than a D category or lower than the accepted gazetted category (NEC)
Practical considerations	In addition to the above practical considerations are also considered to if RQOs can be determined and monitored.	• Availability of EWR site data or other monitoring data (RHP, DWA gauging weirs) located within reach • Accessibility of resource units for monitoring • Safety risk associated with monitoring resource unit

The Resource Unit Prioritisation Tool was applied at a desktop level to all surface water RUs delineated in the Middle Vaal WMA for the seven criteria described above. The desktop results were then presented at two stakeholder engagement workshops for the Middle Vaal WMA study held in Klerksdorp and Welkom over 25 and 26 September 2013 respectively. At these workshops stakeholders provided input on the rating of the resource units and based on their local knowledge and understanding of the study area were given the opportunity to amend the desktop score and

provide a rationale for RU selection and prioritisation. The results of this combined rating process (desktop amended with stakeholder consultation) are presented in Figure 17 . Five RUs were rated as low, five as a moderate priority rating and twenty seven as high. The priority ratings per RU for the Middle Vaal WMA are listed below in Table 17.

Table 17: Priority Rating per RU for the Middle Vaal WMA

IUA	Resource Unit	Overall Priority Rating (based on criteria above)
MA Renoster	R 1	low
	R 2	moderate
	R 3	high
	R 4	high
	R 5	high
MB Vals	V1	low
	V2	moderate
	V3	high
	V4	low
	V5	high
MC Schoon/ Koekemoerspruit	SK1	high
	SK2	high
	SK3	moderate
	SK4	moderate
	SK5	moderate
	SK6	high
	SK7	high
MD1 Upper Sand	US1	low
	US2	high
	US3	high
MD2 Lower Sand	LS1	high
	LS2	high
	LS3	high
ME1 Upper Vet	UV1	high
	UV2	high
	UV3	low
	UV4	high
ME2 Lower Vet	LV1	high
	LV2	high
MF Vaal River	VB1.1	high
	VB1.2	high
	VB1.3	high
	VB2	high
	VB3	high
	VB4	high
	VB5	high
	VB6	high

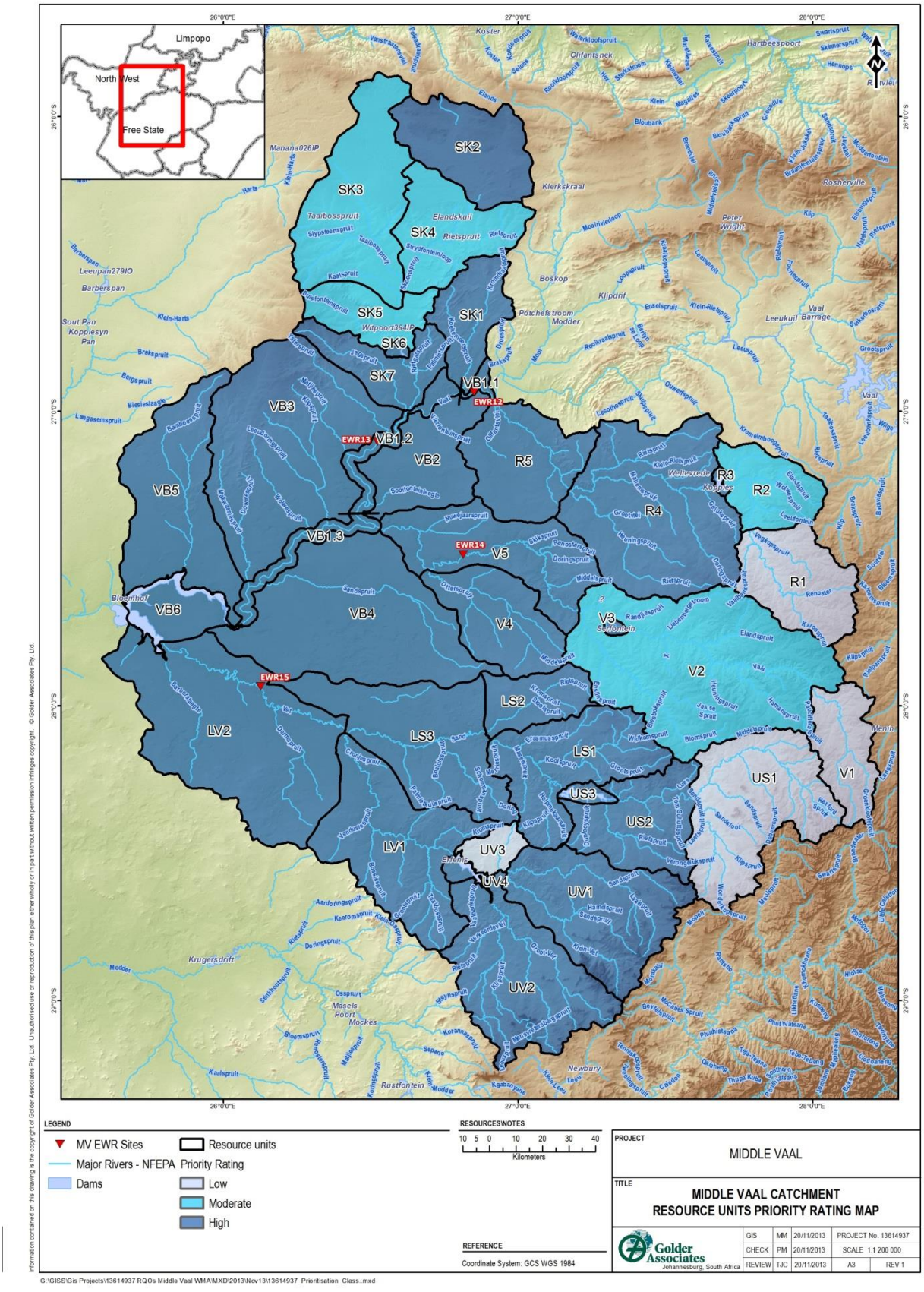

Figure 17: Priority ratings of RUs based on the application of the RU Prioritisation Tool

4.2 SELECTION OF PRIORITY RESOURCE UNITS

Based on the above summary priority ratings, these rankings and weightings were used to select the priority RUs for RQO determination. The evaluation of the RU priority ratings for selection were done at a desktop level and discussed and confirmed at the stakeholder engagement workshops for the Middle Vaal WMA RQO study held in Klerksdorp and Welkom over 25 and 26 September 2013 respectively. The purpose of this sub-step is to finally select those RUs which should be considered for RQO determination of river resources and dams. The scores for all criteria are combined into a priority rating which scores the RUs relative to each other. This provides an integrated measure to inform the selection of RU.

Based on the evaluation process twenty eight river RUs and six dam RUs were prioritised. These are shown Figure 18 and the summary prioritization scores, rating and rationale are provided in **Appendix A**. Three RUs were not selected. These include the most upstream catchments (headwaters) in the Renoster River catchment (R1), Vals River catchment (V1) and Upper Sand catchment (US1).

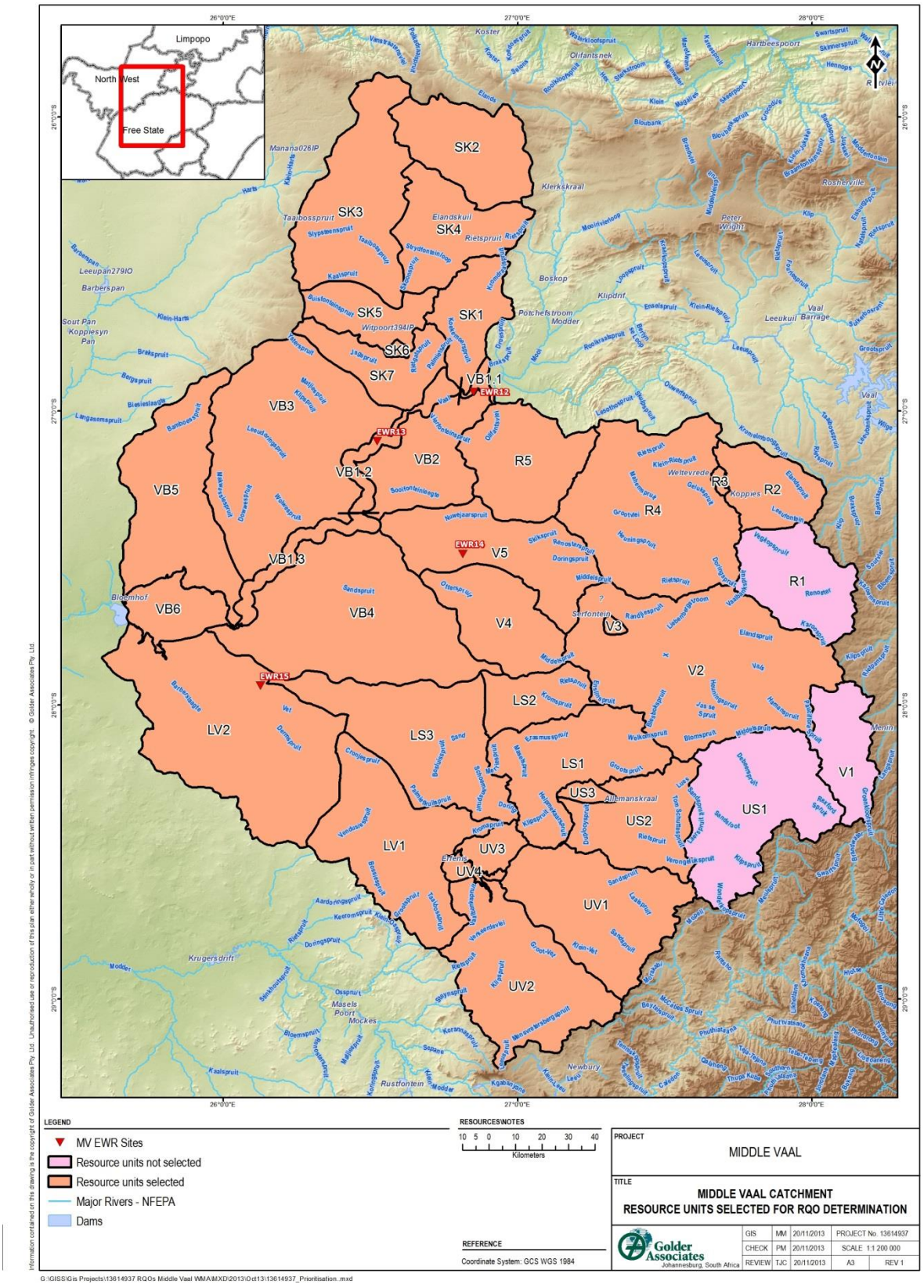

Figure 18: RUs prioritised and selected for RQO determination in the Middle Vaal

5 GROUNDWATER RESOURCE UNITS

Dolomitic Aquifers:

Two dolomitic water areas, the Ventersdorp-Grootpan DWA and the Klerksdorp-Orkney-Stillfontein-Hartebeesfontein (KOSH), are present in the upper reaches of the Schoonspruit and Middle Vaal sub-catchments (*viz.* C24C to C24E, and C24F and C24A and C24B). These dolomitic water resources are extensively used for irrigation (Schoonspruit groundwater and surface water systems) and impacted by mining activities (KOSH area). Several studies have reviewed the status of these systems pre-2004; although recent impacts due to drought conditions and mining activities may not be well incorporated into the total hydrological context.

Ventersdorp/Karoo Aquifers:

These aquifers are generally localised and most of them will discharge into the local surface water drainage systems or support local pans/wetlands.

Confirmed Approach

It is projected that ~94% of the Middle Vaal WMA consists of inter-granular and fractured rock formations; thus the hydrogeological characteristics of the aquifer system should be comparatively simple and uniform in terms of groundwater resource units. The criteria of resource quality objectives in terms groundwater characteristics should therefore be applicable to a consolidated parts of the Middle Vaal WMA. The remaining area consists of dolomite water areas that require a special approach for aquifer resource directed measure; especially with regard to the vulnerability of the dolomite water areas to pollution (gold mining activities) and over-utilisation (mine working dewatering and irrigation activities).

Information of the groundwater resources in the Middle Vaal WMA has been collated through groundwater potential studies (*i.e.* Groundwater Reserve Determination for Middle Vaal WMA, Groundwater Resources Assessment P II and historical/recent specialist studies that focussed on aquifer potential and sustainability. These already provide a baseline reference for aquifer status evaluations and arithmetic data that can be applied for classification and RQO estimations. Information in DWA's NGA and WARMS databases, as well as the newly development CHART (groundwater quality time series data set) will be consulted in addition to those mentioned above.

It is proposed that the demarcation of the groundwater resource units consisting of inter-granular and fractured aquifers can be grouped with the surface water resource units. In terms of demarcation of RU's for the dolomite water areas a different approach is required due to their dynamic flow regimes and complex boundary systems. The approach followed for the Crocodile West and Marico dolomite water areas, required that the boundaries of the Schoonspruit (C24C) and Holpan (C24F) quaternary catchments should be altered to fit in with the dolomite groundwater resource unit demarcations of the Crocodile West. These boundary adjustments were confirmed through high-level airborne geophysical surveys (by DWA and the Council for Geosciences) in the Crocodile West – Marico and Middle Vaal dolomite water areas.

Prioritisation of the Groundwater Resource Units (GRU's)

Functioning of the dolomitic systems is well known from previous investigations and reports and is

based on the natural flow boundaries demarcated by geological structures (vertical dykes).

Two dolomite groundwater RUs (GRUs) occur in the Middle Vaal WMA. Dolomite water areas have been classified as significant aquifer systems due to their unique hydrogeological characteristics. The dependence on water supply and the environmental requirements of both GRU's is extremely important to secure long-term sustainability in terms of quantities and qualities.

Water use activities in both GRU's consist of water supplies for domestic and agriculture uses (Schoonspruit GRU) and dewatering for safe underground mining activities (KOSH GRU). Both activities have the potential to cause significant water quality deterioration; thus the specification of RQO's for these GRU will require additional RQO attributes. It is envisaged that aquifer risk management will be an additional attribute to the basic aquifer management indicators envisaged for dolomite GRU's (Colvin *et al,* 2004). The risk of ground stability during periods of excessive dewatering remains one of the most serious phenomenon's of dolomite aquifer systems associated with its vulnerability to significant intake of polluted substances during periods of excessive recharge events initiated by poor land use management (especially in the aquifer recharge areas).

Demarcation of the dolomite GRU's is an important aspect and the following approach is proposed. The dolomitic water areas, the Schoonspruit and the Klerksdorp-Orkney-Stilfontein-Hartebeesfontein (KOSH) GRU's are situated in the upper reaches of the Schoonspruit and Middle Vaal sub-catchments (*viz*. C24C, C24E & C24F and C24A & C24B). The Schoonspruit GRU hosts the Ventersdorp Eye (a significant dolomite eye with a measured flow rate of 55.4Mm^3/a, or 1756l/s)) which is intensively used for domestic and irrigation water uses downstream of the eye. The catchment of the Ventersdorp Eye lies towards the north and the number of pivot irrigation schemes has increased significantly; thus decreasing the natural discharging flow rate of the systems and significantly reducing the flow sustainability below the Eye. Special management protocols are therefore required based on well-defined RQO criteria.

Demarcation of RU's between the Ventersdorp-Grootpan dolomitic water area, part of the Crocodile West - Marico WMA, and the Schoonspruit dolomitic water area in the Middle Vaal WMA, needs to be clarified especially on the upper portion of the C24F quaternary catchment (*viz.* the Grootpan dolomitic compartment(s). Airborne magnetic data from DWA has been processed and the dolomite water areas boundaries have been demarcated.

The KOSH GRU has been subjected to large scale dewatering due to deep mining activities and consequently significant pollution of the GRU as well. Rewatering of this GRU will happen in future and interaction with the Vaal River is foreseen.

The following are identified as RUs:

Priority: Dolomitic RUs (see Figure 19)

- For the C24C and C24F, the demarcation of the quartenary catchment covers the whole dolomite aquifer unit. The drainage towards the southern part of the quartenary is the same as the surface water drainages. The contribution of the dolomite aquifers to the southern drainages (*viz*. Schoonspruit Eye) is significantly important. However, the northern part of the dolomite drainage needs further refinement as it could drain towards the north due to the fact that the dolomite is dipping northwards. For the C24E, the drainage is south and falls within the quartenary catchment boundaries. The characteristics and contribution of the upstream dolomite aquifer in this quartenary catchment is important.

- For the C24A and C24 B, the dolomite aquifer systems fall within the boundaries of the quartenary catchment and can be included in the surface water RU. It must, however, be noted that this dolomite aquifer system is probably polluted due to the KOSH mining impacts and may contribute poor quality water to the surface resource.

General: Ventersdorp/Karoo Aquifers:

- To be included in the RU as demarcated for the surface water resources (see note above in terms of their local occurrences and direct contributions to surface resources).

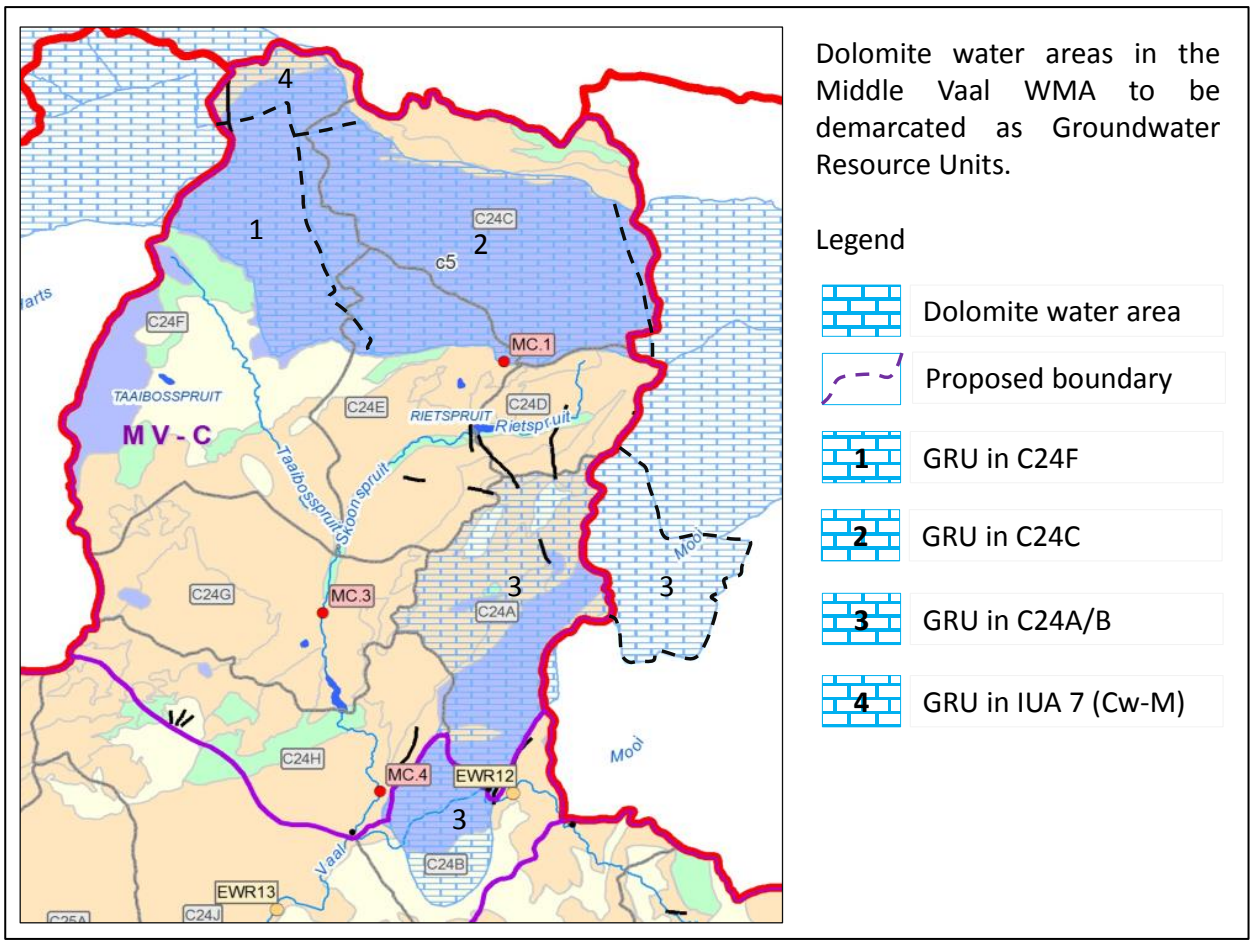

Figure 19: Proposed Groundwater Resource Units in the Middle Vaal WMA for dolomite water areas

Once the GRU have been finalised, the approach will be as proposed by DWA (2011), based on the methodology developed by Colvin *et al* (2004) and Parsons and Wentzel (2007); that is the 7 Step Functional Approach to set RQO's for Groundwater (Colvin et al, 2004 and DWA, 2011). It has been noted (DWA, 2011) that a methodology for Step 3: Prioritise and Select Preliminary Resource Units for RQO Determination, has not been developed. This requirement for the Middle Vaal will be based on the criteria for borehole yield classification as an initial selection process. This criteria classified produces an aquifer rating: Insignificant, through Minor to Moderate and finally Significant which specifically demarcates the dolomite water areas (as Significant Aquifers).

For the non-dolomite water areas (here referenced as the Ventersdorp and Karoo rock type GRU's), the RQO's should be based on basic hydrogeological parameters as observed through baseline groundwater information (1: 500 000 Geohydrological Map/Brochure Series) and

groundwater time series monitoring information (*viz*. National Groundwater Quality Monitoring Programme and detailed water level monitoring records by DWA Regional Offices). These aquifers are generally localised and most of them will discharge into the local surface water drainage systems or support local pans/wetlands; otherwise evapotranspiration losses. The interaction between groundwater and surface run-off needs to be acknowledged as well. Most of these aquifer systems are classified as Minor to Insignificant aquifer types due to relative slow transmission of responses (flow and transport) through the groundwater flow paths, and therefore do not require a high level of investigations in terms of RQO determination. It might, however, be necessary to use land use activities, such as stock feedlots, mining/industries and waste & wastewater treatment facilities as indicators for a higher level of RQO indicators where necessary. Sub-components of these GRU's could be limited to areas where groundwater/surface water interaction is dominant based on existing information (wetlands studies and DWA surface water monitoring information). In terms of indicators, it is foreseen that only those hydrogeological indicators that can be observed and evaluated through time series monitoring programmes, should be considered. In terms of aquifer saturation, the following indicators should be considered:

- water levels depths;
- water level gradients/trends;
- storage/sustainable yields;
- recharge; and
- natural discharge status.

In terms of aquifer water quality:

- reference groundwater quality character and status (macro, micro, trace elements and possibly it's environmental tracer status;
- presence of suspended substances and other potential pollution already part of the natural/induced transport flow regime;
- hydro-chemical trends and spatial coverage; and
- natural deterioration due to geological reasons.

For the dolomite water areas, the RQO's should be based on the results of indicators observed from special studies (long-term quantity and quality trends, ground stability status, recharge mechanisms, Due to the sporadic occurrence of dolomite eyes in these GRU's, basic hydrogeological parameters (water level elevations and water quality status/trend) for groundwater depending ecosystems in dolomite water areas is probably the most important sub-component criteria and indicator for RQO's. In addition, setting of RQO specifications for the recharge areas of dolomite GRU's is required and may be upgraded to a level where total protection of such areas may be considered at a resource quality objective.

Several studies have reviewed the status of the dolomite GRU systems; although recent impacts due to drought conditions and mining activities may not be well incorporated into the total hydrological context. The level of assessment of the dolomite GRU's should therefore be based on recent investigations (e.g. studies undertaken by Anglo Ashanti Gold for the KOSH Dolomite GRU). It was noted that the KOSH GRU monitoring programme is still maintained by the mine;

thus valuable data will be available from this programme.

Some long-term monitoring information limitations may exists for the Schoonspruit GRU and will have to be followed-up with DWA. This study by DWA (1994) may be regarded as historic already, although a systematic approach was applied to produce a set of management principles, structures and tools which can be used as indicators for RQO determination.

6 WETLAND PRIORITIZATION

6.1 APPROACH USED

The prioritisation of the wetlands was based predominantly on available information supported by inputs from provided by stakeholders. The following steps were undertaken in deriving the prioritization:

- Available information on wetlands was obtained from:
    - The National Spatial Biodiversity Assessment (NSBA);
    - The South African National Biodiversity Institute (SANBI) wetland probability map for South Africa;
    - The Freshwater Ecosystem Priority Areas (FEPAs) wetland layer; and
    - The modelled Free State wetland layer.
- Based on a review of the above combined wetland layers, a merged wetland layer was derived by combining the FEPAs and modelled Free State layers. Some desktop mapping was also undertaken where additional wetland signatures were visible on either 1:50 000 topographic maps, Google imagery or air photos. This layer was added to the merged wetland layer and used as the final wetland layer;
- Key wetlands and wetland clusters were then identified by overlaying the 2011 Threatened Ecosystems and the FEPAs wetland layer (see Figure 20 which shows the distribution of wetland FEPAs in the study area), and based on a general assessment of the extent and features associated with the wetland clusters. Other factors used in this assessment included consideration of:
    - The key hydrological drivers;
    - Landform;
    - Soil type (using the available soil coverage's); and
    - Vegetation Grouping and Ecosystem Type;
      (The threat status category of the vegetation grouping and ecosystem type(s) present within the Quarter Degree Square (QDS) was also included. For example Western Highveld Sandy Grassland which occurs in the region is classified as Critically Endangered and has no formal protection within the area of concern).
    - Wetland size;
      (The focus was also to prioritise large systems and networks of pans/depressions).
    - Wetland type and rarity including wetlands occurring in areas where the vegetation grouping has a high threat status (see the National Biodiversity Assessment, 2011 - Driver, Sink, Nel, Holness, Van Niekerk, Daniels, Jonas, Majiedt, Harris and Maze, 2012);
      (The focus was also to prioritise the wetland vegetation types in the highest threat categories e.g. wetlands of the Mesic Highveld Grassland Groups 2 and 4 which are both classified as Critically Endangered).
    - Wetlands known to have unique or high biodiversity;
    - Wetlands known to, or which could potentially support, threatened species.

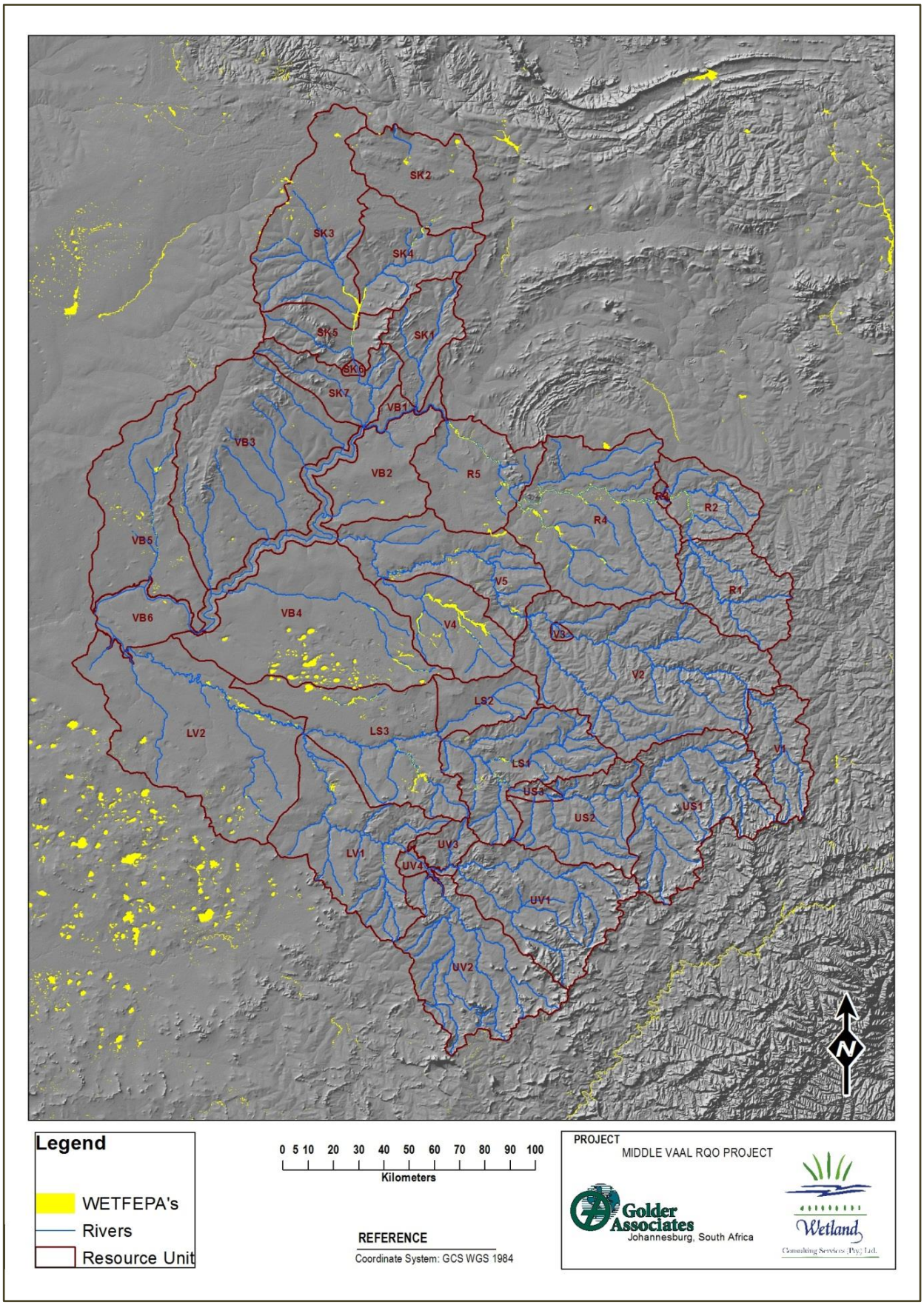

Figure 20: Map showing the distribution of Wetland FEPAs per RU across the Middle Vaal WMA

(*Data provided by Nacelle Collins from Free State Department of Economic Development, Tourism and Environmental Affairs, and data derived from the Southern Africa Bird Atlas Project (SABAP1) in the form of lists of recorded species for each QDS, was used in this assessment. The main focus of the assessment was related to targeted species that utilise wetlands, namely African Grass-Owl, African Marsh-Harrier (also any recordings of other harrier species), Crane species, Korhaan species and flamingos. The Important Bird Areas (IBAs) shapefile was therefore also incorporated into the analysis).*

- Wetlands that occur within formally protected areas;
- Wetland connectivity in the landscape;
- Representative wetlands of the area.

- A desktop PES assessment was undertaken. This was done at a whole wetland scale as opposed to hydrogeomorphic (HGM) scale (Brinson,1993; and modified for South Africa by Marneweck and Batchelor, 2002; and Kotze, Marneweck, Batchelor, Lindley and Collins, 2009) and instead of applying either of the two main PES assessment tools, namely WET-Health (Macfarlane, Kotze, Ellery, Walters, Koopman, Goodman and Goge, 2008) and Index of Habitat Integrity (IHI) (DWAF, 2007), a surrogate measure was used as an indication of wetland health. While the same PES categories as described in the PES methods of Kleynhans (1996), DWAF (1999), the IHI (DWAF, 2007) and Macfarlane et al. (2008) were used, no scores were derived. Instead PES Values were assigned to individual wetlands using a surrogate indicator of their health, namely surrounding land use. These were assigned to the dataset based on the intersection of wetland boundaries with various land-cover types which were derived from SANBI's 2009 national land-cover dataset. The PES score assigned to each land cover type, and hence each wetland as a result of its intersection with a particular land cover type, was as follows:
  - Natural: A/B
  - Degraded: C
  - Cultivation: C/D
  - Plantation: C/D
  - Urban: D/E
  - Mines: E/F
- In the case that a wetland overlapped more than one type of land-cover, the lowest possible PES score was assigned to the individual wetland. In order to avoid an overestimation of the level of degradation from a PES perspective, Mining and Urban/Built up areas smaller than 20 hectares were ignored, as was cultivation, plantation, and degraded areas smaller than 5 hectares.

  (Note that the PES scores derived for the wetlands are hence very general and subject to further verification. They can only be used as a general indication of the expected integrity/health status of the wetlands in a particular area or region. Detailed PES assessments will therefore always replace any of the categories indicated as these are derived from surrogate indicators. The coverage nevertheless provides a broad indication of the general state of the wetlands within each of the RU's and for the purposes of this report provides a basic indication of problems or wetland health concerns at that scale).

- Where possible the general wetland types occurring in particular RU's were described with reference to their HGM classification as were individually prioritized systems for which the classification was already known or which was determined based on examination of available aerial imagery;
  (Note that due to the scale of the project, budget constraints for site visits and the inability to access private land over much of the area, no ground truthing was possible. For this reason a detailed classification of the wetlands was not viable and as such no detailed classification maps were produced).
- A meeting was held with Nacelle Collins from Free State Department of Economic Development, Tourism and Environmental Affairs to verify the findings of the prioritisation and identify any additional wetland systems which might have been missed as part of the initial prioritisation. The prioritisation map was then updated based on these inputs.

  (Note that there may still be other wetlands that could rank as important but which were not captured in any of the databases used, or not identified or pointed out by stakeholders as part of this study).
- Important wetlands and wetland clusters were then identified following consideration of the above (see **Figure 21**);
- The expected importance of these wetlands and/or wetland cluster in providing supporting and regulating services such as flood attenuation, stream flow regulation, sediment trapping, erosion control, water quality enhancement and carbon storage was then considered in order to derive the overall prioritisation of these;

  (*Note that assessing the relative importance of wetlands in providing these services is not easy to achieve even when detailed data are available, not to mention when studies are conducted at a desktop level and where no detailed data are available).*
- An attempt was made to rate the relative importance of the wetlands in providing only flood attenuation, stream flow regulation, sediment trapping, erosion control and water quality enhancement services simply by subjectively rating these based on:
  - The desktop PES assessment;
  - Visible desktop mapping attributes such as extent, slope and position in the catchment;
  - Surrounding and upstream land use;
  - Perceived or known threats from the RU description and characterisations;
  - Location relative to sewage works; and
  - Perceived ability to perform certain services or functions within the landscape based on wetland type.

6.2 GENERAL FINDINGS

6.2.1 Ecosystem Types associated with the wetlands in the study area

- Highveld Alluvial Vegetation – Vulnerable (VU)
- Highveld Salt Pans – Least Threatened (LT)
- Carletonville Dolomite Grassland – Vulnerable (VU)

- Western Highveld Sandy Grassland – Critically Endangered (CR)
- Vaal-vet Sandy Grassland – Endangered (EN)
- Eastern Free State Clay Grassland – Vulnerable (VU)
- Eastern Temperate Freshwater Wetlands – Vulnerable (VU)
- Rand Highveld Grassland – Vulnerable (VU)
- Vredefort Dome Granite Grassland – Vulnerable (VU)
- Kimberley Thornveld – Least Threatened (LT)

Within the study area the most widespread of the threatened ecosystem types that occur is the Vaal-Vet Sandy Grassland. This ecosystem type occurs extensively throughout the central region of the study area. The Western Highveld Sandy Grassland is found only at the Western edge of the study area where an extensive system of small pans and depressions is found and forms part of one of the priority wetland clusters. The Eastern Free State Clay Grassland is found in the south eastern edge of the study area while the Vredefort Dome Granite Grassland and Rand Highveld Grassland occur along the Northern and North-eastern edges being more extensive north of the study area.

6.2.2 Wetland Types occurring in the study area

- Central Bushveld Group 1 - Critically Endangered (CR)
- Mesic Highveld Grassland Group 2 – Critically Endangered (CR)
- Mesic Highveld Grassland Group 4 – Critically Endangered (CR)
- Mesic Highveld Grassland Group 1 – Endangered (EN)
- Dry Highveld Grassland Group 4 – Endangered (EN)
- Dry Highveld Grassland Group 3 – Vulnerable (VU)
- Dry Highveld Grassland Group 5 – Least Threatened (LT)
- Eastern Kalahari Bushveld Group 3 – Least Threatened (LT)

It is important to note that three (38%) of the eight wetland vegetation groups occurring in the area are critically endangered and two (25%) are endangered. The level of protection of these systems is non-existent in most cases. This highlights the need to try to ensure that some of these systems are protected and for this reason a number are incorporated as priority systems.

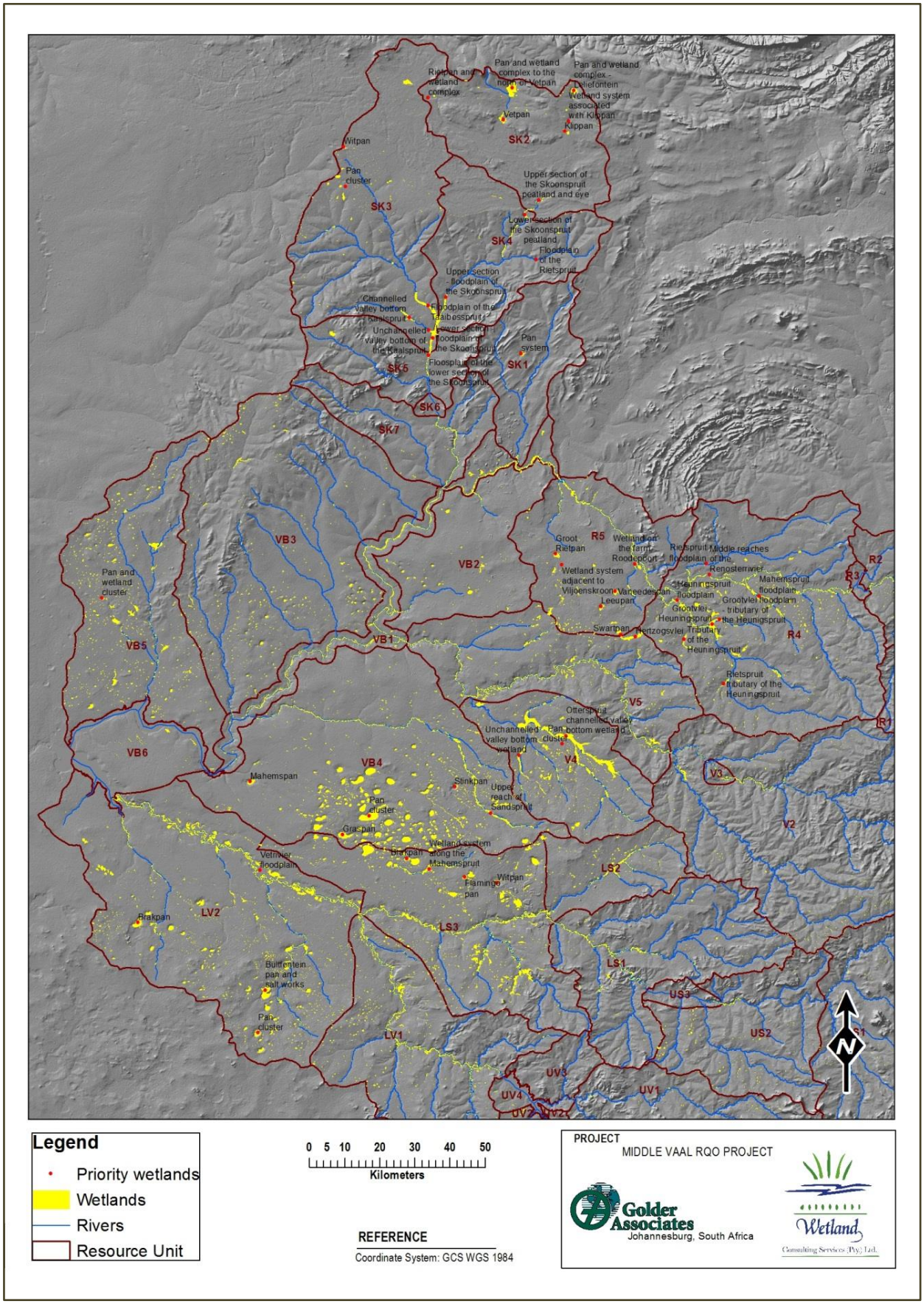

Figure 21: Map showing priority systems/clusters for the RUs in the Middle Vaal WMA

6.3 LIST OF PRIORITY WETLANDS

To date, fifty (50) systems have provisionally been identified as priority wetlands/wetland clusters in the Middle Vaal WMA RU's as indicated below.

6.3.1 Resource Unit SK1

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Pan	Pan	B	High to Very High	Dry Highveld Grassland Group 5 - LT	Vaal Vet Sandy Grassland - EN	No	Endorheic seasonal pan fed by a relatively large localised catchment and drainage lines

6.3.2 Resource Unit SK2

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Pan and wetland complex - Leliefontein	Pans, hillslope seepage, channelled and unchannelled valley bottom wetlands	B to D	High	Dry Highveld Grassland Group 5 - LT	Rand Highveld Grassland - VU Highveld Salt Pans - LT	Some	Endorheic seasonal pans and depressions linked to other wetland complexes
Pan and wetland complex to the north of Vetpan	hillslope seepage and channelled valley bottom wetlands	C to E	High	Dry Highveld Grassland Group 5 - LT	Rand Highveld Grassland - VU Highveld Salt Pans - LT	Some	Endorheic seasonal pans and depressions linked to other wetland complexes
Vetpan and Klippan	Pans	D and B respectively	Very High	Mesic Highveld Grassland Group 4 - CR	Carletonville Dolomite Grassland – CR Highveld Salt Pans - LT	Yes	Seasonal pans and depressions connected to river systems
Wetland system associated with Klippan	Channelled and unchannelled valley bottom and hillslope seepage	C/D	High	Mesic Highveld Grassland Group 4 - CR	Carletonville Dolomite Grassland – CR	Yes	Seasonal pans and depressions connected to river systems
Rietpan pan and wetland complex	Pans and valley bottom wetlands	D	Very High	Dry Highveld Grassland Group 5 - LT	Rand Highveld Grassland - VU Highveld Salt Pans - LT	Yes	Seasonal pan connected to wetland and river system

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Upper section of the Skoonspruit peatland and the Schoonspruit eye	Peatland	B to D	Very High	Dry Highveld Grassland Group 5 - LT	Carletonville Dolomite Grassland - CR	Yes	Peatland associated with dolomites and dolomitic eye

6.3.3 Resource Unit SK3

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Eastern section of Witpan	Pan	B	Very High	Dry Highveld Grassland Group 3 - VU	Vaal-vet Sandy Grassland – EN	Yes	Endorheic seasonal pan
Pan cluster to the north of Coligny	Pans	B to D	Very High	Dry Highveld Grassland Group 3 - VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	Yes	Endorheic seasonal pans and depressions
Floodplain of the Taaibosspruit	Floodplain	D	High	Dry Dry Highveld Grassland Group 3 - VU	Highveld Alluvial Vegetation - VU	Yes	Floodplain
Middle Kaalspruit	Channelled valley bottom wetland	C/D	High	Dry Dry Highveld Grassland Group 3 - VU	Vaal Vet Sandy Grassland - EN	Not channelled valley bottom section – only the floodplain section that joins the Skoonspruit	Channelled valley bottom and floodplain complex
Lower Kaalspruit	Unchannelled valley bottom wetland	B	High	Dry Dry Highveld Grassland Group 3 - VU	Vaal Vet Sandy Grassland - EN	Not channelled valley bottom section – only the floodplain section that joins the Skoonspruit	Unchannelled valley bottom linked to a floodplain complex
Lower section – floodplain of the Skoonspruit	Floodplain	C/D	Very High	Dry Dry Highveld Grassland Group 3 - VU	Highveld Alluvial Vegetation - VU	Yes	Floodplain

6.3.4 Resource Unit SK4

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Lower section of the Skoonspruit peatland	Peatland	D	Very High	Dry Highveld Grassland Group 5 - LT	Carletonville Dolomite Grassland - CR	Yes	Peatland
Floodplain of the Rietspruit	Floodplain	Unknown	High	Dry Dry Highveld Grassland Group 3 - VU	Vaal-vet Sandy Grassland – EN	No	-
Upper section – floodplain of the Skoonspruit	Floodplain	C/D	High	Dry Dry Highveld Grassland Group 3 - VU	Vaal-vet Sandy Grassland – EN Highveld Alluvial Vegetation - VU	Yes	Extensive valley bottom and floodplain wetland system

6.3.5 Resource Unit SK5

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Floodplain of the lower Skoonspruit	Floodplain	C/D	High	Dry Dry Highveld Grassland Group 3 - VU	Highveld Alluvial Vegetation - VU	Yes	Lower end of the floodplain system

6.3.6 Resource Unit R4

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Middle reaches of the Renoster River	Floodplain	C/D	Moderate	Dry Dry Highveld Grassland Group 4 - EN	Central Free State Grassland - VU	Yes	-
Middle reaches of the Heuningspruit	Floodplain	C/D	High	Dry Dry Highveld Grassland Group 4 - EN	Central Free State Grassland - VU	Yes	Extensive and well developed floodplain features present including oxbows
Grootvlei in a tributary of the Heuningspruit and on the Heuningspruit	Floodplain	C/D	High	Dry Dry Highveld Grassland Group 4 - EN	Central Free State Grassland - VU	Yes but only part of the system draining from the south	Large wetland system at the confluence of east, north and south draining arms

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Central and lower reaches of the Mahemspruit	Floodplain	C/D	Moderate	Dry Highveld Grassland Group 3 – VU Dry Highveld Grassland Group 4 – EN	Vaal-vet Sandy Grassland – EN	Lower reach	-
Rietspruit tributary of the Heuningspruit	Unchannelled valley bottom wetland	C/D	Moderate	Dry Dry Highveld Grassland Group 3 - VU	Central Free State Grassland - VU	Yes	-
Tributary of the Heuningspruit	Unchannelled valley bottom wetland	C/D	Moderate	Dry Dry Highveld Grassland Group 3 - VU	Central Free State Grassland - VU	Yes	-
Middle to lower reaches of the Rietspruit	Floodplain	B/C	Moderate	Dry Dry Highveld Grassland Group 3 - VU	Central Free State Grassland - VU and Vaal-vet Sandy Grassland – EN	Small parts of the system	-

6.3.7 Resource Unit R5

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Wetland system adjacent to Viljoenskroon	Unchannelled valley bottom	D/E	Moderate	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN	No	-
Sewage works with an outlet into the system at Viljoenskroon							
Wetland on the farm Roodepoort	Unchannelled valley bottom wetland	B/C	High	Dry Dry Highveld Grassland Group 4 - EN	Central Free State Grassland - VU Highveld Salt Pans - LT	Yes	-
Northern section of Swartpan	Pan and wetland complex	B to D	Very High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	Yes	Pan system linked to a wetland complex

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Leeupan	Pan	D	High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	No	Large pan
Vaneedespan	Pan	D	High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	No	Large pan
Groot Rietpan	Pan	D	High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	No	Large pan

6.3.8 Resource Unit V4

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Middle reaches of the Otterspruit and its tributaries	Channelled valley bottom wetland	B to D	High	Dry Highveld Grassland Group 3 – VU	Highveld Alluvial Vegetation - VU	Yes	Extensive wetland system at the confluence of 4 headwater streams
Pan cluster associated with the middle reaches of the Otterspruit	Pans and hillslope seepage wetlands	B to D	Very High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	Some	Extensive pan and hillslope seepage complex
Tributary of the Otterspruit	Unchannelled valley bottom wetland	C/ D	High	Dry Highveld Grassland Group 3 – VU	Highveld Alluvial Vegetation - VU	Yes	-

6.3.9 Resource Unit V5

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Hertzogsvlei	Valley bottom wetland and hillslope seepage wetlands	B to D	High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	Yes	Wetland system feeding the Swartpan system in RU R5
Southern section of Swartpan	Pan and wetland complex	B to D	Very High	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN Highveld Salt Pans - LT	Yes	Pan system linked to a wetland complex

6.3.10 Resource Unit VB4

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Upper reaches of the Sandspruit (immediately north of Kutloanong)	Unchannelled valley bottom wetland	B to E	High	Dry Highveld Grassland Group 3 – VU	Highveld Alluvial Vegetation - VU	Yes	Extensive wetland system downstream of large urban settlement
Pan cluster around Wesselbron including Volstruispan to the north	Pans and hillslope seepage wetlands	B to D	Very High	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - (VU) Highveld Salt Pans - LT	Yes most of the pan systems	Extensive pan and hillslope seepage complex
Graspan	Pan	D/E	Marginal to Low	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	Yes	Large pan that is part of a pan complex
Sewage works above the pan – also many dams in catchment area and furrows in basin							
Mahemspan	Pan	B	Very High	Eastern Kalahari Bushveld Group 3 – LT	Highveld Alluvial Vegetation - VU	Yes	Linked to a drainage line

6.3.11 Resource Unit LS3

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Ganspan and remaining pans that form the southern part of the Wesselbron pan complex	Pans and hillslope seepage wetlands	B to D	Very High	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	Yes most of the pan systems	Extensive pan and hillslope seepage complex
Wetland system along the Mahemspruit and associated pans including Brakpan	Unchannelled valley bottom wetland and pans	D	Marginal to Low	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU	Yes	Floodplain system with adjacent pan system (Leeupan)
Flamingo Pan	Pan	D/E	Marginal to Low	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	No	Pan below a sewage works
Stinkpan	Pan	E	Marginal to low but supports a large population of Flamingoes	Dry Highveld Grassland Group 3 – VU	Vaal-vet Sandy Grassland – EN	No	Pan below sewage works
Witpan	Pan	D/E	Marginal to Low	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	No	Pan below a sewage works and adjacent to mining and urban development
Welkom sewage works in the catchment of the pan and golf course around the southern edge of the pan							

6.3.12 Resource Unit LV2

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Brakpan	Pan	C/D	Moderate	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	Yes	Saline pan

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Floodplain of the Vetrivier	Floodplain	C/D	Marginal to Low	Dry Highveld Grassland Group 3 – VU Eastern Kalahari Bushveld Group 3 – LT	Highveld Alluvial Vegetation - VU Kimberley Thornveld – LT Vaal-vet Sandy Grassland – EN	Yes	Recognised by Free State DETEA as an important biodiversity corridor
Bultfontein pan and saltworks	Pan	E	Marginal to Low	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans - LT	No	Salt pan and used for salt works
Sewage works and salt works - associated services provided by this pan							
Pan cluster to the south of Bultfontein	Pans	B to D	Moderate	Dry Highveld Grassland Group 3 – VU	Western Free State Clay Grassland - VU Highveld Salt Pans – LT	Yes most of the systems	Seasonal and saline pans

6.3.13 Resource Unit VB5

Wetland	Type	PES	EIS	NFEPA Wetland Vegetation Group and Threat Status	Part of a Threatened Ecosystem	Identified as a WETFEPA	Unique features
Pan cluster along the watershed divide to the west of the Bamboesspruit	Pans, depressions and valley bottom wetlands	B to E	High	Dry Highveld Grassland Group 3 – VU	Kimberley Thornveld – LT Highveld Salt Pans - LT	Yes many of the pan systems	Extensive pan and saline wetland complex impacted by agriculture and mining

7 SUMMARY AND CONCLUSIONS

In terms of the various components and considerations assessed for RU delineation and prioritisation and based on the understanding and expert knowledge of the Middle Vaal WMA, the results of the delineation and prioritisation process are as follows:

- Thirty one surface water resource RUs were delineated and 28 have been prioritised;
- Six dam RUs were delineated and prioritised;
- Three groundwater priority areas were identified (Dolomite aquifer systems) however the selection of the units for groundwater RQO determination are still to be confirmed;
- The general groundwater areas have been described (Ventersdorp/Karoo Aquifer systems)
- Fifty wetlands/wetland clusters have been prioritised in the WMA.

RQOs for the prioritised and selected rivers, dams and groundwater RUs, and wetlands/wetland clusters will be determined as the next step of the process for the sub-components and indicators prioritised (Steps 4 and 5 of the RQO process).

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APPENDIX A

SUMMARY PRIORITIZATION SCORES, RATING AND RATIONALE PER RESOURCE UNIT

Table A1: PRIORITY RUs SELECTED FOR THE MIDDLE VAAL WMA

IUA	Resource Unit	Priority Rating (0 -1)	Rationale for selection
MA Renoster	R 2	0.41	Sewage works present, Issues around licencing
	R 3	0.80	Operation of the dam and supporting activities need to be managed. Recreation, fishing, and cultural are important.
	R 4	1.00	FEPA present. High activity - mining and irrigation. Koppies town present. Wetland priority area.
	R 5	0.76	Lowest most RU within the IUA. FEPA present.
MB Vals	V2	0.4	Includes impacts from land based activities that pose a threat. FEPA present
	V3	0.5	Operation of the dam and supporting activities need to be managed.
	V4	0.1	Wetland priority area – Otterspruit system
	V5	1.0	Lowest most RU within the IUA, most impacted. FEPA present
MC Schoon/ Koekemoerspruit	SK1	1.0	Tributary of Vaa the River. Highly impacted, requires management.
	SK2	0.6	The Schoonspruit Eye needs to be protected. Dolomitic aquifers present (Groundwater priority area)
	SK3	0.4	Groundwater and wetland priority areas
	SK4	0.4	Irrigation impacts
	SK5	0.4	Irrigation impacts
	SK6	0.6	Operation of the dam must be managed
	SK7	1.0	Lowest most RU within the IUA, highly impacted
MD1 Upper Sand	US2	0.6	Impacts from the town of Senekal
	US3	1.0	Allemanskraal Dam - Operation of the dam and supporting activities need to be managed. Irrigation activity
MD2 Lower Sand	LS1	0.7	Abstraction for irrigation. FEPA present
	LS2	0.5	Mining activities in the town of Virginia to be managed
	LS3	1.0	Wetland priority area. Upstream impacts. FEPA present
ME1 Upper Vet	UV1	0.6	Impacts from the town
	UV2	0.7	Agricultural activities
	UV3	0.2	Protect the FEPA
	UV4	1.0	Erfenis Dam – supporting activities around the dam, agricultural water use
ME2 Lower Vet	LV1	0.6	Agricultural and flow impacts. FEPA present
	LV2	1.0	Agricultural impacts and influence from the Sand river, EWR site to be maintained.
MF Vaal River	VB1.1	1.0	The Vaal main stem is important/priority water resource (WMA).
	VB1.2	1.0	
	VB1.3	1.0	
	VB2	0.5	Water quality impacts on Vaal River

IUA	Resource Unit	Priority Rating (0 -1)	Rationale for selection
	VB3	0.6	Land use impacts
	VB4	0.6	Wetland/pans priority area
	VB5	0.6	Wetlans (Pans) priority area
	VB6	0.9	Operation of the system, water quality

Tabulation of the Scores and Results of the application of the Resource Unit Prioritisation Tool (RUPT) in the Middle Vaal WMA

Resource Unit	Position in IUA	Importance to Users					Threat to users	Ecological Importance				Threat faced by Ecological component	Management consideration	Practical Considerations			Priority Rating
	Position of RU	Cultural services to society	Supporting livelihoods	Strategic requirements	Supporting and regulating services	Contribution to the economy	Threat posed to users	High Ecological importance and Sensitivity	EC or PES of A/B	Freshwater Ecosystem Priority Areas	Priority conservation plans	Threat posed to ecology	PES lower than a D or lower than MC	Availability of data	Accessibility	Safety risk	
R 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.0	0.5	0.5	0.5	0.2
R 2	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	1.0	0.0	0.5	0.0	0.5	0.5	0.5	0.4
R 3	1.0	0.5	0.5	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.5	0.8
R 4	0.0	0.5	0.0	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.5	1.0	1.0	0.5	1.0	0.5	1.0
R 5	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.5	0.0	0.5	0.5	0.5	0.8
V1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.5	0.5	0.1
V2	0.0	0.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	1.0	0.5	0.5	0.0	0.5	1.0	0.5	0.4
V3	1.0	0.5	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	1.0	0.5	0.5
V4	0.0	0.5	0.5	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.1
V5	1.0	0.5	0.5	0.0	0.5	0.5	1.0	0.0	0.0	1.0	0.5	1.0	1.0	1.0	1.0	0.5	1.0
SK1	1.0	0.0	0.5	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	0.5	1.0
SK2	0.0	0.5	0.5	0.0	0.0	0.0	1.0	0.0	0.0	0.5	0.5	1.0	1.0	0.5	0.5	0.5	0.6
SK3	0.0	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.5	0.5	1.0	0.0	0.5	0.5	0.4
SK4	0.0	0.0	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.0	1.0	0.5	1.0	0.5	0.5	0.5	0.5
SK5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.5	0.5	0.5	1.0	0.0	0.5	0.5	0.4
SK6	0.0	0.5	0.5	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.5	0.5	1.0	0.5	1.0	0.5	0.6
SK7	1.0	0.5	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.5	1.0	1.0	1.0	1.0	0.5	1.0
US1	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.5	0.5	0.2
US2	1.0	0.0	0.5	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.5	0.5	0.6
US3	1.0	0.5	0.5	0.0	0.0	1.0	0.5	0.0	0.0	0.0	1.0	1.0	1.0	0.5	0.5	0.5	1.0
LS1	0.0	0.5	0.5	0.0	0.0	1.0	1.0	0.0	0.0	1.0	0.0	1.0	1.0	0.5	0.5	0.5	0.7
LS2	0.0	0.5	0.5	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.5	1.0	1.0	0.0	0.5	0.5	0.5
LS3	1.0	0.5	0.5	0.0	1.0	1.0	1.0	0.0	0.0	1.0	0.5	1.0	1.0	0.5	0.5	0.5	1.0
UV1	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	1.0	0.0	0.5	0.5	0.6
UV2	0.0	0.5	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5	0.5	1.0	0.0	0.5	0.5	0.7
UV3	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.5	0.2
UV4	1.0	0.5	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	1.0
LV1	0.0	0.5	0.5	0.0	0.0	0.5	0.5	0.0	0.0	1.0	0.5	0.5	1.0	0.5	0.5	0.5	0.6
LV2	1.0	0.5	0.5	0.0	1.0	0.5	0.5	0.0	0.0	0.0	0.5	0.5	1.0	1.0	0.5	0.5	1.0
VB1.1	1.0	0.5	0.5	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.5	1.0	1.0	0.5	0.5	1.0
VB1.2	1.0	0.5	0.5	1.0	0.0	1.0	1.0	0.0	0.0	0.0	0.5	0.5	1.0	1.0	1.0	0.5	1.0
VB1.3	1.0	0.5	0.5	1.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.5	1.0	1.0	1.0	0.5	1.0
VB2	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.5	0.5	0.5
VB3	1.0	0.5	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.5	0.5	0.6
VB4	1.0	0.5	0.5	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.5	0.5	0.6
VB5	1.0	0.5	0.5	0.0	0.5	0.5	0.0	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.5	0.5	0.6
VB6	1.0	1.0	0.5	1.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	0.5	1.0	1.0	0.5	0.5	0.9

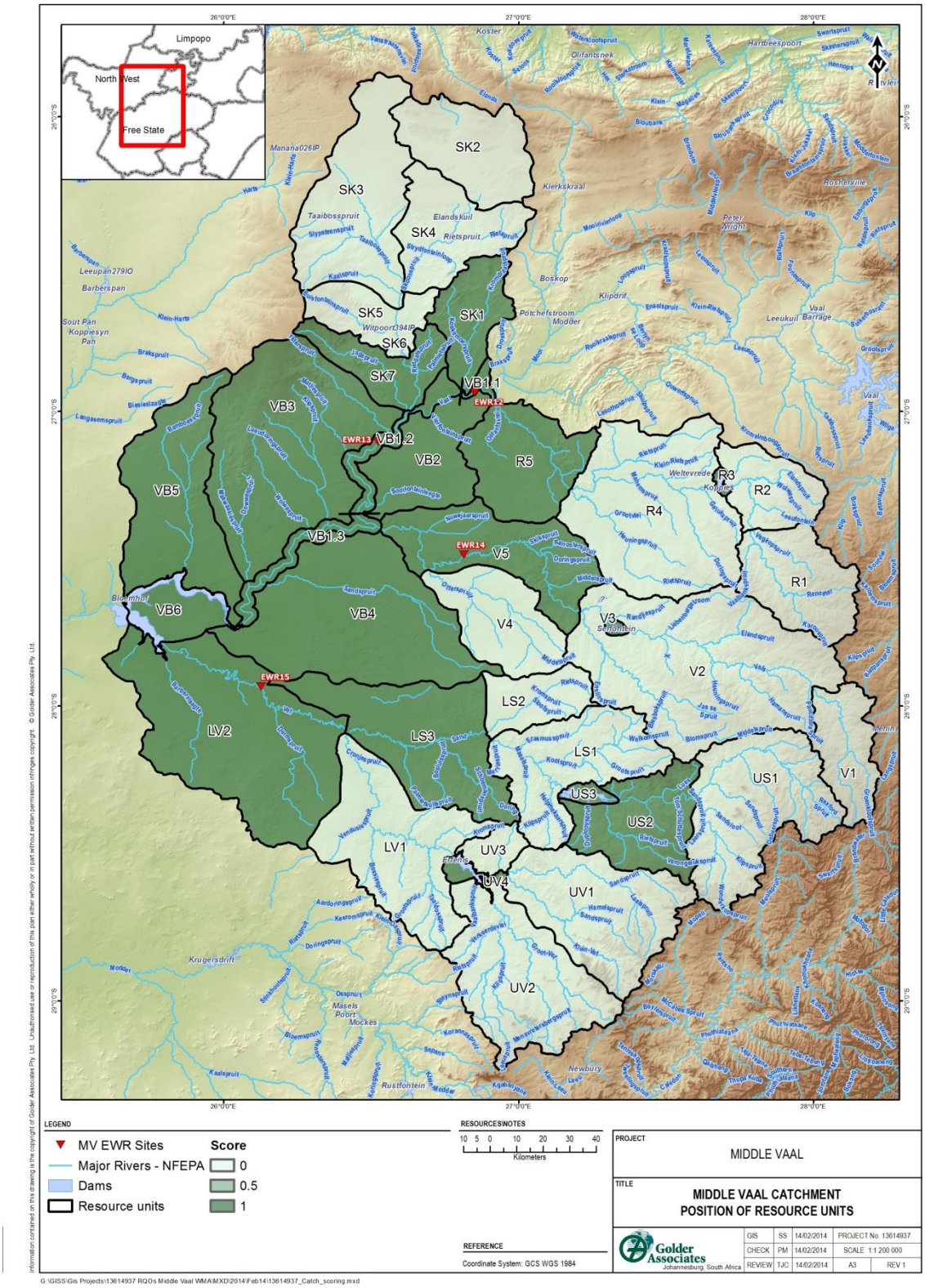

Figure A-22: Middle Vaal WMAs Position of Resource Units

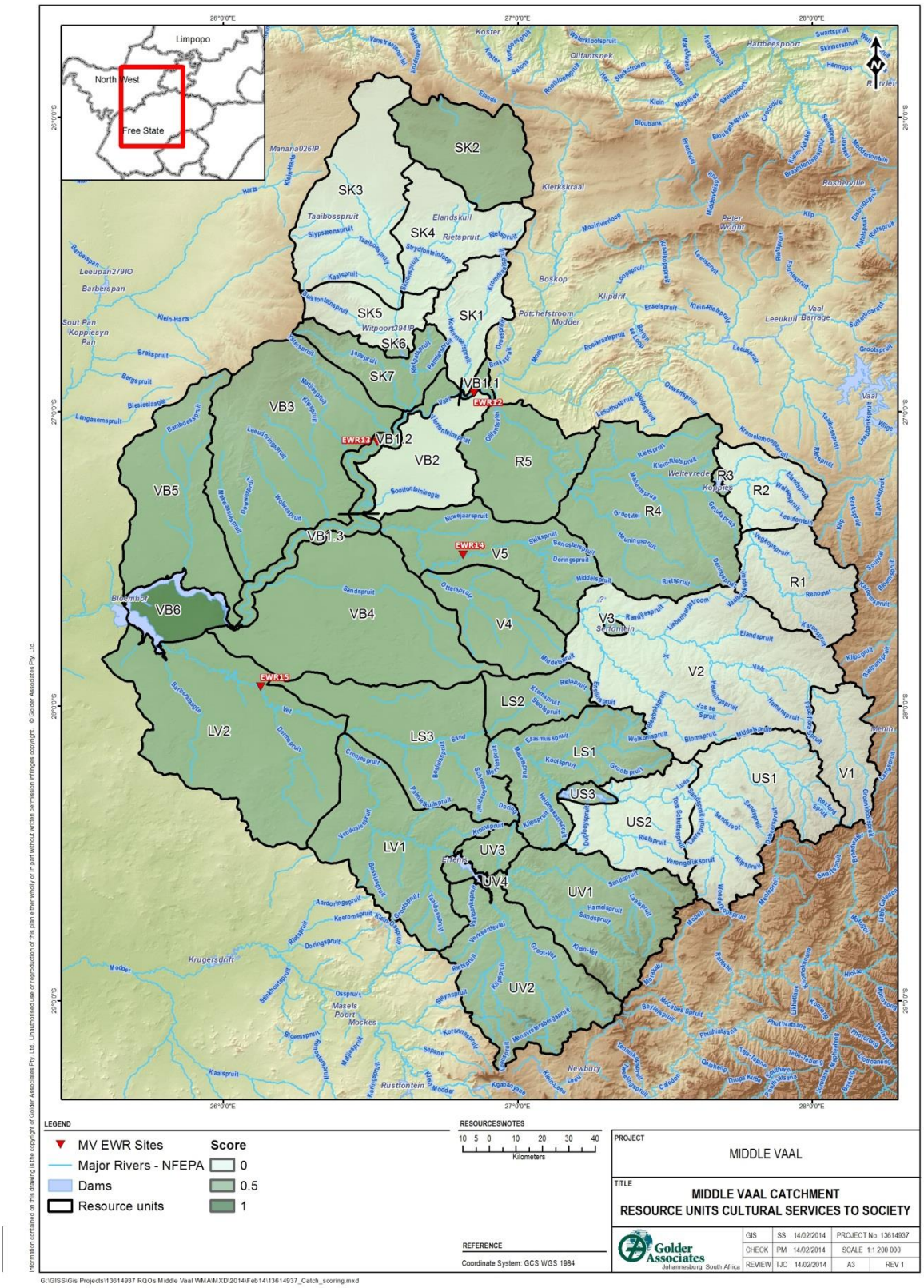

Figure A-23: Middle Vaal Catchment Resource Units Cultural Services to Society

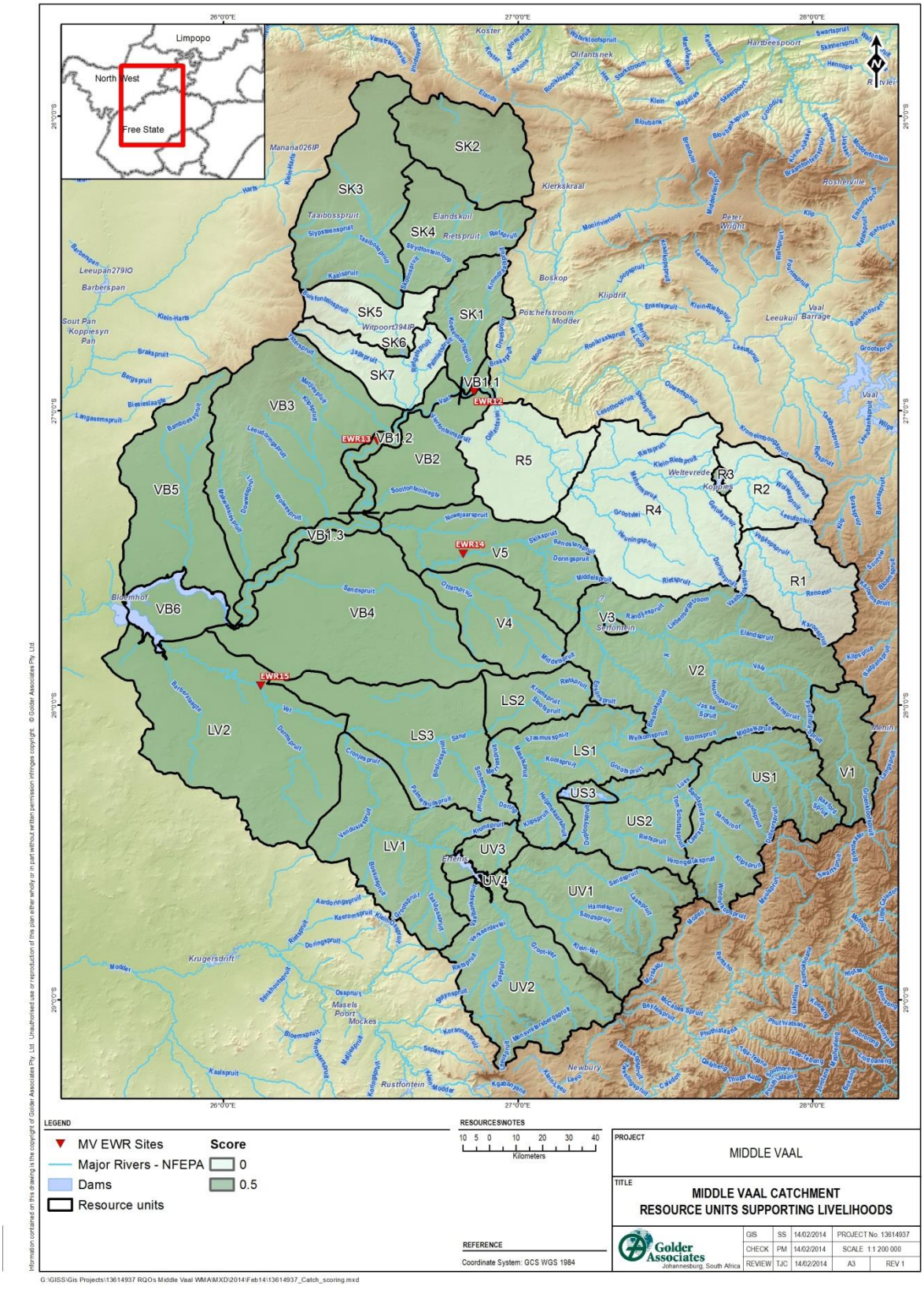

Figure A-24: Middle Vaal Catchment Resource Units Supporting Livelihoods

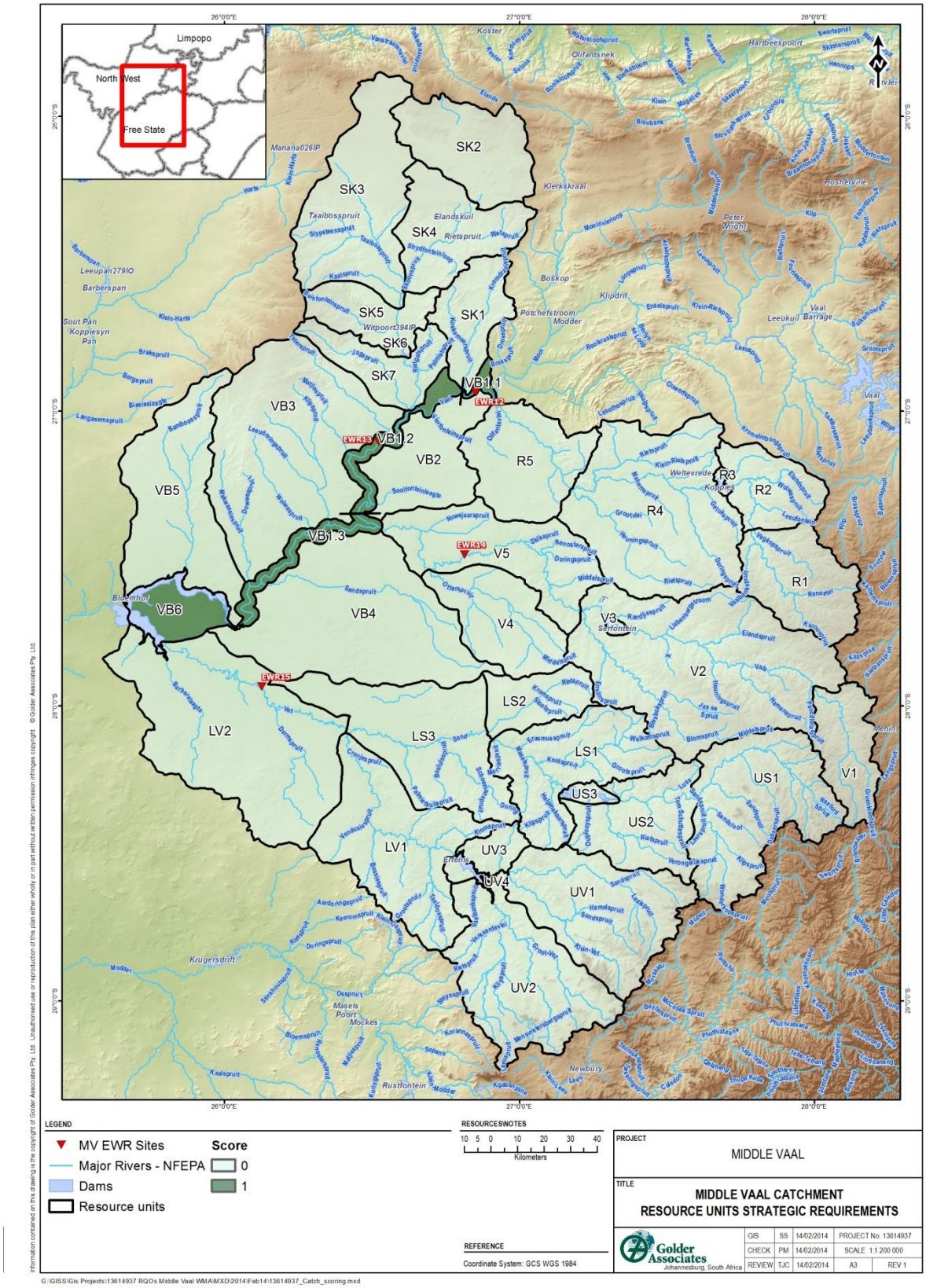

Figure A- 25: Middle Vaal Catchment Resource Units Strategic Requirements

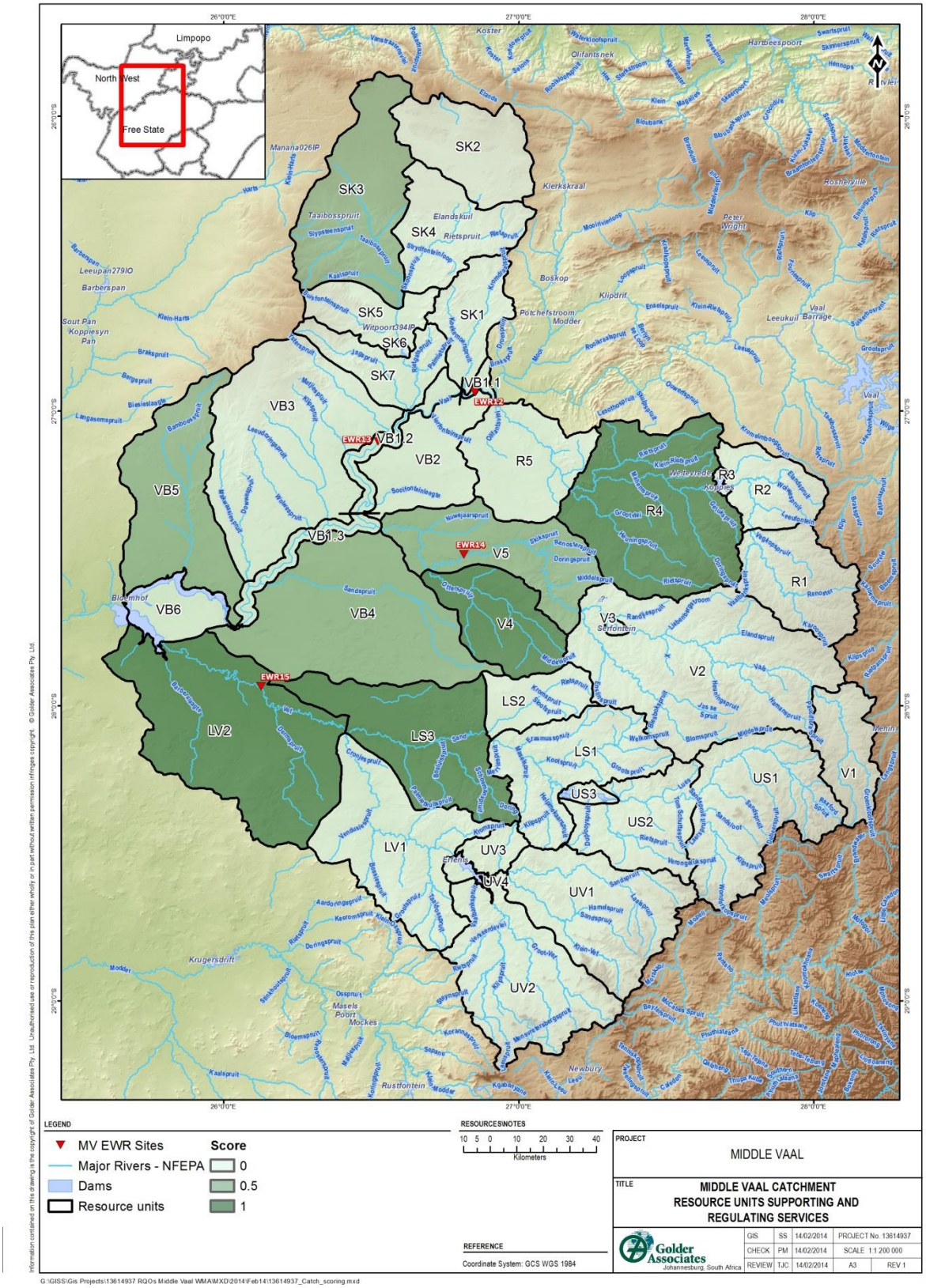

Figure A-26: Middle Vaal Catchment Resource Units Supporting and Regulating Services

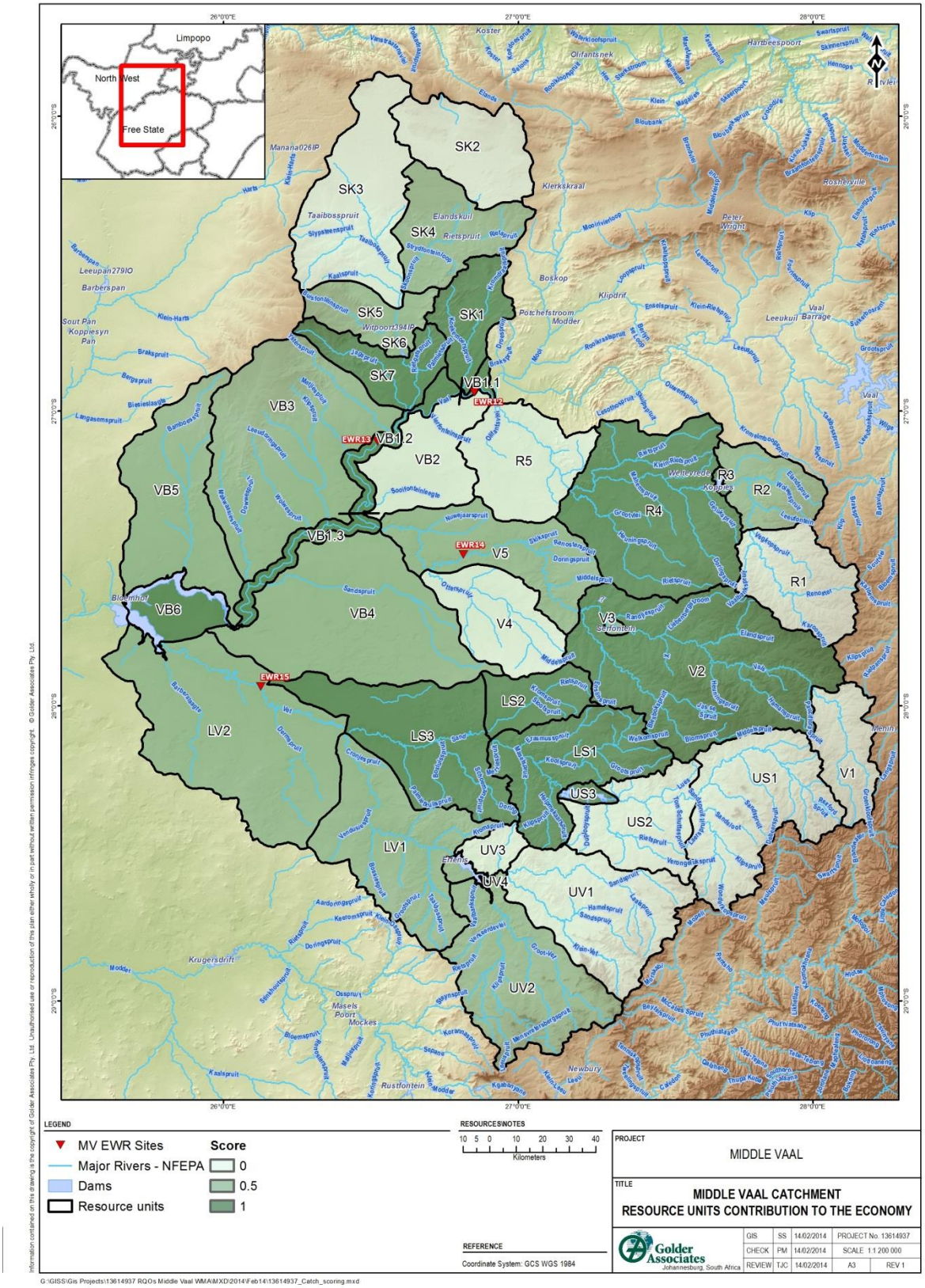

Figure A- 27: Middle Vaal Catchment Resource Units Contribution to the Economy

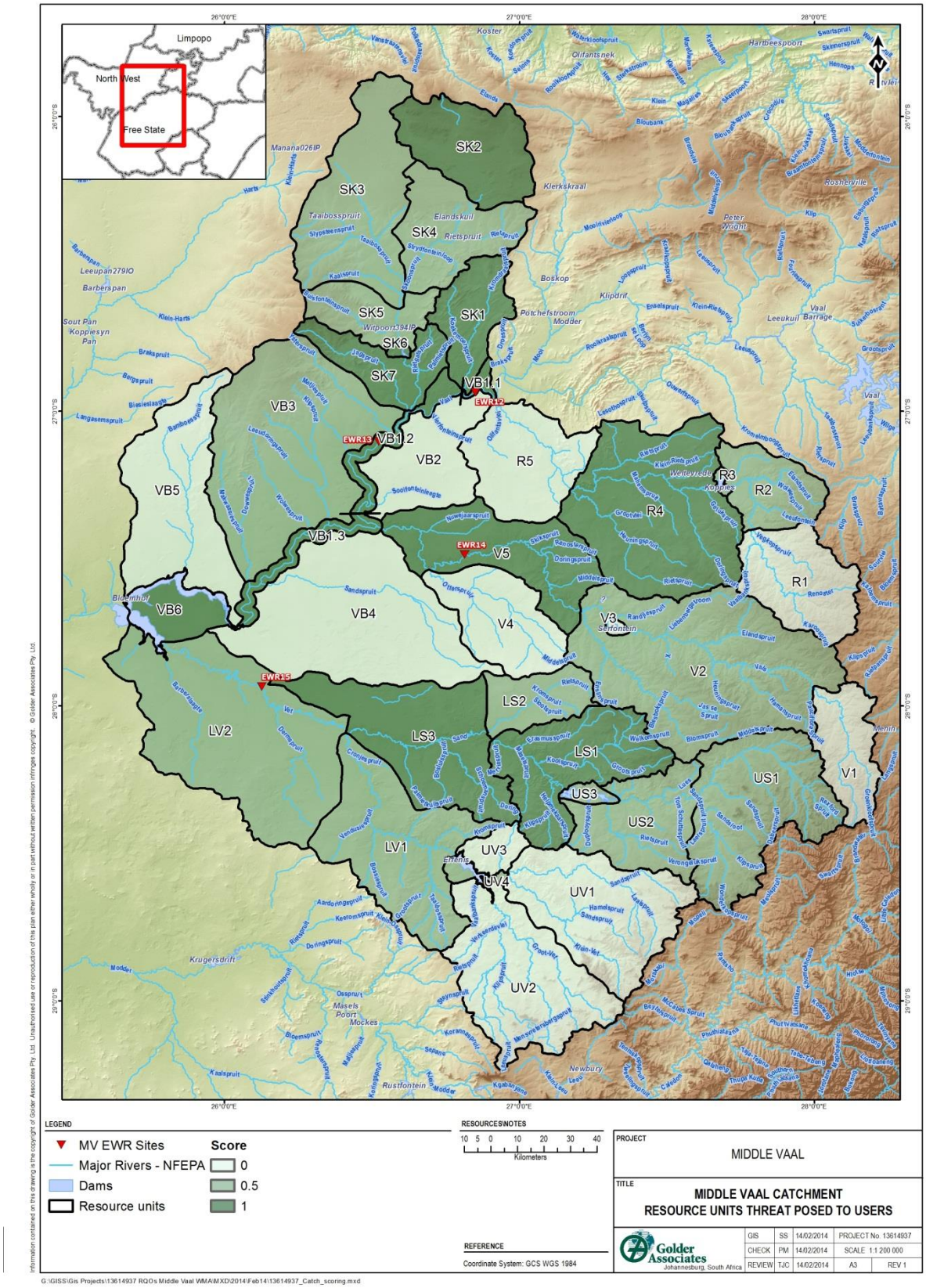

Figure A-28: Middle Vaal Catchment Resource Units Threat Posed to Users

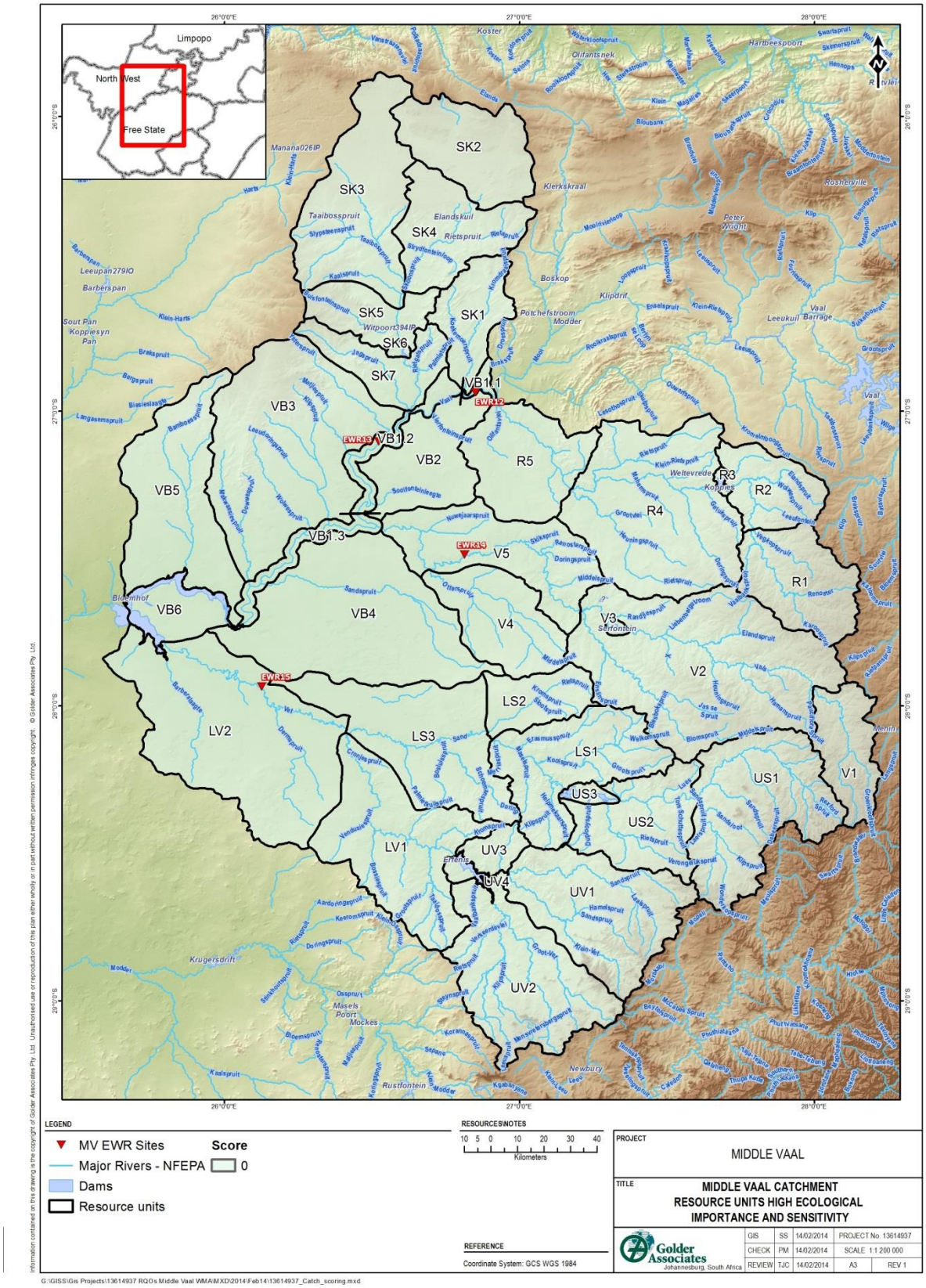

Figure A-29: Middle Vaal Catchment Resource Units High Ecological Importance and Sensivity

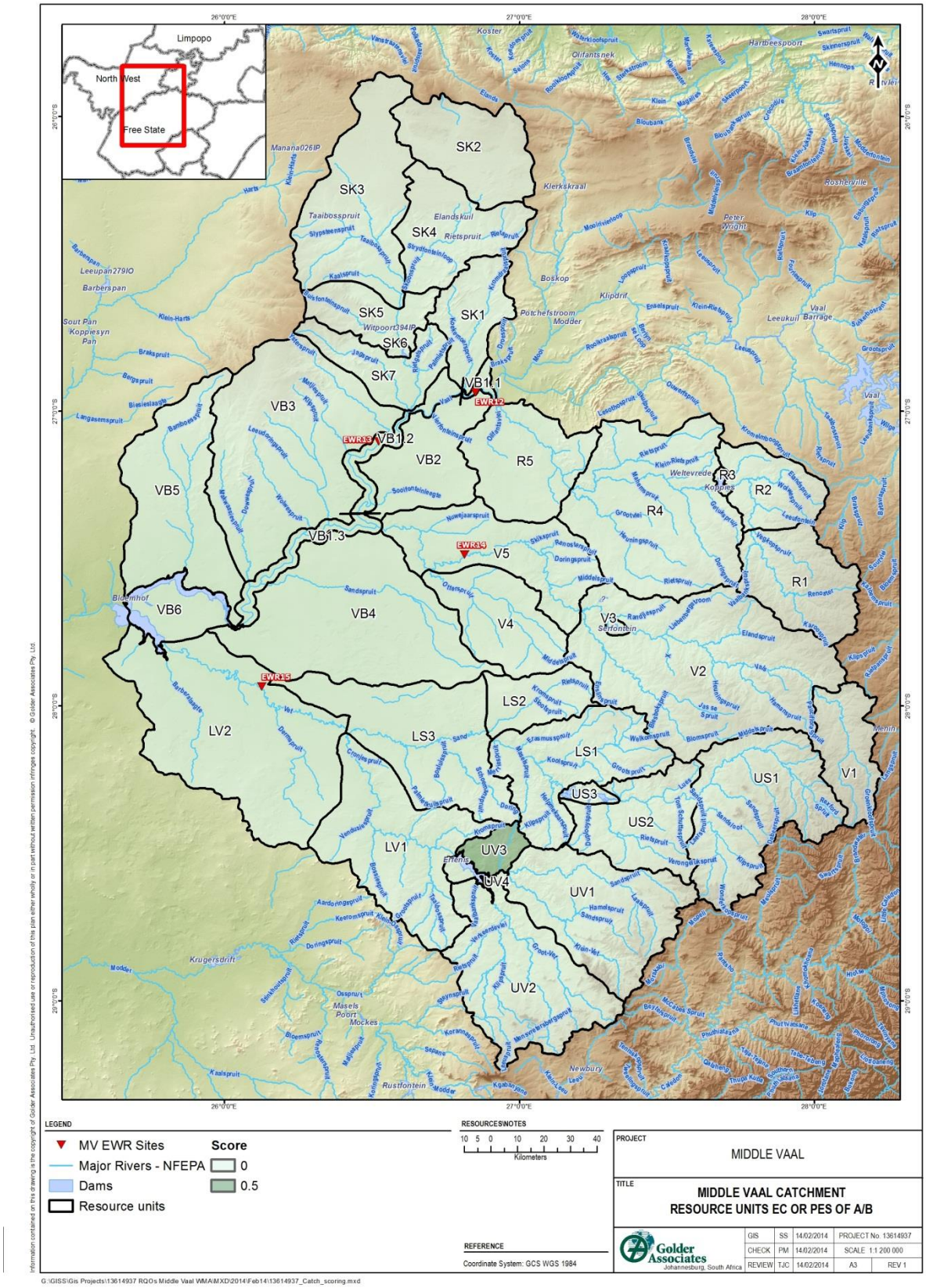

Figure A-30: Middle Vaal Catchment Resource Units EC or PES of A/B

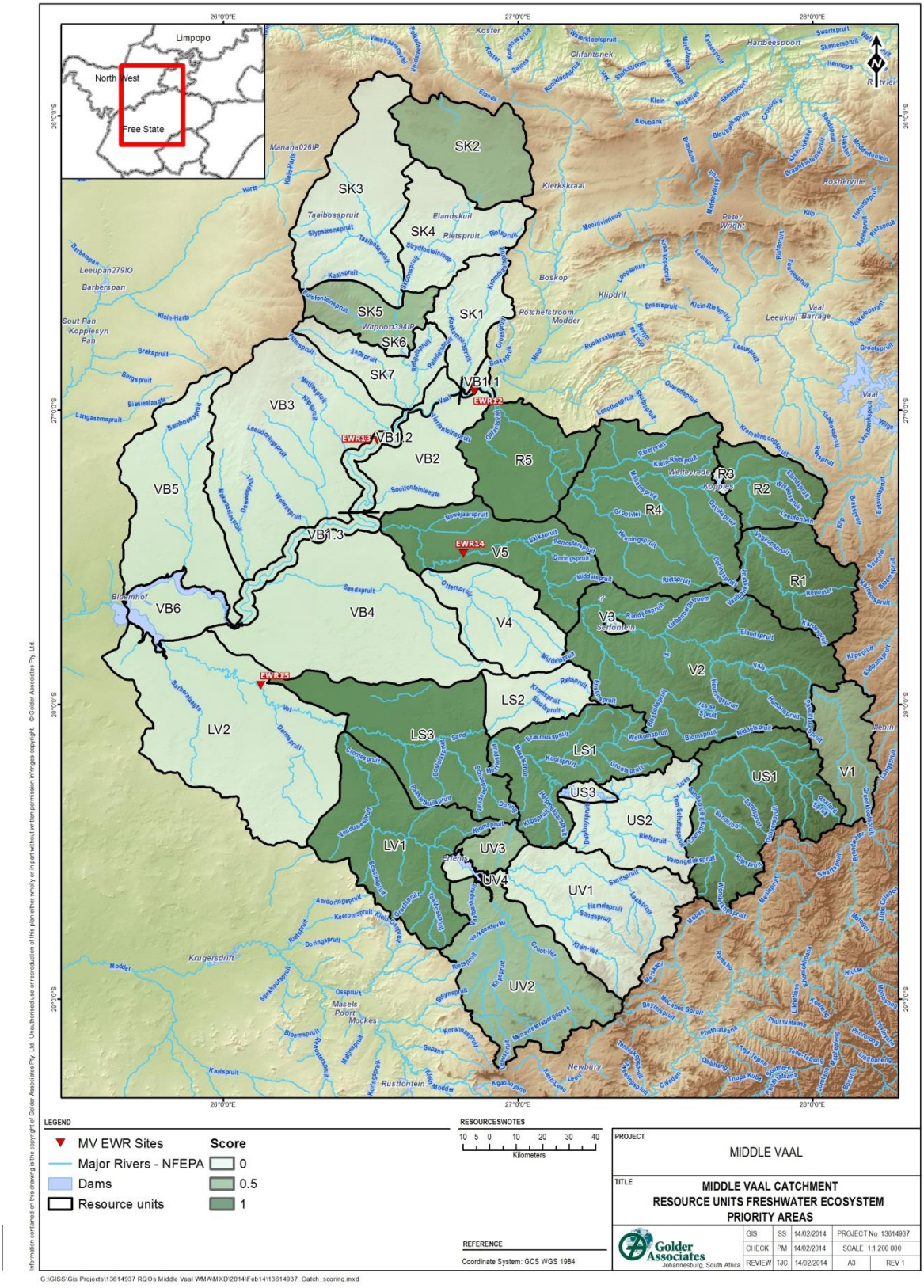

Figure A-31: Middle Vaal Catchment Resource Units Freshwater Ecosystem Priority Areas

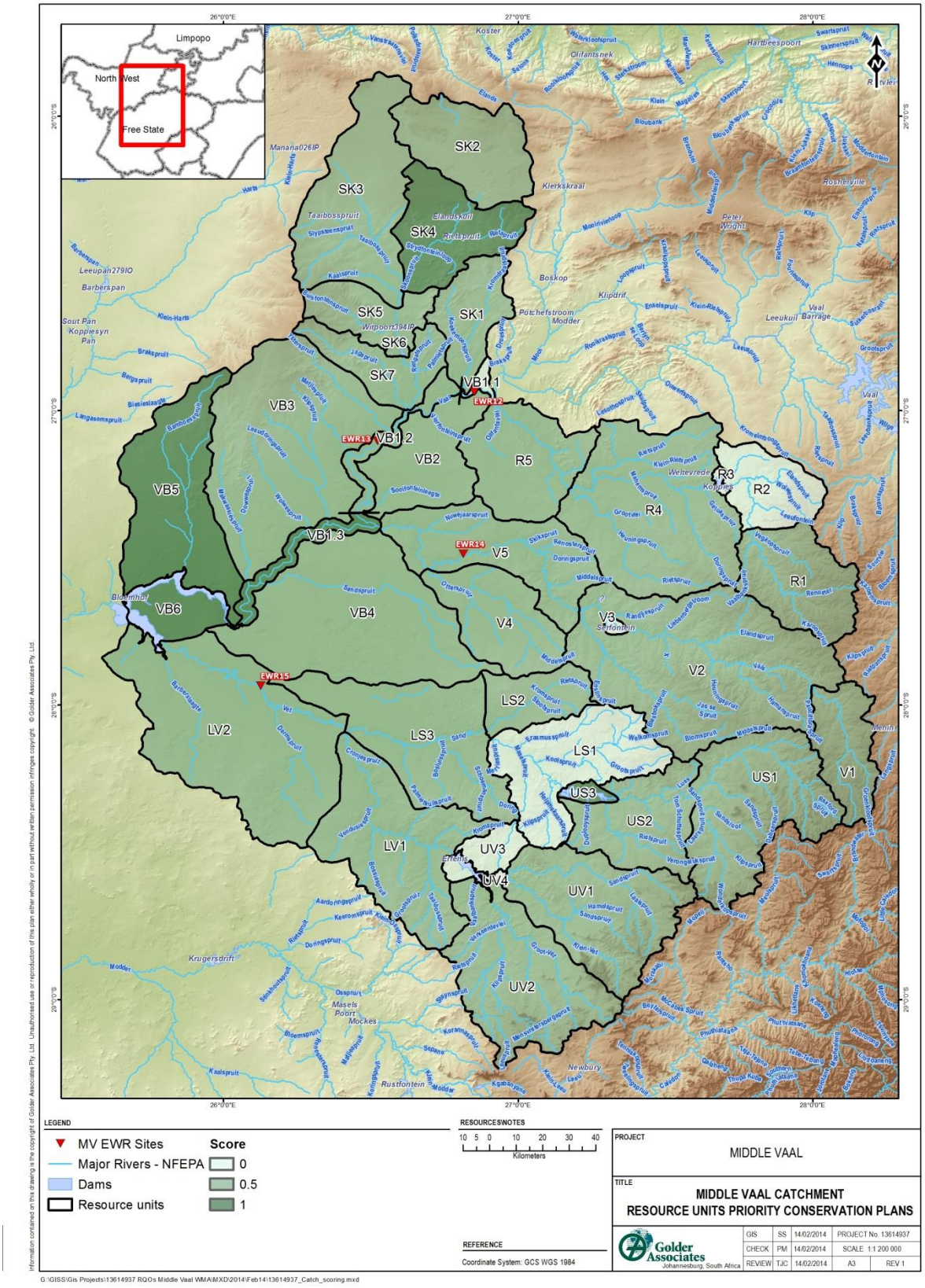

Figure A-32: Middle Vaal Catchment Resource Units Priority Conservation Plans

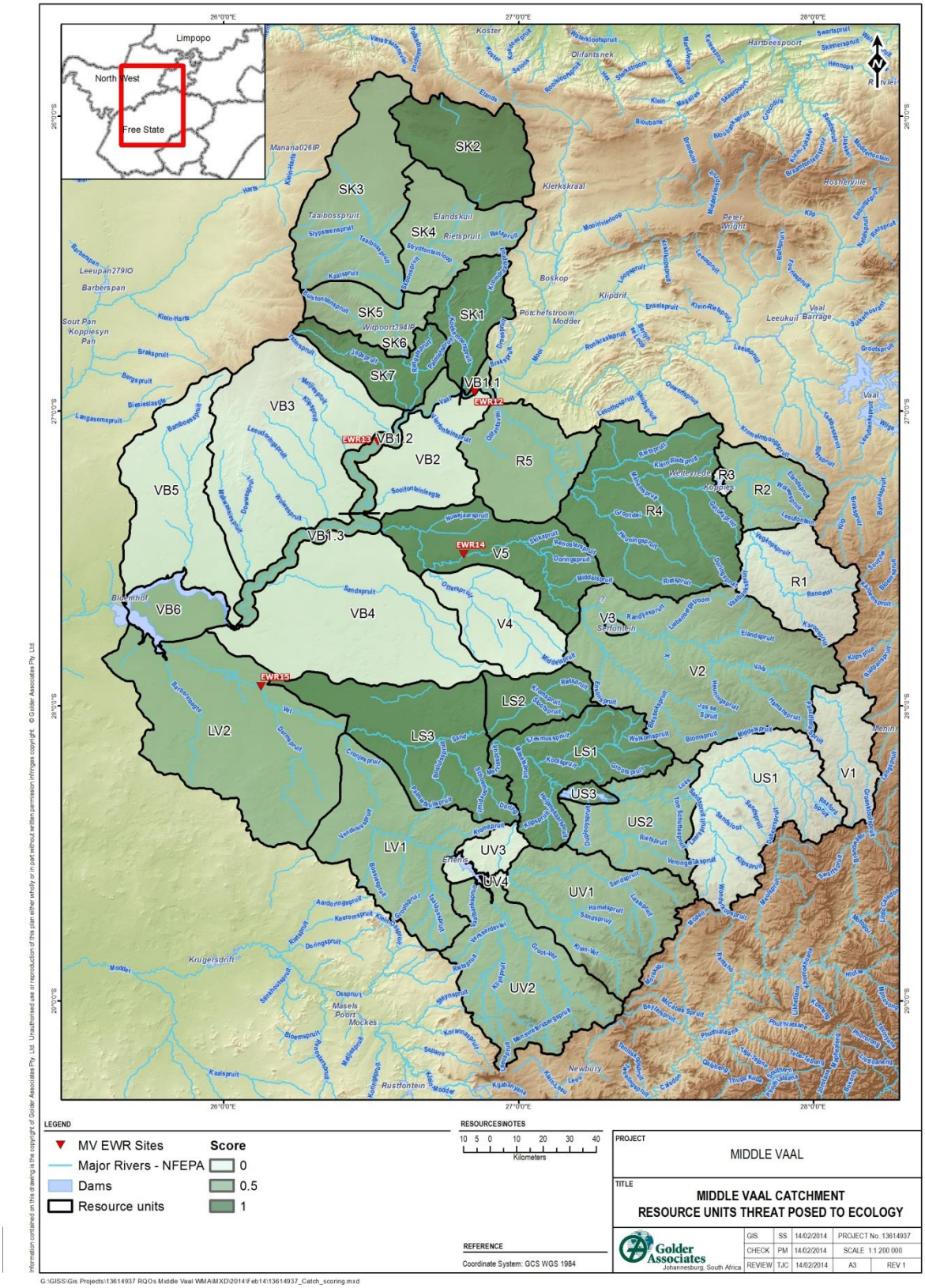

Figure A-33: Vaal Catchment Resource Units Threat Posed to Ecology

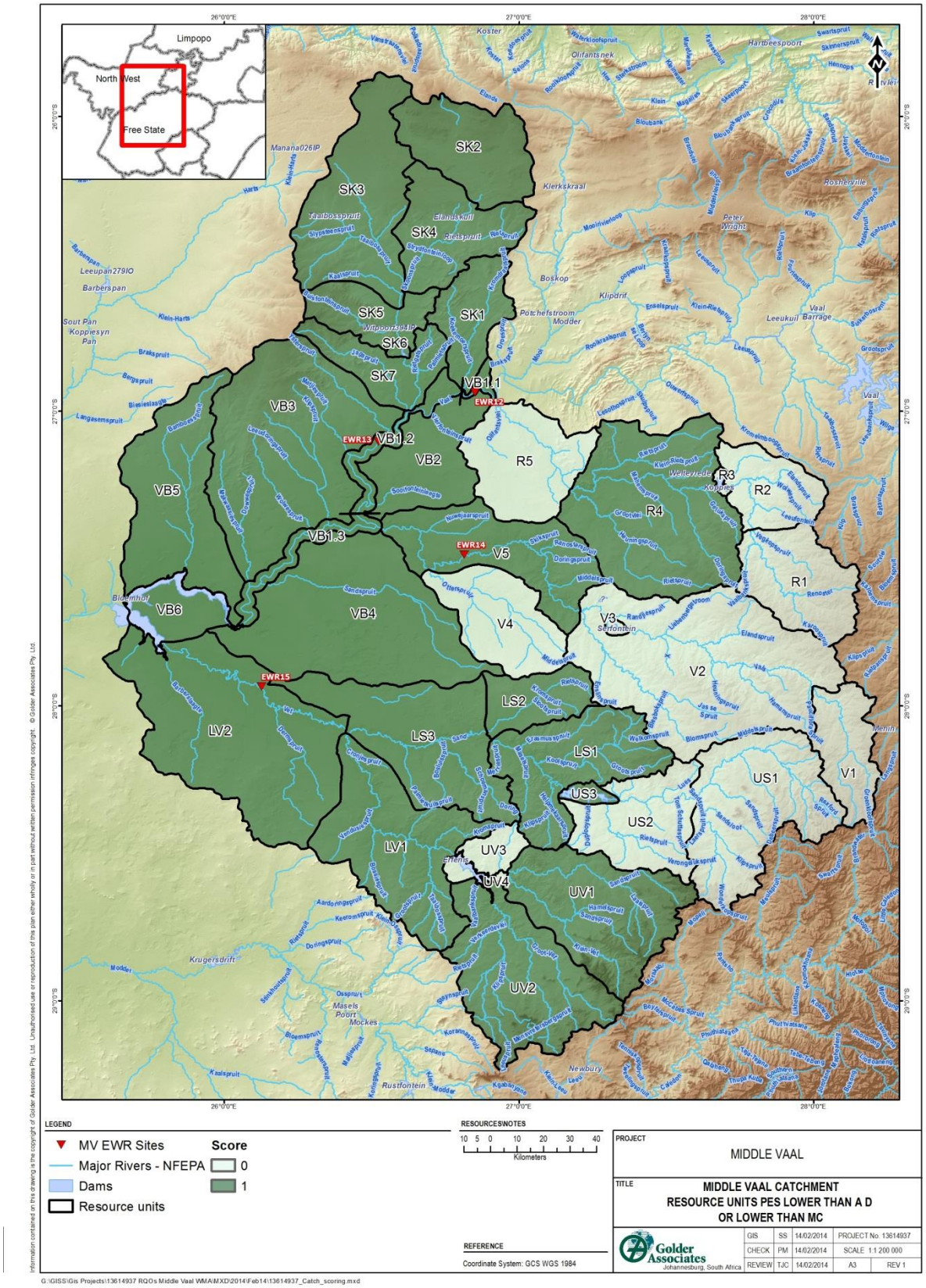

Figure A-34: Vaal Catchment Resource Units PES lower than a D EC or lower than the MC

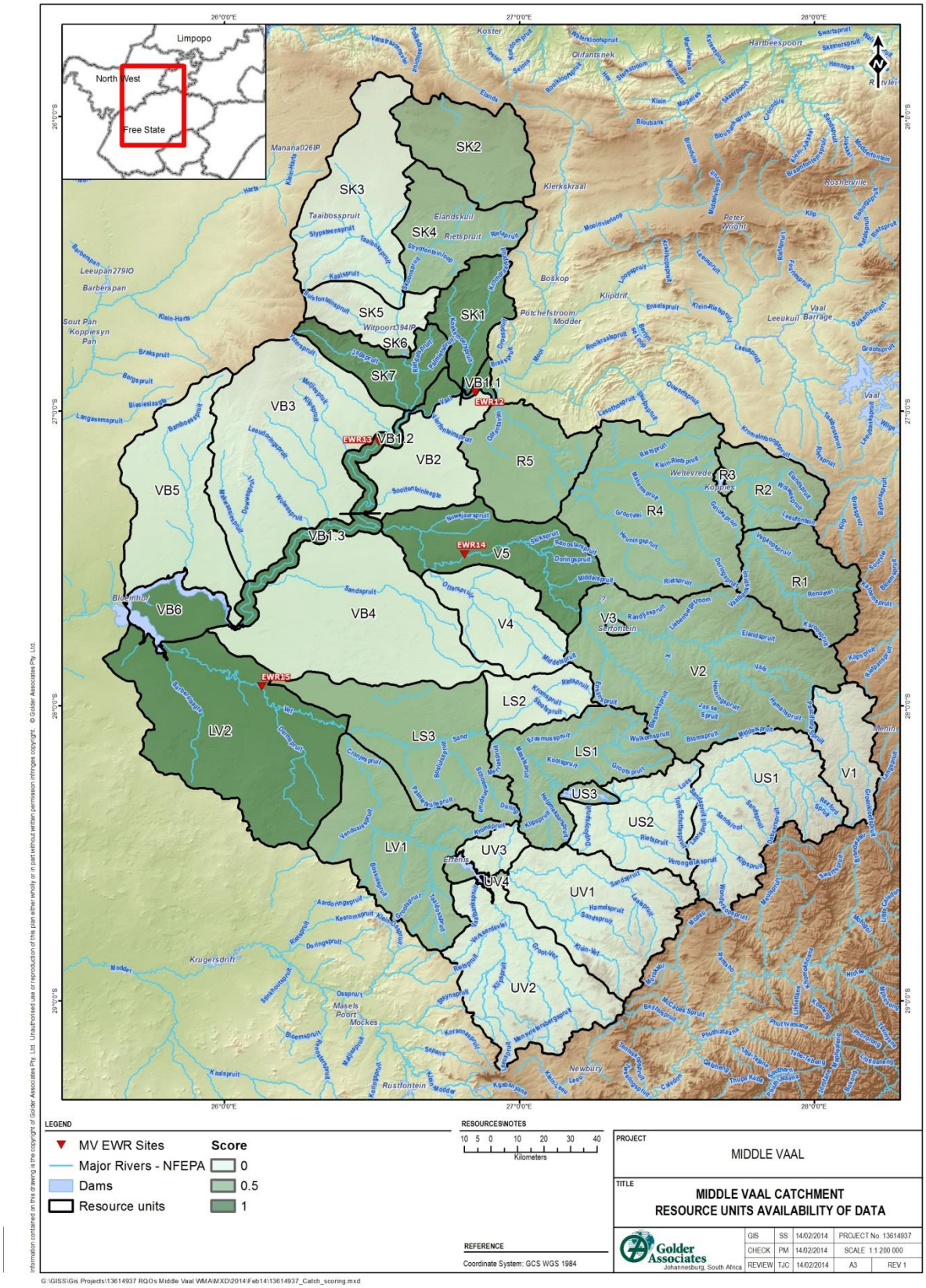

Figure A-35: Vaal Catchment Resource Units Availability of Data

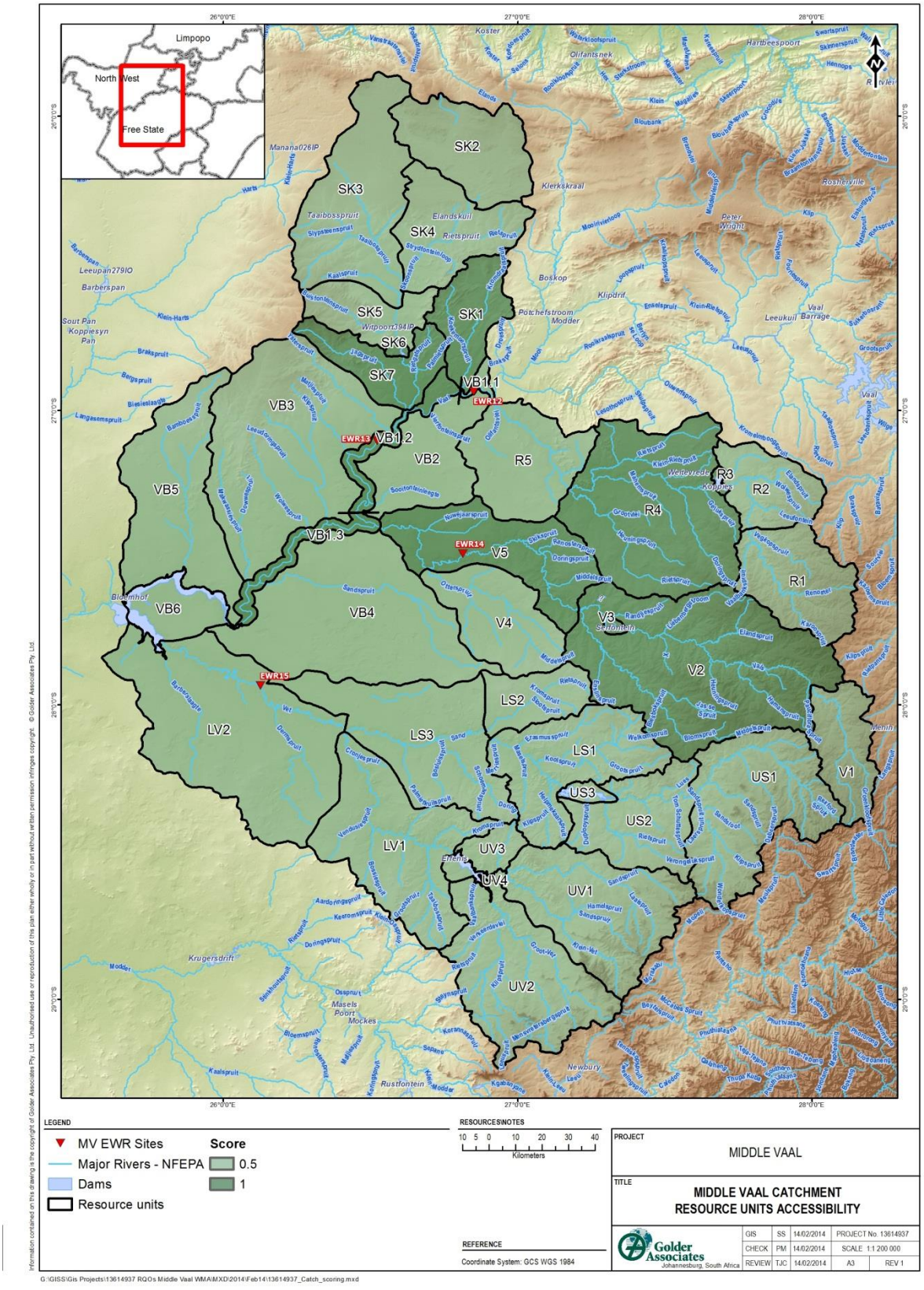

Figure A-36: Vaal Catchment Resource Units Accessibility

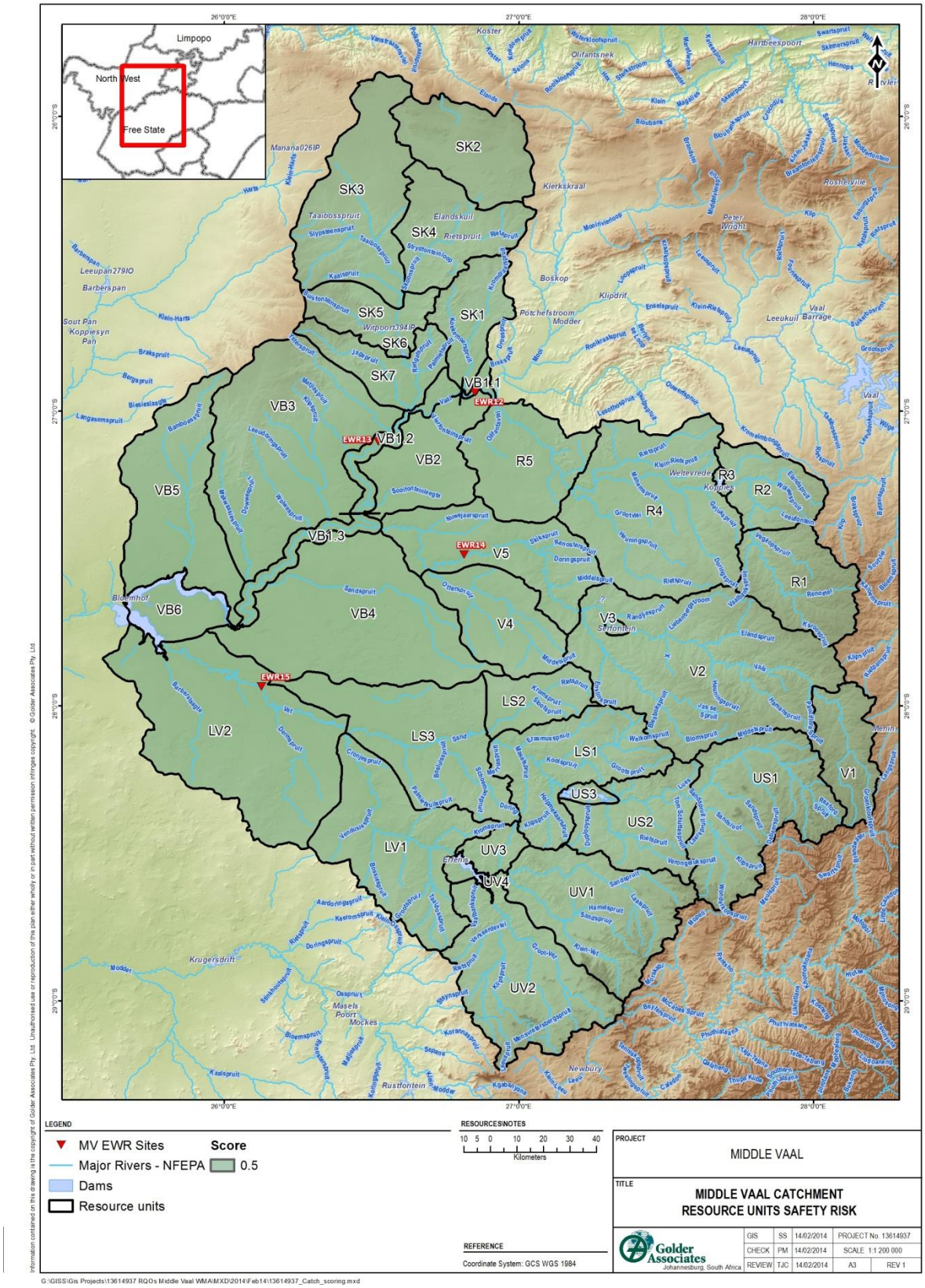

Figure A-37: Vaal Catchment Resource Units Safety Risk

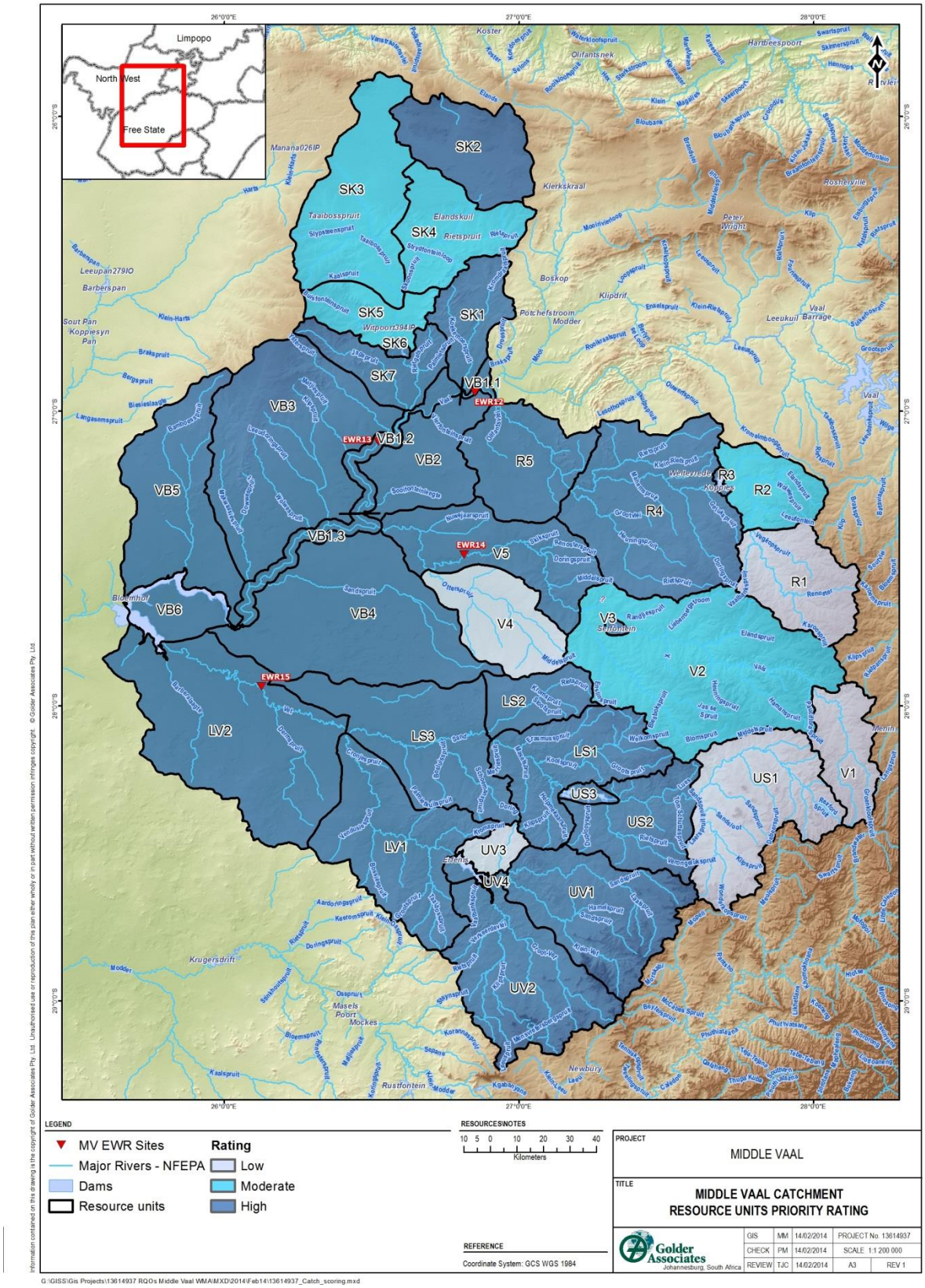

Figure A-38: Vaal Catchment Resource Units Priority Rating

IUA MA: RENOSTER RIVER		R 1	R 2	R3 (Kopiies Dam)	R 4	R 5
PRIORITIZATION SCORES	Position in IUA	0.00	0.00	0.25	0.00	0.25
	Concern for users	0.00	0.08	0.11	0.18	0.01
	Concern for environment	0.03	0.10	0.00	0.16	0.10
	Management and practical considerations	0.06	0.06	0.09	0.22	0.06
	Total Prioritization Score	0.10	0.24	0.46	0.56	0.42
	Priority Rating	0.2	0.4	0.8	1.0	0.7
Select Resource Unit for RQO determination?			✓	✓	✓	✓
Rationale for selection of resource units		Maintain current status	SW present (Heilbron), licencing issues	Operation of the dam and supporting activities, recreation, fishing, cultural.	FEPA, high activity mining and irrigation. Koppies town, wetland priority area.	Lower most RU within the IUA
PRIORITY RUs			4	2	1	3

1	R 4	Downstream Koppies Dam to confluence with the Heuningspruit	C70E, C70D, C70F, C70G, C70H
2	R 3	Koppies Dam	C70C
3	R 5	Downstream Heuningspruit confluence to confluence with the Vaal River	C70J, C70K
4	R 2	Downstream Vaalbankspruit and Vegkopspruit tributary confluences to Koppies Dam	C70C

IUA MB: VALS RIVER		V1	V2	V3 (Serfontein Dam)	V4	V5
PRIORITIZATION SCORES	Position in IUA	0.00	0.00	0.25	0.00	0.25
	Concern for users	0.02	0.11	0.04	0.04	0.17
	Concern for environment	0.02	0.10	0.06	0.00	0.16
	Management and practical considerations	0.04	0.09	0.09	0.04	0.24
	Total Prioritization Score	0.07	0.29	0.44	0.08	0.82
	Priority Rating	0.1	0.4	0.5	0.1	1.0
Select Resource Unit for RQO determination?			✓	✓	✓	✓
Rationale for selection of resource units			Includes impacts from land based activities that pose a threat	Operation of the dam, supporting activities	Wetland priority area/Ottospruit	Lowest RU, most impacted
PRIORITY RUs			4	2	3	1

1	V5	From the Kroonval weir to the Vaal River confluence	C60G, C60J
2	V3	Serfontein Dam	C60D
3	V4	Middelspruit Tributary catchment	C60H
4	V2	Downstream Pauciflora Spruit confluence to Kroonstad	C60B, C60C, C60D, C60E, C60F

IUA MC: SCHOONSPRUIT/KOEKEMOERSPRUIT		SK1	SK2	SK3	SK4	SK5	SK6 (Johan Nesser Dam)	SK7
PRIORITIZATION SCORES	Position in IUA	0.25	0.00	0.00	0.00	0.00	0.00	0.25
	Concern for users	0.17	0.15	0.09	0.09	0.08	0.16	0.16
	Concern for environment	0.13	0.14	0.06	0.06	0.08	0.06	0.13
	Management and practical considerations	0.24	0.19	0.16	0.19	0.16	0.22	0.24
	Total Prioritization Score	0.78	0.48	0.31	0.34	0.32	0.44	0.78
	Priority Rating	1.0	0.6	0.4	0.4	0.4	0.6	1.0
Select Resource Unit for RQO determination?		✓	✓	✓	✓	✓	✓	✓
Rationale for selection of resource units		Tributary of Vaal, highly impacted, requires management.	The Schoonspruit eye to be protected/dolomatic aquifers-groondwater priority area	Groundwater and wetland priority areas	Irrigation impacts	Irrigation impacts	Operation of the dam.	Lowest RU in the IUA, highly impacted
PRIORITY RUs		1	2	3	3	3	2	1

1	SK1	From origin of Koekemoerspruit to confluence with Vaal River	C24A, C24B
1	SK7	From Klerkskraal Dam to confluence with the Vaal River	C24H
2	SK2	Schoonspruit eye	C24C
2	SK6	Klerkskraal Dam	C24G
3	SK3	Taaibospruit tributary catchment	C24F
3	SK4	From Schoonspruit eye to Kaalspruit confluence	C24D, C24E
3	SK5	Kaalspruit and Bulsfonteinspruit tributary catchment	C24G

IUA MD1: UPPER SAND RIVER		US 1	US 2	US 3 (Allemanskraal Dam)
PRIORITIZATION SCORES	Position in IUA	0.00	0.25	0.25
	Concern for users	0.08	0.08	0.11
	Concern for environment	0.03	0.06	0.13
	Management and practical considerations	0.04	0.04	0.19
	Total Prioritization Score	0.15	0.43	0.68
	Priority Rating	0.2	0.6	1.0
Select Resource Unit for RQO determination?			✓	✓
Rationale for selection of resource units		Maintain current status	Impacts from Senekal town to be managed	The dam to be managed
PRIORITY RUs			2	1

1	US3	Allemanskraal Dam	C42E
2	US2	Downstream Klipspruit confluence to Allemanskraal Dam	C42D, C42E

IUA MD2: LOWER SAND RIVER		LS 1	LS 2	LS 3
PRIORITIZATION SCORES	Position in IUA	0.00	0.00	0.25
	Concern for users	0.18	0.11	0.20
	Concern for environment	0.16	0.13	0.16
	Management and practical considerations	0.19	0.16	0.19
	Total Prioritization Score	0.52	0.40	0.79
	Priority Rating	0.7	0.5	1.0
Select Resource Unit for RQO determination?		✓	✓	✓
Rationale for selection of resource units		Abstraction for irrigation	Mines, Activities in Virginia town to be managed	Wetland priority area, upstream impacts to be managed
PRIORITY RUs		2	3	1

1	LS3	Downstream Rietspruit confluence to confluence with the Vet River	C42K, C42L, C43B
2	LS1	Allemanskraal Dam to Merriespruit confluence	C42F, C42G, C42H,
3	LS2	Rietspruit tributary catchment	C42J

IUA ME1: UPPER VET RIVER		UV1	UV2	UV3	UV4 (Erfenis Dam)
PRIORITIZATION SCORES	Position in IUA	0.00	0.00	0.00	0.25
	Concern for users	0.02	0.04	0.02	0.10
	Concern for environment	0.06	0.08	0.03	0.00
	Management and practical considerations	0.16	0.16	0.04	0.06
	Total Prioritization Score	0.25	0.28	0.09	0.41
	Priority Rating	0.6	0.7	0.2	1.0
	Select Resource Unit for RQO determination?	✓	✓	✓	✓
	Rationale for selection of resource units	Town impacts to be managed	Agricultural activities	Protect the FEPA	The dam to be managed
PRIORITY RUs		3	2	4	1

1	UV4	Erfenis Dam	C41E
2	UV2	Origin of Vet River and Leeuspruit tributary catchment to Erfenis Dam	C41C, C41D
3	UV1	Klein Vet and Laaispruit tributary catchments	C41A, C41B
4	UV3	Soutspruit tributary catchment	C41E

IUA ME2: LOWER VET RIVER		LV1	LV2
PRIORITIZATION SCORES	Position in IUA	0.00	0.25
	Concern for users	0.10	0.12
	Concern for environment	0.10	0.06
	Management and practical considerations	0.19	0.21
	Total Prioritization Score	0.38	0.64
	Priority Rating	0.6	1.0
	Select Resource Unit for RQO determination?	✓	✓
	Rationale for selection of resource units	Agricultural and flow impacts	Agricultural impacts and influence from the Sand river, EWR site to be
PRIORITY RUs		2	1

1	LV2	Downstream Sand River confluence to Bloemhof Dam	C43A, C43C, C43D
2	LV1	Erfernis Dam to confluence with Sand River	C41F, C41G, C41H, C41J

IUA MF: MIDDLE VAAL RIVER		VB1.1, 1.2, 1.3 (Vaal Main stem)	VB2	VB3	VB4	VB5	VB6 (Bloemhof Dam)
PRIORITIZATION SCORES	Position in IUA	0.25	0.25	0.25	0.25	0.25	0.25
	Concern for users	0.22	0.02	0.10	0.05	0.05	0.22
	Concern for environment	0.13	0.00	0.00	0.00	0.00	0.06
	Management and practical considerations	0.21	0.16	0.16	0.16	0.16	0.21
	Total Prioritization Score	0.80	0.43	0.51	0.46	0.46	0.74
	Priority Rating	1.0	0.5	0.6	0.6	0.6	0.9
Select Resource Unit for RQO determination?		✓	✓	✓	✓	✓	✓
Rationale for selection of resource units		The Vaal main stem is important/priority water resource (WMA).	Water quality impacts on Vaal River	Some land use impacts	Wetland/pans priority area	Wetlans (Pans) priority area	Operation of the system, water quality
PRIORITY RUs		1	5	4	3	3	2

1	VB1	Vaal River main stem from start of WMA at Vermaasdrift to Bloemhof Dam	C24B, C24J, C25C, C25F
2	VB6	Bloemhof Dam	C25E, C25F, C43D
3	VB4	Sandspruit tributary catchment	C25C, C25B, C25F, C43B
3	VB5	Bamboespruit tributary catchment	C25E
4	VB3	Ysterspruit, Matjiespruit, Klipspruit, Wolwespruit and Makwassiespruit tributary catchments	C24J, C25A, C25C, C25D
5	VB2	Vierfonteinspruit (South of the Vaal River)	C24B, C24J

Indication of whether the FEPAs are present within the Prioritised RUs in Middle Vaal WMA

FEPA ID	FEPA TYPE	Quaternary Catchment(s)	IUA	Prioritised RU
1661	Phase 2: River Ecosystem	C24G	Schoonspruit (MC)	Yes - SK3
2023, 2024, 2039, 2061, 2088	River Ecosystem, Wetland Ecosystem	C70E, C70J	Renoster (MA)	Yes – R4, R5
2208, 2238, 2293	Wetland Ecosystem, wetland clusters, River Ecosystem	C70G, C70H	Renoster (MA)	Yes – R4
2183, 2233, 2241	Wetland Ecosystem, River Ecosystem, Fish species (Barbus anoplus)	C70C	Renoster (MA)	Yes – R2
2323, 2324, 2393	Wetland Ecosystem, River Ecosystem, Wetland clusters, Fish species (Barbus, anoplus)	C70A, C70B	Renoster (MA)	Yes – R1
2607, 2782, 2805	Wetland clusters, Fish species (Barbus, anoplus), wetland ecosystem	C60A	Vals (MB)	*No*
2507, 2564, 2471	River Ecosystem	C60C, C60D	Vals (MB)	Yes – V2
2262, 2280, 2286, 2318	River Ecosystem, Wetland Ecosystem	C60G, C60J	Vals (MB)	Yes – V5
2724, 2756	River Ecosystem	C42F	Lower Sand (MD2)	Yes – LS1
2628, 2659, 2741	River Ecosystem, Wetland Ecosystem	C42H, C42J	Lower Sand (MD2)	Yes – LS1, LS2
3107	River Ecosystem	C42C	Upper Sand (MD1)	*No*
2802, 2881, 2857, 2947, 2956, 2989	River Ecosystem, Wetland Ecosystem	C42G, C42K	Lower Sand (MD2)	Yes – LS3, LS1
3227, 3295	River Ecosystem	C41B	Upper Vet (ME1)	Yes – UV1

FEPA ID	FEPA TYPE	Quaternary Catchment(s)	IUA	Prioritised RU
3793, 3799	River Ecosystem	C41C	Upper Vet (ME1)	Yes – UV2
3299	River Ecosystem, Wetland Ecosystem	C41D	Upper Vet (ME1)	Yes – UV2
3184	River Ecosystem	C41D	Upper Vet (ME1)	Yes – UV2
2989	River Ecosystem, Wetland Ecosystem	C41E	Upper Vet (ME1)	Yes – UV3
3237, 3243, 3198, 3190, 3078	River Ecosystem, Wetland Ecosystem	C41F	Lower Vet (ME2)	Yes – LV1
2948	River Ecosystem	C41H	Lower Vet (ME2)	Yes – LV1