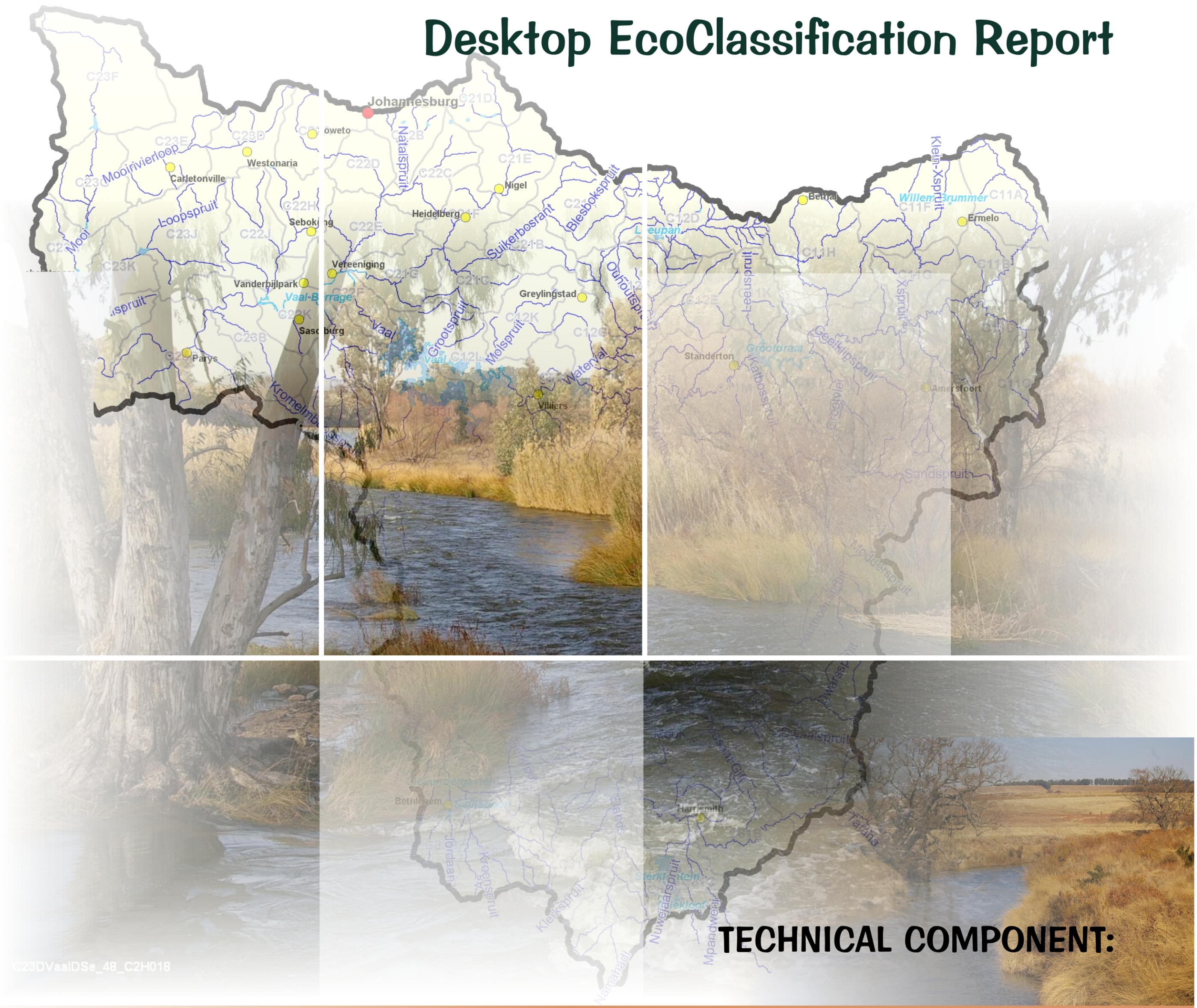
COMPREHENSIVE RESERVE DETERMINATION
INTEGRATED VAAL RIVER SYSTEM
SURFACE WATER

Desktop EcoClassification Report



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COMPREHENSIVE RESERVE DETERMINATION STUDY OF THE INTEGRATED VAAL RIVER SYSTEM

UPPER VAAL WATER MANAGEMENT AREA
TECHNICAL COMPONENT: DESKTOP ECOCLASSIFICATION REPORT

Report number:RDM/WMA8C000/01/CON/0207

DECEMBER 2008

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1.2	**RDM/WMA8C000/01/CON/0207**	**Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: Desktop EcoClassification Report**
1.3	RDM/WMA8C000/01/CON/0610	Resource Directed Measures: Comprehensive Reserve determination study of the Integrated Vaal River System. Upper Vaal Water Management Area Technical Component: Basic Human Needs Reserve. Included in the Main Report.
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Bold indicates this report

APPROVAL

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- Mr Greg Huggins (Water for Africa);
- Dr PieterKotze(Clean Stream Biological Services).

The specialists from DWAF: RQS involved in this study were:

- Dr CJ Kleynhans
- Ms Christa Thirion

Input on water resource stress was provided by Mr Pieter van Rooyen and Ms Susan Swart from Water Resource Planning (WRP).
Input on water quality was provided by Dr Ralph Heath from Golder and Associates

Comments on the report were provided by:

- Retha Stassen

EXECUTIVE SUMMARY

BACKGROUND

The CD: RDM identified the Integrated Vaal River System, with the focus of this study, the Upper Vaal Water Management Area (WMA) as requiring a comprehensive Reserve assessment as to provide input to the Reconciliation studies and the integrated water quality management plan for the Vaal River undertaken by the National Water Resources Planning Directorate (D: NWRP) of the DWAF. These studies require higher levels of confidence in the Reserve determination results as is currently available. This will assist the DWAF to make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of the present and proposed developments.

A Desktop EcoClassification will serve as a scoping phase to investigate the WMA at a desktop level and at the scale of quaternary catchments and serves as the basis for most other tasks in the Reserve determination process. This scoping assessment provides an overview of the WMA and a better understanding when focussing on the EWR sites and the sections of rivers where comprehensive assessments will be undertaken. The output of the information also identifies areas of potential concern based on an integrated importance (combination of Ecological Importance and Sensitivity, Socio-Cultural Importance and Present Ecological State).

APPROACH

The objective of the EWR study is to provide information at two levels of detail, i.e. at scoping or desktop level, as well as a more detailed assessment. This report presents the results of the Desktop assessment of the EcoClassification process for each quaternary catchment. The term used for Ecological Classification "EcoClassification" (Kleynhansand Louw, 2007) refers to the determination and categorisation of the Present Ecological State (PES) - or health or integrity - of various biophysical attributes of rivers, compared with the natural or close to natural reference condition. The purpose of EcoClassification is to gain insight into the causes and sources of the deviation of the PES from the reference condition. This provides the information needed to derive the desirable and attainable future ecological objectives for the river. The present state of the river is described in terms of Ecological Categories (A to F).

The EcoClassification process also includes an assessment of Ecological Importance and Sensitivity (EIS), and Socio-Cultural Importance (SCI). These are described in terms of Low to Very High (EIS) and Minimal to Very High (SCI). All assessments include a confidence rating that may range from 1 (low confidence) to 5 (high confidence).

ECOLOGICAL IMPORTANCE AND SENSITIVITY

The ecological importance of a river is an expression of its contribution to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh*et al*., 1988; Milner, 1994).

Standard EIS models are used, irrespective of the level of assessment. The data which is used to populate the models vary, dependant on the level.

No areas of Very High EIS are present in the WMA. The few areas of high EIS are the following:

- C13C (Klip River): Due to the presence of a RAMSAR site, the Seekoeivlei.
- C21C (Suikerbosrand): Due to species taxon richness and the presence of rare and endangered *Labeobarbuskimberleyensis.*
- C23C and C23L (Vaal River near and downstream of Parys): The river is situated in a World Heritage site and the rare and endangered *Labeobarbuskimberleyensis* is present.
- C83E (Tierkloof): Most of the metrics rates high with specific emphasis on the diversity of habitat types and the species diversity and sensitivity.

Most of the rest of the quaternary catchments were rated as moderate. The confidence of the evaluation ranged mostly from moderate to high with approximately 30% as low.

SOCIO-CULTURAL IMPORTANCE

The SCI was determined from:

- A site visit that covered points along the river; and
- extrapolation to sites not visited by reference to available literature, as well as to existing mapping.

The SCI was generated by scoring each quaternary, based on the following features:

- Ritual Use (e.g., ceremonial purposes, spiritual/religious activities.).
- Aesthetic Value.
- Resource Dependence (it refers to the goods and services delivered by the river system and peoples dependence on these components).
- Recreational Use.
- Historical/Cultural Value (e.g., Fugitives Drift on the Buffalo or components of the Mzimvubu that have played a central role in Xhosa cultural history).

Scores were then weighted to reflect the adjudged importance of each component relative to the other. The Resource Dependence component was given the highest weighting, because this component is designed to reflect the importance of a healthy riverine system to people who are often in the grips of poverty, and for whom the availability of such resources is a question of survival.

Areas dominated by relatively low population densities and given over to commercial farming enterprises (typically the upper parts of the catchment) as well as portions of the middle catchment tended to score relatively low in terms of SCI. An obvious exception is recreational use. Portions of the WMA with water related recreational activity scored slightly higher. Areas dominated by mining and industrialisation also scored generally low in terms of SCI. It should be emphasised that low SCI score does not indicate low economic importance. In terms of economic importance the catchment is obviously critical to the RSA.

PRESENT ECOLOGICAL STATE

The PES of the river is expressed in terms of various components, i.e., **drivers** (Physico-chemical variables, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic invertebrates), as well as an integrated state, the EcoStatus.

A Desktop Level EcoStatus assessment was designed for use when assessments for planning purposes on large scale have to be undertaken. As the name indicates, this is done at desktop level, and is therefore based on available information and expert judgement. However, due to the lack of relevant information in some of the areas, a site visit was undertaken during this study to provide additional information.

The bulk of the rivers in WMA 8 are in a C, C/D and D category. Please note that this does not include all the smaller tributaries but only refer to the main rivers in the quaternaries. The rivers in a B category are the following:

- C11C: Klein Vaal
- C13E: Kommandospruit
- C81L & C81M: Meul
- C82A: Cornelis
- C83K: Kromspruit
- C83L: Klipspruit

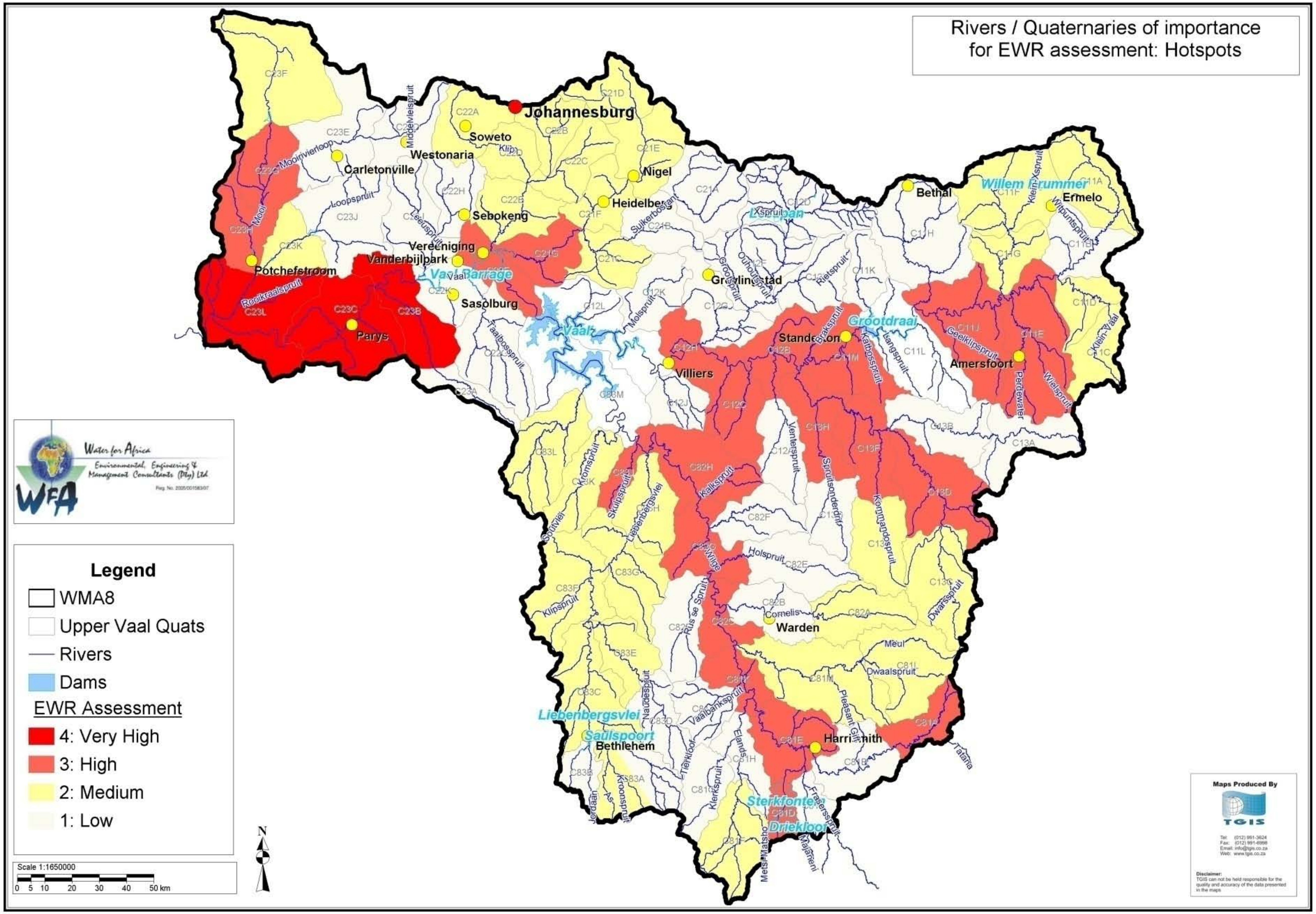
This means that there are very few rivers in this large WMA which are potentially still in a good condition. The reason for this is the high utilisation of the catchment due to mining, irrigation and the urban sprawl of Gauteng. Water quality issues are prevalent in many streams as well as increased flows, i.e. more than natural.

WATER RESOURCE USE RATING

The priority rating method consists of assigning a qualitative score to a river reach for four variables or factors that represent the status of the instream flow. The scores of the four variables are combined to determine (qualitatively) an overall score which represents the importance of the river reach in terms of the water resource use and guides decision making with regard to what level of assessment is needed (DWAF, 2007). These ratings are an indication of possible impacts in the area that can affect the PES. They are not applied in the actual models and do not contribute quantitatively to the PES, EIS or SCI.

RECOMMENDATIONS

An evaluation has been undertaken comparing areas of Integrated Importance which consists of Ecological, Socio-Cultural and Present Ecological State, with an importance evaluation of Water Resource Use. All quaternary catchments with either a high (3) or very high (4) rating were identified and are illustrated in the map below. These quaternary catchments would require EWR of reasonably high confidence and detailed studies are therefore recommended. This information will play an important role in identifying the areas where EWR sites are to be selected.


Rivers / Quaternaries of importance
for EWR assessment: Hotspots
Legend
WMA8
Upper Vaal Quats
Rivers
Dams
EWR Assessment
4: Very High
3: High
2: Medium
1: Low
Scale 1:1650000
0 5 10 20 30 40 50 km
N
Water for Africa
Environmental, Engineering & Management Consultants (Pty) Ltd
Maps Produced By
TGIS
Johannesburg
Soweto
Westonaria
Carletonville
Nigel
Heidelberg
Sebokeng
Vereeniging
Vanderbijlpark
Vaal Barrage
Potchefstroom
Sasolburg
Parys
Grootdraai
Standerton
Villiers
Amersfoort
Bethal
Ermelo
Willem Brummer
Warden
Liebenbergsvlei
Saulspoort
Bethlehem
Harrismith
Sterkfontein
Driekloof

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ACRONYMS

CD: RDM	Chief Directorate: Resource Directed Measures
D:NWRP	Directorate: National Water Resource Planning
D:RQS	Directorate: Resource Quality Services
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
GDP	Gross Domestic Product
GGP	Gross Geographic Product
IHI	Index of Habitat Integrity
LHWP	Lesotho Highlands Water Project
LVA	Loxton Venn and Associates
NWA	National Water Act
PES	Present Ecological State
PSP	Professional Service Provider
QHI	Quick Habitat Integrity
REC	Recommended Ecological Category
RU	Resource Unit
SCI	Socio Cultural Importance
SSF	Sasol Synthetic Fuels
TDS	Total Dissolved Salts
TLC	Transitional Local Council
ToR	Terms of Reference
VRESAP	Vaal River Eastern Sub-system Augmentation Project
VRSAU	Vaal River System Analysis Update
WMA	Water Management Area

1 INTRODUCTION

1.1 BACKGROUND

The CD:RDM identified the Integrated Vaal River System, with the focus of this study, the Upper Vaal Water Management Area (WMA) as requiring a comprehensive Reserve assessment as to provide input to the Reconciliation studies and the integrated water quality management plan for the Vaal River studies undertaken by the National Water Resources Planning Directorate (D:NWRP) of the DWAF. These studies require higher levels of confidence in the Reserve determination results as is currently available. This will assist the DWAF to make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of the present and proposed developments.

The Desktop EcoClassificationserves as a scoping phase to investigate the WMA at a desktop level and at the scale of quaternary catchments and serves as the basis for most other tasks in the Reserve determination process. This scoping assessment provides an overview of the WMA and a better understanding when focussing on the (Ecological Water Requirement) EWR sites and the sections of rivers where comprehensive assessments will be undertaken. The output of the information also identifies areas of potential concern based on an integrated importance (combination of Ecological Importance and Sensitivity, Socio-Cultural Importance and PresentEcologicalState).

1.2 STUDY AREA

The study area for the Reserve determination is the Upper Vaal system as represented by WMA 8. WMA 8 is part of a larger water supply system, which includes adjacent WMAs, and Lesotho. The Upper Vaal WMA is one of three WMAs in the Vaal River catchment, which is the drainage area of the Vaal River from its headwaters to the confluence of the Vaal and Orange Rivers (DWAF, 2004).

The Upper Vaal WMA includes the Vaal, Klip, Wilge, Liebenbergsvlei and MooiRivers and extends to the confluence of the Mooi and VaalRivers. It covers a catchment area of 55 565 km^2. This WMA includes the very important Vaal, Grootdraai and Sterkfontein dams. The southern half of the WMA extends over the Free State; the north-east mainly falls within Mpumalanga and the northern and western parts in Gauteng and North West provinces respectively (DWAF, 2004).

1.3 OBJECTIVES OF THE UPPER VAAL RESERVE DETERMINATION STUDY

The overall aim of the project as described in the Terms of Reference (ToR) is to provide EcoClassification results and Reserves for WMA 8. The detailed aims, objectives and proposed outcomes of the study are as follows:

- Provide the typing, importance and habitat integrity for wetlands and make recommendations regarding Reserve assessments.
- Provide a Desktop assessment per quaternary catchment of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and Socio-cultural Importance (SCI) as part of the EcoClassification process.
- Provide a Level 4 EcoStatus assessment for the Resource Units (RUs) represented by comprehensive Ecological Water Requirements (EWRs) sites as part of the EcoClassification process.

- Identify other Ecological Categories (ECs) and provide implications / consequences of these categories.
- Determine EWRs for each of these ECs.
- Determine the impact of EWRs on the allocatable yield and, based on the impacts, devise additional scenarios to optimise the allocatable yield.
- Determine the ecological and resource-economic consequences of each of these additional scenarios.
- Provide the Ecological Specifications (EcoSpecs), as input to the Resource Quality Objectives (RQOs), associated with the Management Class provided to the Provisional Service Provider (PSP).
- Train selected specialist trainees in specific tasks relating to Reserve determinations.

1.4 PURPOSE OF THIS REPORT

This report provides the outcomes of the following study:
A Desktop assessment per quaternary catchment of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and Socio-cultural Importance (SCI) as part of the EcoClassification process.

The objective of this report is to summarise the approach, document the results on a quaternary basis and provide recommendations on the level of EWR assessment.

1.4.1 Desktop EcoClassification

The more detailed objectives and approach to the Desktop EcoClassification was:

- Determining the Present Ecological State (PES) of the system, applying a Quick Habitat Integrity (QHI), as well as considering the biota's responses within the EcoQuat model.
- Determining the Ecological Importance and Sensitivity (EIS): This assessment of the EIS uses indicators such as presence of rare and/or sensitive species and sensitive habitats to provide an evaluation.
- The Socio-Cultural Importance (SCI): This assessment of the importance of the river was undertaken in terms of sustainable utilisation of the ecological goods and services provided by the river, as well as assessing the cultural use and aesthetical values of the river.
- Incorporating the results of the water resource use ratings for the Upper Vaal river reaches, as compiled by WRP Consulting Engineers. The results are available in Appendix A of this report.

Evaluations are provided on a quaternary scale with the degree of confidence in the evaluations attached to each quaternary. Note that the main rivers in the quaternaries were mostly assessed with limited emphasis on the rivers at sub-quaternary level.

Various study sites will be selected during the course of this study. At these sites, Level 4 EcoClassification (Kleynhans and Louw, 2007) will be applied. This refers to a more Comprehensive level process.

1.4.2 Recommendations on the level of Ecological Reserve assessments

To enable these assessments a comparison (or overlay) must be made between the importance of water resource use and ecological importance. This assessment would guide decision making with regard to what areas are in need of higher confidence Reserves for future planning. The water resource use priority rating of the river reaches in the VaalRiver system was completed by WRP Consulting Engineers (Appendix A). The results of this study in conjunction with the Desktop EcoClassification study will ultimately guide the technical team during EWR site selection and defining the level of assessment of each site.

1.5 REPORT OUTLAY

This report combines various aspects that relates to the Desktop EcoClassification. The chapters are summarised as follows:

1.5.1 **Chapter 2: EcoClassification**

This chapter provides an overview of the purpose of EcoClassification and the process. Detail on where information was sourced with specific emphasis on the PES, the EIS and the SCI is given. The level of EcoClassification and confidence levels are discussed.

1.5.2 **Chapter 3: Ecological Importance and Sensitivity**

This chapter details the use and application of the EIS model, which ecological aspects were considered as the basis for the estimation of EIS, a description of the electronic database and the EIS results. The EIS per quaternary catchment with associated confidence is provided in map format.

1.5.3 **Chapter 4: Socio-Cultural Importance**

This chapter provides an overview of the economic importance of the study area as well as the social environment. The chapter provides detail on how SCI scores were generated and the application of the SCI model. SCI results and a map illustrating SCI rating and confidence is provided.

1.5.4 **Chapter 5: Present Ecological State**

This chapter deals with a description and application of the PES model, what level of detail was applied and what information was used in the desktop analysis. The electronic database is explained and the results are provided. A PES map illustrating PES categories and confidence are provided.

1.5.5 **Chapter 6: Recommendations**

This chapter discusses the results of the desktop assessment in terms of Integrated Ecological Importance of the rivers assessed in WMA 8. A map illustrating areas of high Integrated Importance for WMA 8 is provided. These areas are then compared to areas of high water resource use and areas which require detailed EWR assessments are thus identified.

2 ECOCLASSIFICATION

2.1 BACKGROUND

EcoClassification(Kleynhans and Louw, 2007) is the term used for Ecological Classification. It refers to the determination and categorisation of the PES (in terms of health or integrity) of various biophysical attributes of rivers as compared to the natural, or close to natural, reference condition. The purpose of undertaking EcoClassificationwas to gain insight into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provided the information needed to derive desirable and attainable future ecological objectives for the river. The EcoClassification process also supports a scenario-based approach when a range of ecological endpoints have to be considered.

The state of the river is expressed in terms of biophysical components:

- Drivers (e.g. physico-chemical variables, geomorphology, hydrology), which provide a particular habitat template; and
- Biological responses (displayed by e.g. fish, riparian vegetation and aquatic macroinvertebrates).

Different processes were followed for each component to assign a category from A→F (where A isnatural, and F is critically modified) to each component. Ecological evaluation againstthe expected reference conditions, followed by integration of the categories of each component, provides a description of the Ecological Status or *EcoStatus* of a river. Thus, the EcoStatus can be defined as the totality of the features and characteristics of the river and its riparian areas that influence its ability to support an appropriate natural flora and fauna (modified from: Iversen*et al*., 2000). This ability relates directly to the capacity of the system to provide a variety of goods and services.

2.2 PROCESS

The steps followed in EcoClassification are as follows:

- Determine the reference conditions for each component.
- Determine the PES for each component, as well as for the EcoStatus.
- Determine the trend for each component, as well as for the EcoStatus.
- Determine reasons for the PES and whether these are flow or non-flow related.
- Determine the EIS for the biota and habitat.
- Determine the SCI.
- Considering the PES, the EIS and the SCI; suggest a realistic Recommended Ecological Category (REC) for each component, as well as for the EcoStatus.
- Determine alternative Ecological Categories (ECs) for each component, as well as for the EcoStatus.

The flow diagram (Kleynhans and Louw, 2007) (Figure 2.1) illustrates the process.

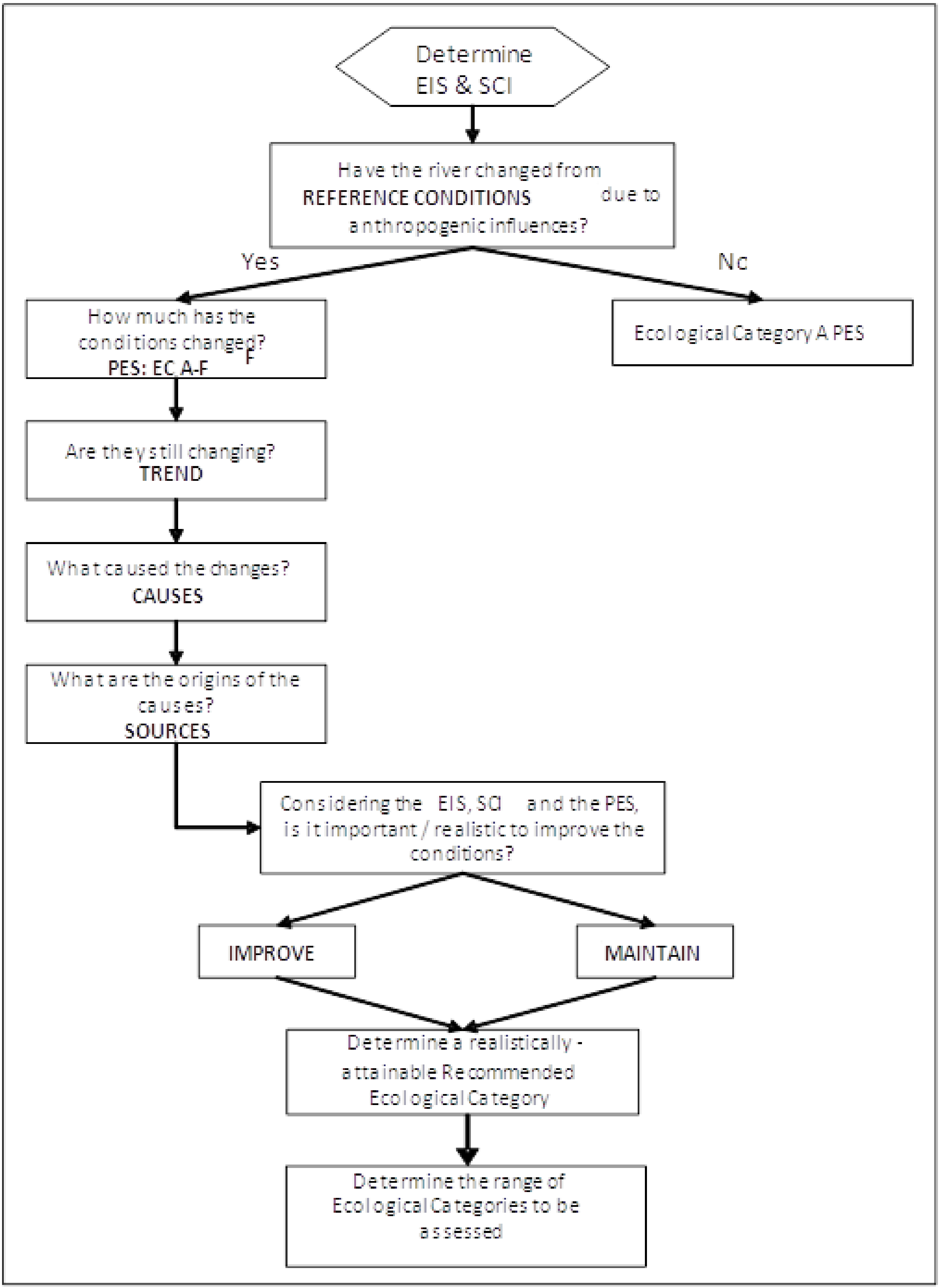


Figure 2.1 Flow diagram illustrating the information generated to determine the range of ECs for which EWRs will be determined.

This study aimed to collate all information pertaining to the EcoClassification with specific emphasis on the PES, the EIS and the SCI. Information on the EcoClassification for the studyarea wassourced from:

- Previous Ecological Reserve assessments.
- Extensive fish surveys covering the whole study area.
- Macroinvertebrate surveys.
- Desktop PES and EIS database for South Africa and quaternary catchments (Kleynhans, 2000).
- Reconnaissance site visit. Sixty one points on the rivers of WMA 8 were visited,which represented 46 of the 90 quaternary catchments. Various other rivers have also been visited during biodiversity assessments and other work undertaken by Dr Pieter Kotze.
- Various aerial videos undertaken through Habitat Integrity surveys for the main rivers in WMA 8.
- Analysis of 1:50000 topographical maps covering the region.
- Analysis of the Demarcation Board socio-economic database for the area and other relevant planning documentation at district and local municipality level.

The original PES-EIS database (Kleynhans, 2000) was updated with new information for all quaternary catchments, based either on expert input or recent studies undertaken, as well as by completing the process for the quaternary catchments in the Study area that were not previously assessed and is presented in this report.

NOTE: Quaternary catchments that were dominated by backups from dams in the area were not included in this assessment.

The database is supplied in electronic format (Excel) as worksheets. The worksheetsare summarised in this document, using tables and maps.

2.3 LEVEL OFECOCLASSIFICATIONASSESSMENT

2.3.1 Importance

Importance consists of Ecological and Socio-Cultural importance which is assessed separately. StandardImportance models were used irrespective of the level of assessment, although the information used to populate the models variedaccording to the level of assessment.

2.3.2 Present Ecological State (PES)

A range of EcoStatus levels, with tools of correspondingly different complexitywere utilised in consideration of time and funding constraints. As EcoStatus levels become less complex, lesscomplex tools must be used.The following tools were used to determine the PES within the EcoQuat Model:

- Quick Habitat Integrity (QHI).
- Desktop Fish Response Rating.
- Desktop Invertebrate Response Rating.
- Desktop Riparian Vegetation Response Rating.

These tools wereused to generate a database which in turn provideda PES for the EcoStatus of the MAIN rivers in the quaternary catchments of WMA 8.

2.4 CONFIDENCE LEVELS

The Confidence levels were evaluated as follows:

1. – low confidence;
2. – low to moderate confidence;
3. – moderate confidence;
4. – moderate to high confidence; and
5. – high confidence.

Confidence was evaluated by considering the information available, the tools used and the expert knowledge available.For this level of assessment, the expected confidence is between 1 and 3. The confidence is indicated in the database and summary tables.

3 ECOLOGICAL IMPORTANCE AND SENSITIVITY

3.1 EIS MODEL

The EIS Model was developed by Dr CJ Kleynhans(DWAF, 1999a).The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh*et al*., 1988; Milner, 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of Ecological Importance and Sensitivity (EIS).

This approach estimates and classifies the EIS of the streams in a catchment by considering a number of components surmised to be indicative of these characteristics. This procedure was originally developed for assessment of mainstream rivers in quaternary catchments (Schulze *et al.,* 1997). Although the delineation of quaternary catchments is not based on ecological principles, the EIS approach can be used for anyriver delineation. However, it must be realised that the EIS and the reality of theapproach may be low due to the omission of an ecological typing framework.

The following ecological aspects were considered as the basis for the estimation of EIS (Kleynhans in DWAF, 1999a):

- The presence of rare and endangered species, unique species (i.e., endemic or isolated populations) and communities, intolerant species and species diversity were taken into account for both the instream and riparian components of the river.
- Habitat diversity was also considered. This included specific habitat types such as reaches with a high diversity of habitat types, i.e., pools, riffles, runs, rapids, waterfalls, riparian forests, etc.

With reference to the points above, biodiversity in its general form (i.e., Noss, 1990) was taken into account as far as the available information allowed:

- The importance of a particular river or stretch of river in providing connectivity between different sections of the river, i.e., whether it provided a migration route or corridor for species,was considered.
- The presence of conservation or relatively natural areas along the river section also served as an indication of Ecological Importance and Sensitivity.
- The sensitivity (or fragility) of the system and its resilience (i.e., the ability to recover following disturbance) of the system to environmental changes was also considered. Consideration of both the biotic and abiotic components was included here.

This system is regarded as a guideline for the professional ecological judgement by individuals familiar with a particular area. The assessors scored a number of biotic and habitat determinants considered to be important for the determination of EIS. The median of these scores was calculated to derive the EIS category(Table 3.1). This was only applicable to the main stem river in a quaternary catchment.

Table 3.1 EIS categories (Modified from DWAF, 1999)

EIS Categories	General Description
Very high	Quaternaries/delineations that are considered to be unique on a national or even international level, based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.
High	Quaternaries/delineations that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications, but in some cases, may have a substantial capacity for use.
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use.
Low	Quaternaries/delineationsthat is not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.

3.2 ELECTRONIC DATABASE

The electronic database (Vaal PESEIS Version 3) is provided on a CD and explained below.The EIS information is in the Excel worksheet: *EIS*. The columns and colouration are explained below:

Colour coding:Light yellowin column A, E and Gindicates the quaternaries which have been updated and the specific ratings (scores) which have changed from the Kleynhans database (Kleynhans, 2000).

- Column A: Quaternary catchment number.
- Column B: Main river per quaternary.
- Column C: EIS metrics.
- Column D: The original 1999 score per metric.
- Column E: The revised or new 2007 score per metric.
- Column F: The original 1999 confidences out of 4 per metric.
- Column G: The revised or new 2007 confidences out of 4 per metric.
- Column H: Overall 1999 EIS score (calculated in spreadsheet).
- Column I: Overall 2007 EIS score (calculated in spreadsheet).
- Column J: 1999 EIS evaluation (calculated in spreadsheet).
- Column K: 2007 EIS evaluation (calculated in spreadsheet).
- Column L: Commentsregarding biota with regard to the EIS metrics.
- Column M: Column N: Overall average of revised EIS confidence rating out of 4 for refined 2007 EIS assessment (calculated in spreadsheet) (Scoring according to Kleynhans, 1999).
- Column N: Overall average of revised EIS confidence rating out of 5 (calculated in spreadsheet).

3.3 EIS RESULTS

The results are provided as follows:

- Summarised EIS per quaternary catchment (Table 3.2). High EIS ratings are highlighted in green.
- Bar graphs (Figure 3.1).
- Catchment maps (Figure 3.2).

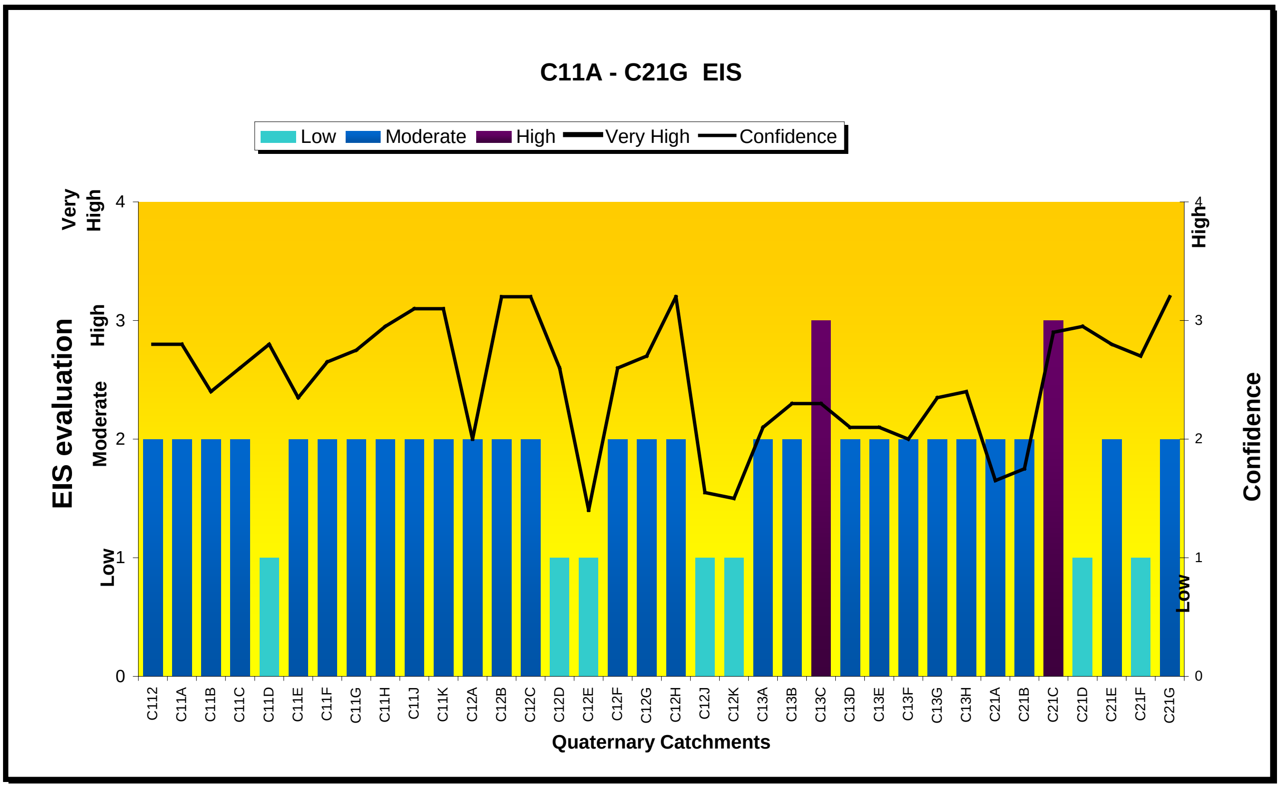
Note that the following GIS coverages used in the maps were provided by D: RQS:

- WMA, EcoRegions, Geomorphic zones, 1:500 000) rivers coverage.

Table 3.2 Summarised revised EIS results per quaternary catchment

Quaternary catchment	River	EIS	Confidence (0 - 4)
C11A	Vaal	MODERATE	2.8
C11B	Vaal	MODERATE	2.8
C11C	Klein Vaal	MODERATE	2.4
C11D	Klein Vaal	LOW	2.6
C11E	Vaal	MODERATE	2.8
C11F	Drinkwaterspruit	MODERATE	2.35
C11G	Drinkwaterspruit	MODERATE	2.65
C11H	Blesbokspruit	MODERATE	2.75
C11J	Vaal	MODERATE	2.95
C11K	Leeuspruit	MODERATE	3.1
C11M	Vaal (downstream from Grootdraai Dam)	MODERATE	3.1
C12A	Venterspruit	MODERATE	2
C12B	Vaal (main)	MODERATE	3.2
C12C	Vaal (main)	MODERATE	3.2
C12D	Waterval (Kleinspruit)	LOW	2.6
C12E	Boesmanspruit	LOW	1.4
C12F	Waterval (Kleinspruit)	MODERATE	2.6
C12G	Waterval (Kleinspruit)	MODERATE	2.7
C12H	Vaal (main)	MODERATE	3.2
C12J	Unnamed tributary.	LOW	1.55
C12K	Molspruit	LOW	1.5
C13A	Sandspruit	MODERATE	2.1
C13B	Sandspruit	MODERATE	2.3
C13C	**Seekoeivlei (Klip River)**	**HIGH**	**2.3**
C13D	Klip (after confluence with Modderspruit/Gansvleispruit system)	MODERATE	2.1
C13E	Kommandospruit	MODERATE	2.1
C13F	Klip (after confluence with Kommandospruit)	MODERATE	2
C13G	Spruitsonderdrif	MODERATE	2.35
C13H	Klip	MODERATE	2.4
C21A	Suikerbosrand	MODERATE	1.65
C21B	Suikerbosrand	MODERATE	1.75
C21C	**Suikerbosrand**	**HIGH**	**2.9**
C21D	Blesbokspruit	LOW	2.95
C21E	Blesbokspruit	MODERATE	2.8
C21F	Blesbokspruit	LOW	2.7
C21G	Suikerbosrand	MODERATE	3.2
C22A	Klip River	MODERATE	3.1
C22B	Natalspruit	LOW	2.3
C22C	Rietspruit (after confluence with Natalspruit)	LOW	2.2
C22D	Klip	MODERATE	2.7
C22E	Klip	MODERATE	2.1
C22F	Vaal (downstream from Vaal Dam)	MODERATE	2.7
C22G	Taaibosspruit	MODERATE	2.2
C22H	Rietspruit	LOW	1.5
C22J	Leeuspruit	MODERATE	1

Quaternary catchment	River	EIS	Confidence (0 - 4)
C23A	Kromellemboogspruit	MODERATE	2.1
C23B	Vaal	MODERATE	3.1
C23C	**Vaal (Parys)**	**HIGH**	**2.6**
C23D	Wonderfonteinspruit	LOW	1.3
C23E	Mooirivierloop	MODERATE	1
C23F	Schoonspruit main stem	MODERATE	1.6
C23G	Mooi (upstream from Boskop Dam)	MODERATE	2
C23H	Mooi (just before confluence with Loopspruit)	MODERATE	2
C23J	Loopspruit (above KlipdrifDam)	LOW	2.65
C23K	Loopspruit	LOW	2.65
C23L	**Vaal (downstream from Parys)**	**HIGH**	**2.6**
C81A	Wilge (main stem)	LOW	1
C81B	Wilge (main stem)	MODERATE	1.45
C81C	Modder/Fraser	MODERATE	1
C81E	Wilge (main stem)	MODERATE	1.3
C81F	Elands (Wilgetributary)	MODERATE	2.1
C81G	Klerkspruit (Elands (Wilge tributary)?)	MODERATE	1
C81H	Elands (Wilge tributary)	MODERATE	1.5
C81J	Vaalbanks (Wilge tributary)	MODERATE	1
C81K	Wilge (main stem)	MODERATE	1.4
C81L	Meul (Wilge tributary)	MODERATE	2.4
C81M	Meul (Wilge tributary)	MODERATE	2.4
C82A	Cornelis (Wilge tributary)	MODERATE	1.65
C82B	Cornelis (Wilge tributary)	MODERATE	1.9
C82C	Wilge (main stem)	MODERATE	2.35
C82D	Rus se Spruit (Wilge tributary)	MODERATE	1.8
C82E	Holspruit (Wilgetributary)	MODERATE	2.3
C82F	Grootspruit (Wilgetributary)	MODERATE	2.3
C82G	Wilge (main stem)	MODERATE	2.2
C82H	Wilge (main stem)	MODERATE	2.7
C83A	Liebenbergsvlei River section in quaternary	LOW	2.7
C83A	Ash River section in quaternary	LOW	2.7
C83B	Jordaans	MODERATE	1.0
C83C	Liebenbergsvlei	MODERATE	2.7
C83D	Tierkloof	MODERATE	1.0
C83E	**Tierkloof**	**HIGH**	**1.1**
C83F	Liebenbergsvlei	MODERATE	2.9
C83G	Liebenbergsvlei	MODERATE	2.9
C83H	Liebenbergsvlei	MODERATE	3.1
C83J	Wilge (main stem)	MODERATE	3.0
C83K	Kromspruit	MODERATE	1.8
C83L	Klip	MODERATE	1.8



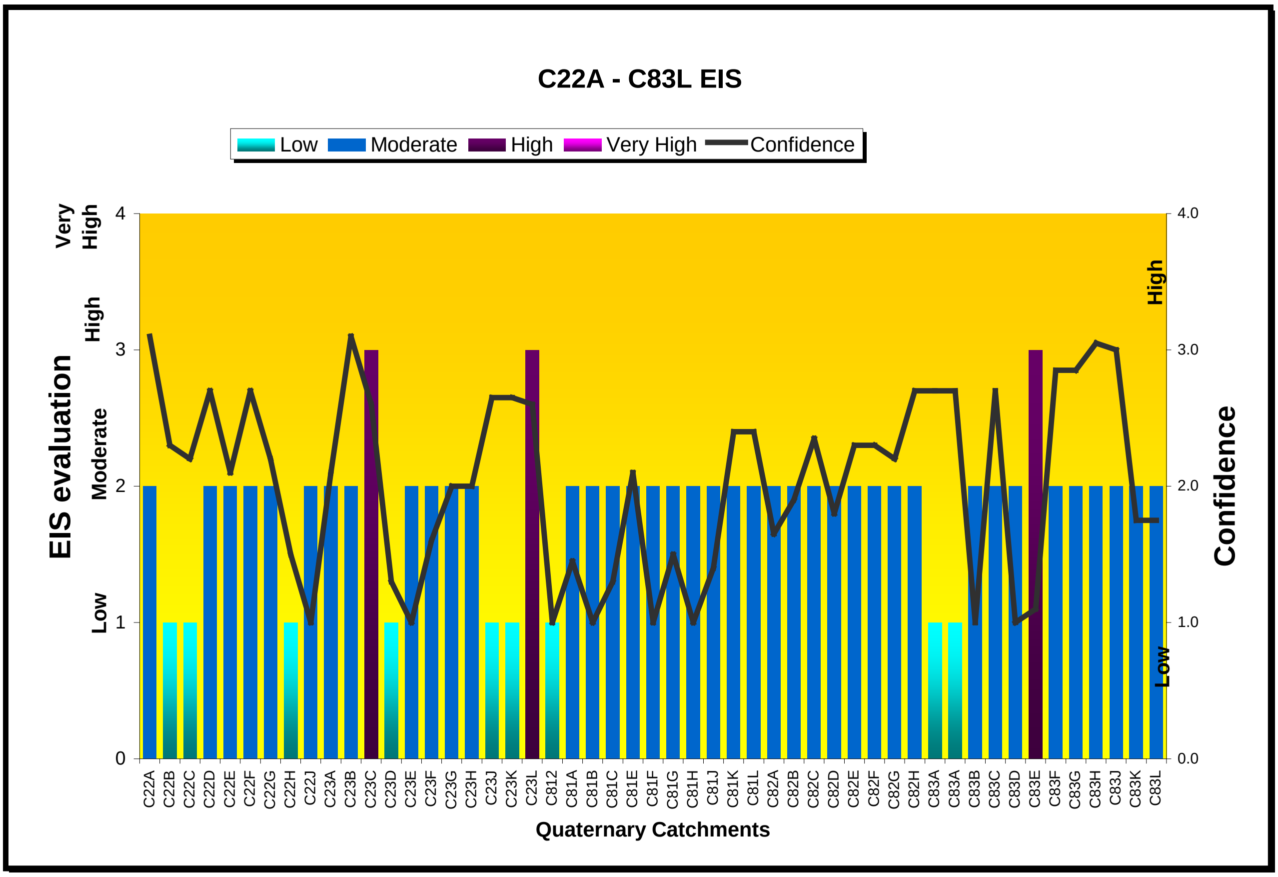


Figure 3.1 EIS and confidence evaluation illustrated as bar graphs for the Upper Vaal WMA

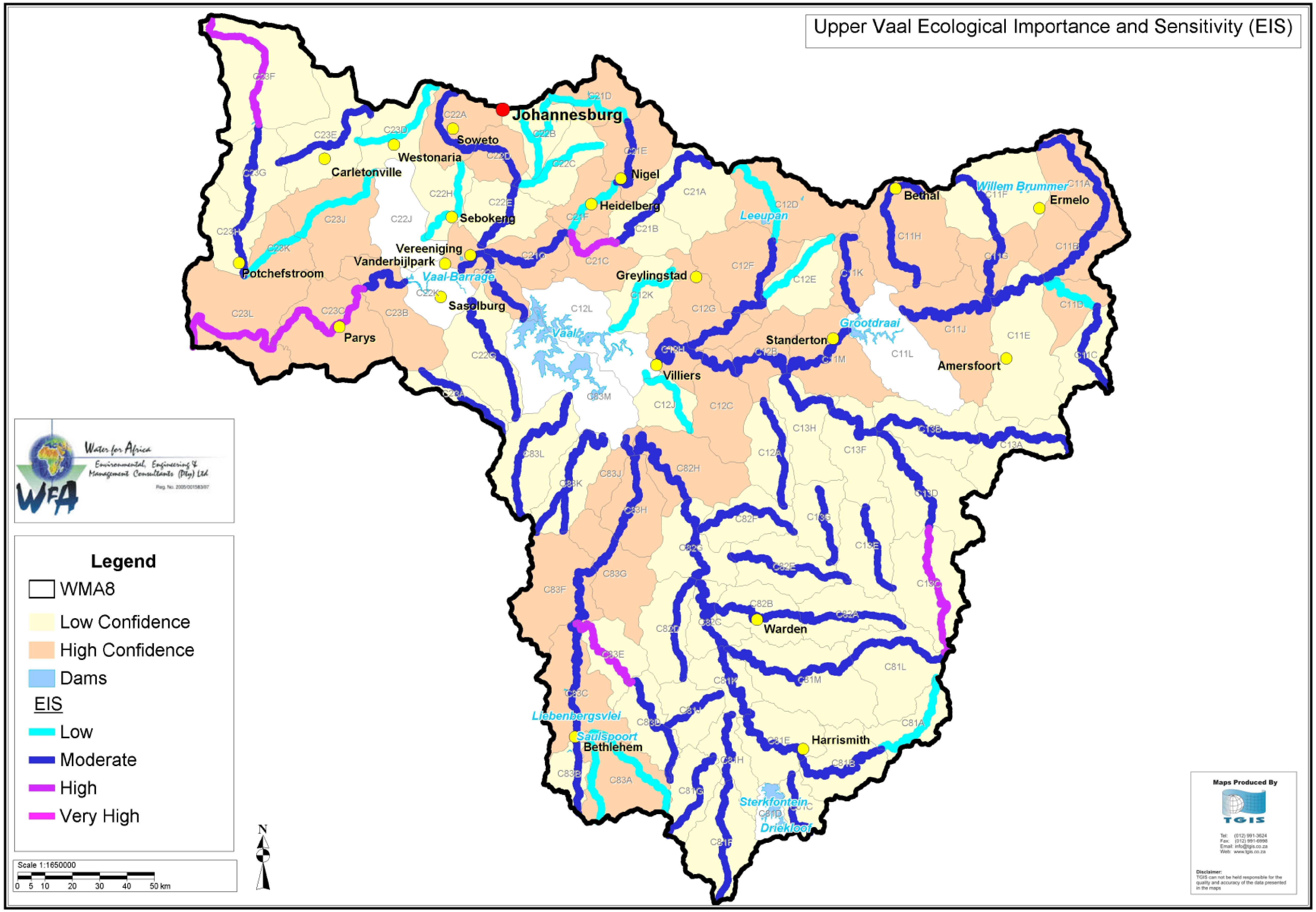


Figure 3.2 EIS per quaternary catchment with associated confidence

3.4 CONCLUSIONS

No areas of Very High EIS are present in the WMA. The few areas of high EIS are the following:

- C13C (Klip River): Due to the presence of a RAMSAR site, the Seekoeivlei.
- C21C (Suikerbosrand): Due to species taxon richness and the presence of rare and endangered *Labeobarbuskimberleyensis.*
- C23C and C23L (Vaal River near and downstream of Parys): The river is situated in a World Heritage site and the rare and endangered *Labeobarbuskimberleyensis* is present.
- C83E (Tierkloof): Most of the metrics rate high with specific emphasis on the diversity of habitat types and the species diversity and sensitivity.

Most of the rest of the quaternary catchments were rated as moderate. The confidence of the evaluation as can be seen from Figure 3.1 ranged mostly from moderate to high with approximately 30% as low.

This EIS evaluation was only undertaken for the main rivers in the quaternaries. Evaluation is still required to identify those rivers of high and very high importance on a sub-quaternary scale.

4 SOCIO-CULTURAL IMPORTANCE

Sections 4.1 and 4.2 have been adapted from DWAF (2004).

4.1 OVERVIEW

This WMA is economically one of the most important in the country and nearly 20% of the Gross Domestic Product (GDP) of South Africa originates from the Upper Vaal WMA. Only the adjacent Crocodile (West) and Marico WMA, with about 24%, contributes more to the GDP. The contribution of the different sectors to the Gross Geographic Product (GGP) in the Upper Vaal WMA reflects a diversified economy with a strong industrial and financial base. Despite the large areas under cultivation, agriculture only contributes about 2% of the GGP. Agriculture, however, has important linkages to other sectors and provides livelihood to a large proportion of the rural population (DWAF, 2006).

The potential for future growth in this WMA remains strong. Growth will largely be attracted to the already strong urban and industrial areas in the Johannesburg - Vereeniging-Vanderbijlpark complex. New mining developments will mainly replace worked out mines with a long term decline expected in this sector. There is however potential for further development of coal mining on the Eastern Highveld and in the Vereeniging area downstream of Vaal Dam (DWAF, 2004).

Products of the mining industry in the Upper Vaal WMA include coal, precious metals (gold, uranium, etc.), base metals, semi-precious stones and industrial minerals. The major impact of the mines on the water resource is the water pumped from the mines to dewater the underground workings mainly of the gold mines. The salinity loads associated with these mine discharges together with the sewage return flows contribute significantly to the salinity problems that are experienced in the Vaal Barrage and downstream river system. The mine dewatering and the diffuse salinity contributions from the highly developed urban and industrial areas in the Vaal Barrage catchment has resulted in the need for the currently applied blending and/or dilution operating rules applied downstream of Vaal Dam (DWAF, 2004).

Major industries in this WMA include Sasol I (Sasolburg), Mittal Steel, Sappi, the Sasol Midlands Plant and Sasol Synthetic Fuels (SSF) (Secunda). Sasol I is located in the Free State province near Sasolburg and abstracts water from the Vaal Barrage. The production of petro-chemicals is the main activity. Mittal Steel is located near Vanderbijlpark and is supplied with water from the Vaal Barrage. The production of iron and steel products is the main activity. SSF are located in MpumalangaProvince near the Secunda urban area. Water for SSF is supplied by pipeline from Grootdraai Dam. The production of petro-chemicals products is the main activity. Other important industries such as Sappi and Sasol Midlands Plant receive water from the urban centres where they are located. All these industries are economically important and provide significant employment. There are three operational coal fired power stations located in the WMA. The power stations are the Lethabo, Tutuka and Majuba Power Stations (DWAF, 2004).

The irrigation areas were estimated by Loxton Venn and Associates (LVA) in the report entitled "*Report for the Vaal River Irrigation Study*" (DWAF, 1999b). Since the completion of the irrigation study, the registration of water use has been completed. Comparisons between the registered water use and the irrigation figures given in the report highlighted the uncertainties in the irrigation areas and water use, with the registered water use exceeding the LVA information. The verification process, which has been started in the WMA, will provide more certainty on the irrigation numbers.

About 75% of the irrigation is upstream of major storage dams and are supplied from run-of-river or farm dams. These areas will be supplied at a lower assurance of supply than the irrigation areas located in the Mooi sub-catchment (Mooi Government Water Scheme, Klipdrift and Vyfhoek Schemes) and Barrage to Mooi sub-catchment (Rietpoort and Koppieskraal Irrigation Boards) which are supported by major dams and conveyance infrastructure (DWAF, 2004).Land use in the south and east is dominated by cultivated dry land agriculture with the main crops being maize and wheat. Beef and sheep farming is range extensive.

The land use in the Upper Vaal WMA is characterised by the sprawling urban and industrial areas in the northern and western parts of the WMA. There are also extensive coal and gold mining activities located in the Upper Vaal WMA. These activities generate substantial return flow volumes in the form of treated effluent from the urban areas and mine de-watering that are discharged into the river system. These discharges have significant impacts on the water quality in the main stem of the Vaal River (DWAF, 2004).

4.2 SOCIAL ENVIRONMENT

The Upper Vaal WMA is the most populous WMA in South Africa. The total population is estimated at 5.6 million people in the year 1995. More than 80% of the population in the WMA reside in the area downstream of the Vaal Dam with nearly 97% living in an urban environment.

The demography of the WMA will be influenced by economic opportunities and potential. Projections are therefore for continued strong growth in urban population in the sub-area downstream of Vaal Dam where most of the economic activity is centred. A decline in population is projected for the Wilge sub-area due to the movement of people out of Phuthaditjaba and the former QwaQwa area.

The poor in urban areas and rural villages are as important, in the consideration of the distribution and use of water resource, as the small (poor) rural subsistence farmer.

The use of water for recreational purposes is one of the 11 water uses regulated in termsof the NWA.Water resources offer a very significant recreational outlet and that recreation is an important public and social asset necessary for national health and productivity. Recreational use can take many forms and only occasionally has any direct impact on the water resource. Most obvious are activities such as power-boating, which can have quality / pollution impacts. Far more significant in terms of both quantity and quality is the release of water to allow for canoeing and other water sports downstream especially in the areas downstream of the water transfer outfalls and the areas around Parys. The dams in the WMA, particularly the Vaal Dam are important recreational zones. These activities can bring very significant economic benefits to the WMA.

4.3 SCI MODEL

The Socio-Cultural Importance (SCI) was determined from:

- A site visit that covered points along the river; and
- extrapolation to unvisited sites by reference to available literature, as well as to existing mapping.

Given the size of the budget and the geographical scope of the work most of the information used to influence the score was derived from direct observation and consideration of the literature available. A limited number of direct interviews were held with people who are resident proximate to the river.

The SCI was generated by scoring each quaternary catchment based on the following features discussed below.

Ritual use: This was scored between 0 – 5 by asking the question “How much ritual use of the river takes place?” Typically,ritual use would be for ceremonial purposes or for spiritual/religious activities, for example using pools for traditional initiation purposes.

Aesthetic value: This was scored between 0 – 5 by asking the questions “How important is the aesthetic value to people? Does the river stretch add value to people lives as an object of natural beauty? Would changing flows detract from this value?”

Resource dependence: This was scored between 0 -5. This refers to the goods and services delivered by the river system and peoples dependence on these components.This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or “for financial gain” usage of resources is excluded from consideration in this instance. It should be noted that for the Upper Vaal there was no quaternary in which this aspect proved to be relevant. As such it was excluded from final consideration of the scoring of the SCI.

Recreational use: This was scored between 0 – 5by asking the question “Does the river stretch provide recreational facilities to people and would this be affected by changing flows?”

Historical/cultural value: This was scored between 0 – 5by asking the question “Does the river have a strong cultural or historical value?”Examples would be Fugitives Drift on the Buffalo or components of the Mzimvubu that have played a central role in Xhosa cultural history.

Scores were then weighted to reflect the relative importance of each component relative to the other. The Resource dependence component was given the highest weighting given that this component is designed to reflect the importance of a healthy riverine system to people who are often in the grips of poverty and for whom the availability of such resources are a question of survival.

The weighted scores were then combined to generate an overall score between 0 and 5. The meaning of the score is as set out in Table 4.1below.

Note: The SCI for Upper Vaal was generally low and water quality issues do not seem to play a major role other than periodic issues attached to recreational aspects on the Vaal below the barrage. This does however not influence the SCI scoring.

Table 4.1 SCI rating

0-1	Minimal	Of little or no socio-cultural importance.
1-2	Low	Of some importance. PES not critical, but caution should be displayed with regard to negative impact on dependant communities.
2-3	Moderate	Of moderate importance. PES should not be allowed to be negative affected without strong motivation.
3-4	High	Of high importance. A score in this range motivates for maintain or potentially positive change to PES.
4-5	Very High	Of extreme importance. A score in this range motivates for positivechange to PES.

4.4 SCI RESULTS

The model is provided in the electronic database asthe worksheet labelled*CSI*.

The results are provided as follows:

- SCI per quaternary catchment (Table 4.2).
- Catchment maps.
- Bar graphs.

Table 4.2 SCI results

Quaternary catchment	River	SCI	Confidence (0 – 5)
C11A	Vaal	MODERATE	3
C11B	Vaal	MODERATE	3
C11C	Klein Vaal	MODERATE	3
C11D	Klein Vaal	MODERATE	3
C11E	Vaal	MODERATE	3
C11F	Drinkwaterspruit	LOW	3
C11G	Drinkwaterspruit	LOW	3
C11H	Blesbokspruit	LOW	1
C11J	Vaal	LOW	1
C11K	Leeuspruit	LOW	1
C11M	Vaal (downstream from Grootdraai)	LOW	3
C12A	Ventersspruit	LOW	3
C12B	Vaal (main)	LOW	3
C12C	Vaal (main)	LOW	3
C12D	Waterval (Kleinspruit)	LOW	3
C12E	Boesmanspruit	LOW	3
C12F	Waterval (Kleinspruit)	MODERATE	1
C12G	Waterval (Kleinspruit)	MODERATE	3
C12H	Vaal (main)	LOW	3
C12J	Unnamedtributary	LOW	3
C12K	Molspruit	LOW	1
C13A	Sandspruit	LOW	1
C13B	Sandspruit	MODERATE	1

Quaternary catchment	River	SCI	Confidence (0 – 5)
C13C	Seekoeivlei (Klip River)	LOW	3
C13D	Klip (after confluence with Modderspruit/Gansvleispruit system)	LOW	3
C13E	Kommandospruit	LOW	3
C13F	Klip (after confluence with Komandospruit)	MODERATE	3
C13G	Spruitsonderdrif	MODERATE	3
C13H	Klip	LOW	3
C21A	Suikerbosrand	LOW	1
C21B	Suikerbosrand	LOW	1
C21C	Suikerbosrand	LOW	3
C21D	Blesbokspruit	MODERATE	3
C21E	Blesbokspruit	MODERATE	3
C21F	Blesbokspruit	MODERATE	1
C21G	Suikerbosrand	LOW	1
C22A	Klip River	LOW	3
C22B	Natalspruit	LOW	1
C22C	Rietspruit (after confluence with Natalspruit)	MODERATE	1
C22D	Klip	LOW	1
C22E	Klip	LOW	1
C22F	Vaal (downstream from Vaal dam)	LOW	3
C22G	Taaibosspruit	LOW	3
C22H	Rietspruit	LOW	3
C22J	Leeuspruit	MODERATE	3
C23A	Kromellemboogspruit	LOW	3
C23B	Vaal	LOW	1
C23C	Vaal (Parys)	MODERATE	3
C23D	Wonderfonteinspruit	LOW	1
C23E	Mooirivierloop	MODERATE	3
C23F	Schoonspruit main stem	MODERATE	3
C23G	Mooi (upstream from Boskop)	LOW	3
C23H	Mooi (just before confluence with Loopspruit)	LOW	1
C23J	Loopspruit (above Klipdrif dam)	LOW	3
C23K	Loopspruit	LOW	1
C23L	Vaal (downstream from Parys)	LOW	3
C81A	Wilge (main stem)	LOW	3
C81B	Wilge (main stem)	LOW	3
C81C	Modder/Fraser	LOW	3
C81E	Wilge (main stem)	LOW	1
C81F	Elands (Wilgetributary)	LOW	1
C81G	Klerkspruit (Elands (Wilgetributary)?)	MODERATE	1
C81H	Elands (Wilgetributary)	LOW	3
C81J	Vaalbanks (Wilgetributary)	LOW	1
C81K	Wilge (main stem)	LOW	1
C81L	Meul (Wilgetributary)	LOW	3
C81M	Meul (Wilgetributary)	LOW	1
C82A	Cornelis (Wilgetributary)	LOW	1
C82B	Cornelis (Wilgetributary)	LOW	1

Quaternary catchment	River	SCI	Confidence (0 – 5)
C82C	Wilge (main stem)	LOW	1
C82D	Rus se Spruit (Wilgetributary)	LOW	1
C82E	Holspruit (Wilgetributary)	LOW	3
C82F	Grootspruit (Wilgetributary)	MODERATE	1
C82G	Wilge (main stem)	LOW	1
C82H	Wilge (main stem)	LOW	1
C83A	Liebenbergsvlei River section in Quaternary	LOW	3
C83A	Ash River section in quaternary	LOW	3
C83B	Jordaans	LOW	3
C83C	Liebenbergsvlei	LOW	3
C83D	Tierkloof	LOW	3
C83E	Tierkloof	LOW	3
C83F	Liebenbergsvlei	LOW	3
C83G	Liebenbergsvlei	LOW	1
C83H	Liebenbergsvlei	LOW	1
C83J	Wilge (main stem)	LOW	3
C83K	Kromspruit	LOW	3
C83L	Klip	LOW	3

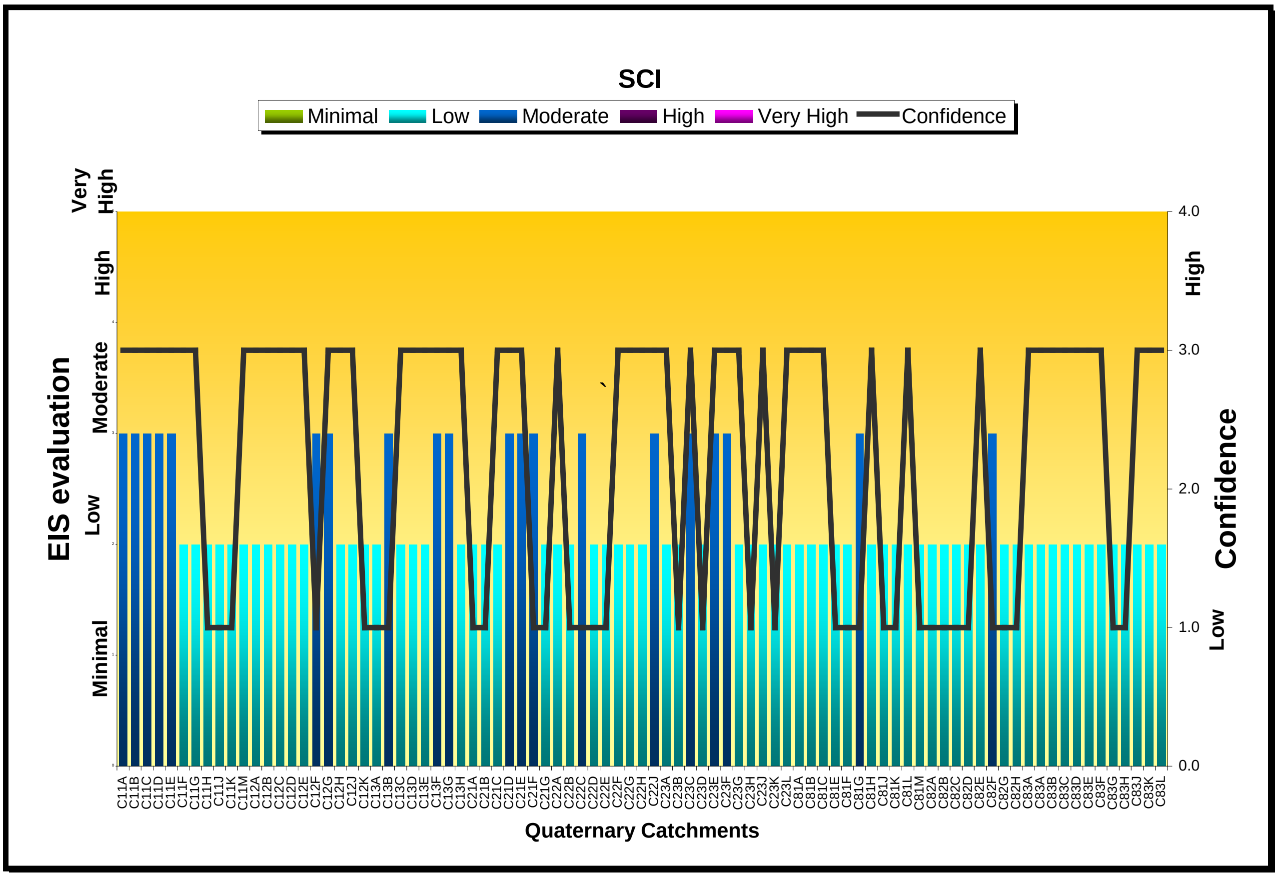


Figure 4.1 SCI and confidence evaluation illustrated as bar graphs

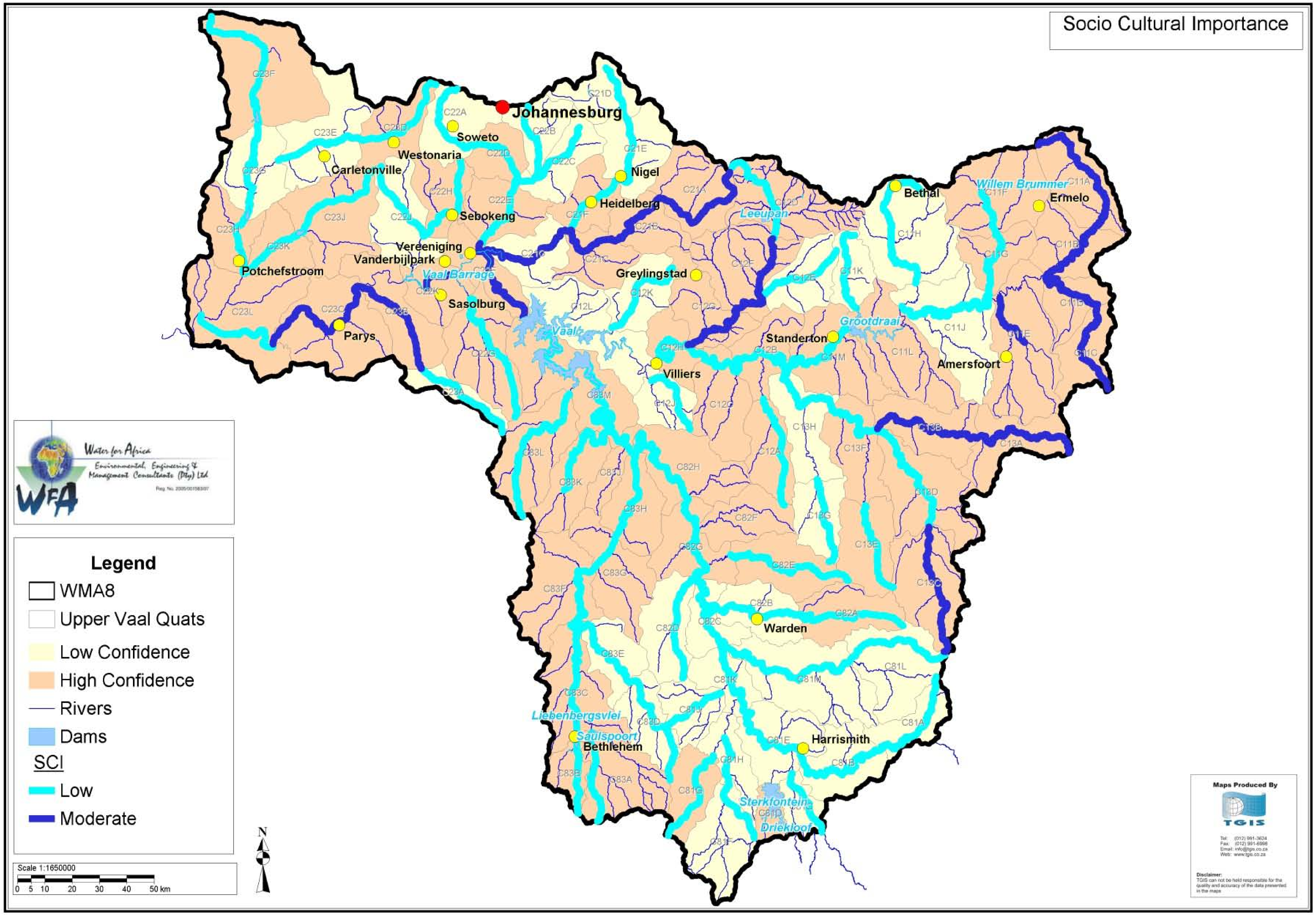


Figure 4.2 SCI map illustrating SCIrating and confidence

4.5 CONCLUSIONS

Areas dominated by relatively low population densities and given over to commercial farming enterprises (typically the upper parts of the catchment) as well as portions of the middle catchment tended to score relatively low in terms of SCI. An obvious exception is recreational use. Portions of the WMA with water related recreational activity scored slightly higher. Areas dominated by mining and industrialisation also scored generally low in terms of SCI. It should be emphasised that low SCI score does not indicate low economic importance. In terms of economic importance the catchment is obviously critical to the RSA.

5 PRESENT ECOLOGICAL STATE

5.1 PES MODEL (MODIFIED FROM KLEYNHANS AND LOUW, 2007)

The PES of a river is expressed in terms of various components, i.e.,**drivers** (Physico-chemical variables, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic macroinvertebrates), as well as in terms of an integrated state, the EcoStatus. The ecological state of the components and the EcoStatusare categorisedfrom A to F. It must be emphasised that the scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. There may therefore be cases where there is uncertainty as to which category a particular entity belongs. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*., 2004). For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D, and so on. The B/C boundary category, for example, is indicated as the dark-blue to light green area inFigure 5.1.

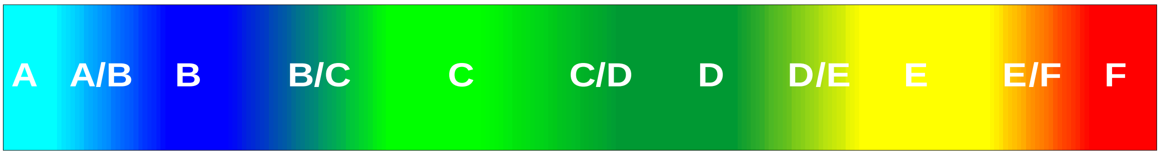


Figure 5.1 Illustration of the distribution of ecological categories on a continuum

A Desktop Level EcoStatusassessment (Figure 5.2) was designed for use when assessments for planning purposes on large scale have to be undertaken. As the name indicates, this method is usually carried out at desktop level, and is therefore based on available information and expert judgement. In this instance, however, a site visit was undertaken to provide additional information due to the lack of relevant information in some of the study areas.

A Desktop EcoClassificationserves as a scoping phase to investigate the WMA at a desktop level and at the scale of quaternary catchments. This provides the basis for the planning of a Comprehensive study and serves as the basis for most other tasks in the Reserve determination process. This scoping assessment provides an overview of the WMA and a better understanding when focussing on the EWR sites and the sections of rivers where comprehensive assessments will be undertaken. The output of the information also identifies areas of potential concern based on an integrated importance (combination of Ecological Importance and Sensitivity, Socio-Cultural Importance and Present Ecological State).

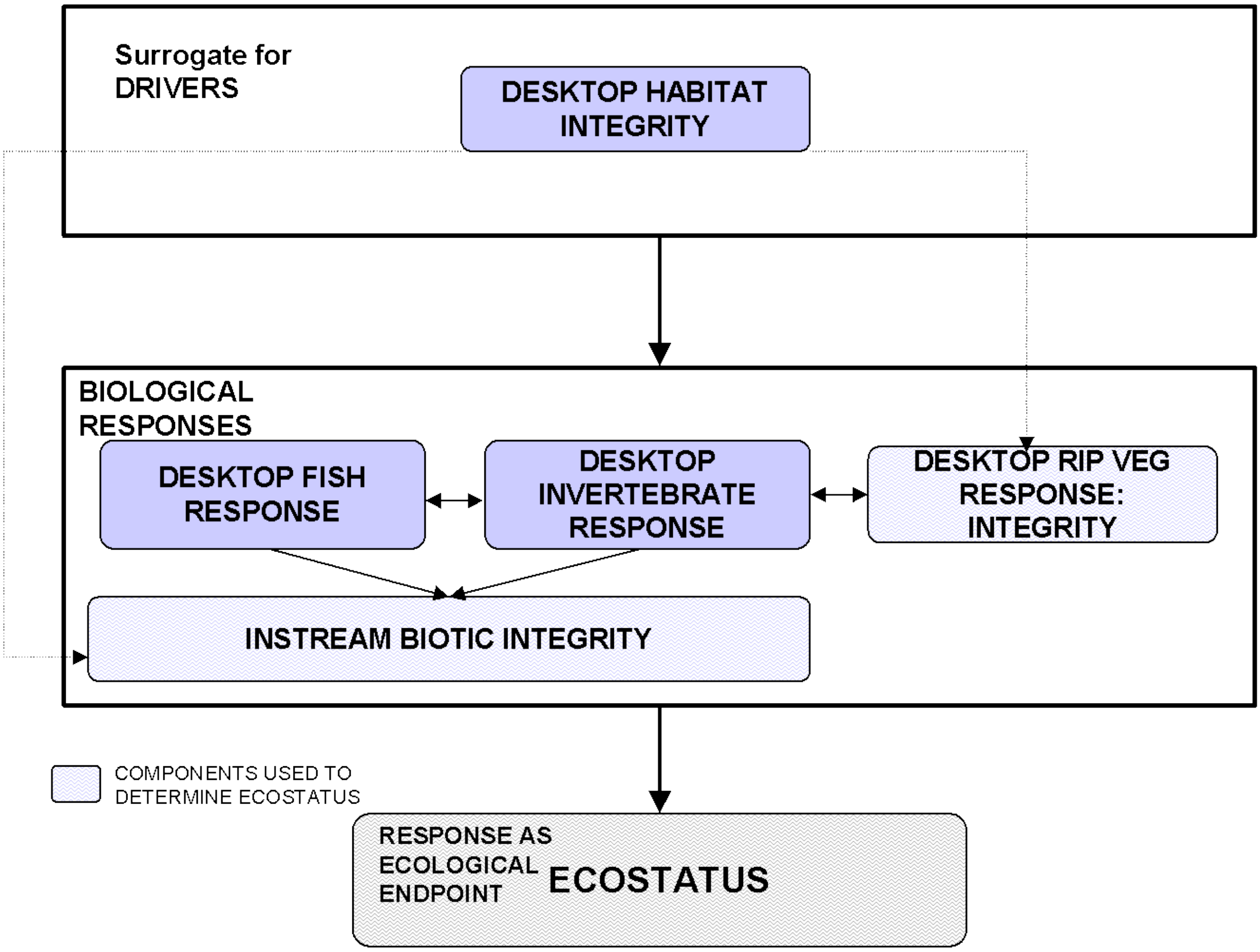


Figure 5.2 Desktop EcoStatus determination

To accommodate the less-detailed process, the following deviations from the detailed EcoStatus level methodwere required: Note: the detailed level will be applied to river reaches in which the EWR sites are situated.

- A Quick Habitat Integrity was developed. Thisapproach allows for a coarse assessment and rates the habitat according to a scale of 0 (close to natural) to 5 (critically modified), according to the following metrics:
  - Bed modification.
  - Flow modification.
  - Introduced instreambiota.
  - Inundation.
  - Riparian/bank condition; and
  - Water quality modification.
- This Quick Habitat Integrity approach serves as a substitute for the drivers, as well as playing a role in assessing the EcoStatus. This is necessary because the response information is of low confidence.
- To accommodate the lack of fish and invertebrate response information, the Quick Habitat Integrity results are brought into the equation to calculate the InstreamEcological Category (EC). The instream EC is therefore a combination of the Desktop Habitat Integrity and the Desktop fish, macroinvertebrateand riparian vegetation ECs.

As the EcoStatus is primarily targeted towards the Instream Integrity, and as the derived vegetation EC is inherently of lower confidence, the instream EC comprises two thirds of the EcoStatus. The model is illustrated inFigure 5.3.

DESKTOP LEVEL	
	RATING*
Bed modification	2.0
Flow modification	1.0
Introduced instream biota	3.0
Inundation	1.0
Riparian/bank condition	3.0
Water quality modification	1.0
HABITAT INTEGRITY	1.8
DESKTOP MACROINVERTEBRATE RATING	3.0
DESKTOP FISH RATING	3.0
INSTREAM EC%	**56.9**
INSTREAM EC	**D**
DESKTOP VEGETATION	2.0
ECOSTATUS %	**60.7**
ECOSTATUS EC	**C**

*For information on calculations, refer to Kleynhans and Louw(2007).

Figure 5.3 EcoStatus desktop level

5.2 ELECTRONIC DATABASE

The model is provided in the electronic database asthe worksheet labelled*PES.*

The columns are explained below:

- Column A: Quaternary catchment number.
- Column B: Main river per quaternary, according to the Kleynhans database, and corrected, where required.
- Column D-T: Quick Habitat Integrity metrics.
- Column V: Quick Habitat Integrity (calculated in spreadsheet).
- Column W: DesktopMacroinvertebrate rating (value provided from 0 – 5).
- Column X: DesktopMacroinvertebrate % (calculated in spreadsheet).
- Column Z: Desktop Fish rating (value provided from 0 – 5).
- Column AA: Desktop Fish % (calculated in spreadsheet).
- Column AC: Instream EC % (calculated in spreadsheet).
- Column AE: Instream EC (calculated in spreadsheet).
- Column AF: Desktop Riparian vegetation rating (value provided from 0 – 5).
- Column AG: Desktop Riparian vegetation % (calculated in spreadsheet).
- Column AI: EcoStatus percentage (calculated in spreadsheet).
- Column AK: EcoStatus EC (calculated in spreadsheet).

- Column AL: Confidence evaluation out of 5.
- Column AM: Source and comments relevant.

5.3 PES RESULTS

The results are provided as follows:

- Summarised PES per quaternary catchment (Table 5.1).
- Bar graphs for the PES (Figure 5.4).
- Catchment maps of the PES (Figure 5.5).

Table 5.1 Summarised PES results per quaternary catchment

Quaternary catchment	River	PES EcoStatus	Confidence (0 - 5)	Source
C11A	Vaal	B/C	3	Fish surveys undertaken for mining, Google Earth, land coverage, water quality assessment, operational information.
C11B	Vaal	C	2.5	Sites visited, Google Earth, land coverage, water quality assessment, operational information.
C11C	Klein Vaal	B	2	Evaluate quaternary as upstream of transfer which is near the quaternary border, Google Earth, water quality assessment.
C11D	Klein Vaal	C	2	Downstream of transfer, Google Earth, water quality assessment, area visited.
C11E	Vaal	C	3.5	Sites visited, Google Earth, land coverage, water quality assessment, operational information.
C11F	Drinkwaterspruit	C	2.5	Derived from C11G and other catchments.
C11G	Drinkwaterspruit	C	3	Sites visited, Google Earth, land coverage, water quality assessment, operational information.
C11H	Blesbokspruit	C/D	3	Fish surveys undertaken for mining, Google Earth, land coverage, water quality assessment, operational information.
C11J	Vaal	C	2.5	Google Earth, land coverage, water quality assessment, operational information.
C11K	Leeuspruit	D	3.5	Google Earth, land coverage, water quality assessment, operational information, upstream surveys, and site visited, but inundated.
C11M	Vaal (downstream from Grootdraai Dam)	D	3	Surveys, Google Earth, landuse, visit.
C12A	Ventersspruit	B/C	2	No survey information, derived.
C12B	Vaal (main)	C	3	Sites visited, Google Earth, land coverage, water quality assessment, operational information, survey information available.
C12C	Vaal (main)	C	3	Sites visited, Google Earth, land coverage, water quality assessment, operational information, survey information available.
C12D	Waterval (Kleinspruit)	D	3	*Clariasgaripinus* occurs, but in small numbers. Were not taken into consideration. Site visited, Google Earth, land cover.
C12E	Boesmanspruit	D	2	Visited, Google Earth, land cover, no biological information.
C12F	Waterval (Kleinspruit)	D	3	*C. garipinus* occurs, but in small numbers. Were not taken into consideration. Site visited, Google Earth, landcover, water quality assessment, operational information.
C12G	Waterval (Kleinspruit)	D	3	Site visited, Google Earth, landcover, water quality assessment, operational information.
C12H	Vaal (main)	C	3	Site visited, Google Earth, land cover, water quality assessment, operational information.

Quaternary catchment	River	PES EcoStatus	Confidence (0 - 5)	Source
C12J	Unnamedtributary	C/D	2	Derived - Standard range of information used.
C12K	Molspruit	C/D	2	Derived - Standard range of information used.
C13A	Sandspruit	B/C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13B	Sandspruit	C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13C	Seekoeivlei (Klip River)	B/C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13D	Klip (after confluence with Modderspruit/Gansvleispruit system)	B/C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13E	Kommandospruit	B	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13F	Klip (after confluence with Kommandospruit)	C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information.
C13G	Spruitsonderdrif	C	2.5	Site visited, Google Earth, landcover, water quality assessment, operational information, fish surveys.
C13H	Klip	C	3	Derived from available information.
C21A	Suikerbosrand	B/C	3	Site visited, Google Earth, landcover, water quality assessment, operational information, fish surveys.
C21B	Suikerbosrand	C	2.5	Site visited high resolution Google Earth, landcover, water quality assessment, and operational information.
C21C	Suikerbosrand	C	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C21D	Blesbokspruit	E/F	4	River lies mostly in urban and mining areas. Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys, information from Kotze, 2002.
C21E	Blesbokspruit	D/E	4	Measured against reference conditions and based on the fact that this is an artificial wetland, information from Kotze, 2002.
C21F	Blesbokspruit	D/E	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys, information from Kotze, 2002.
C21G	Suikerbosrand	C/D	3.5	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys, information from Kotze, 2002.
C22A	Klip River	E	4	Rand Water Klip River study (1997-1999).
C22B	Natalspruit	E	3.5	Rand Water studies.
C22C	Rietspruit (after confluence with Natalspruit)	E	3.5	Rand Water studies.
C22D	Klip	D	3.5	Rand Water Klip River study (1997-1999).
C22E	Klip	D/E	3.5	Rand Water Klip River study (1997-1999).
C22F	Vaal (downstream from Vaal Dam)	D	3	Sections inundated by backup from the barrage.Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C22G	Taaibosspruit	C	2.5	Quaternary largely upstream of Sasol pollution, therefore the lower water quality problems (4 rating) not considered.
C22H	Rietspruit	D/E	2.5	Derived - Standard range of information used.
C22J	Leeuspruit	D/E	2.5	Derived - Standard range of information used.
C23A	Kromellemboogspruit	B/C	2	Derived - Standard range of information used.
C23B	Vaal	D	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C23C	Vaal (Parys)	D	3	Site visited high resolution Google Earth, landcover, water

Quaternary catchment	River	PES EcoStatus	Confidence (0 - 5)	Source
				quality assessment, operational information, fish surveys.
C23D	Wonderfonteinspruit	E	3	Video, Google Earth, Newspaper articles, Scientific report – radio activity problem.
C23E	Mooirivierloop	E	3	See above.
C23F	Schoonspruit main stem	C/D	3	Information regarding peat mining.
C23G	Mooi (upstream from Boskop Dam)	D	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C23H	Mooi (just before confluence with Loopspruit)	D	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C23J	Loopspruit (above KlipdrifDam)	D	3	Video available, narrative of impacts, high quality Google Earth.
C23K	Loopspruit	D	2.5	Video available, narrative of impacts, high quality Google Earth.
C23L	Vaal (downstream from Parys)	D	3	Site visited high resolution Google Earth, landcover, water quality assessment, operational information, fish surveys.
C81A	Wilge (main stem)	B	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81B	Wilge (main stem)	B/C	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81C	Modder/Fraser	B/C	2	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81E	Wilge (main stem)	D	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81F	Elands (Wilge tributary)	D	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81G	Klerkspruit (Elands (Wilge tributary)?)	C	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81H	Elands (Wilge tributary)	C	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81J	Vaalbanks (Wilge tributary)	C	2.5	Derived - Standard range of information used, Kotze en Niehaus, 2000.
C81K	Wilge (main stem)	C	2.5	Derived - Standard range of information used.
C81L	Meul (Wilge tributary)	B	2.5	Site visited, Google Earth, land cover, water quality assessment, operational information.
C81M	Meul (Wilge tributary)	B	2.5	Site visited, Google Earth, land cover, water quality assessment, operational information.
C82A	Cornelis (Wilge tributary)	B	2	Site visited, Google Earth, land cover, water quality assessment, operational information.
C82B	Cornelis (Wilge tributary)	C	3	Google Earth, land cover, water quality assessment, operational information.
C82C	Wilge (main stem)	C	2.5	Carp present, however other impacts more significant therefore left out. Site visited, Google Earth, land cover, water quality assessment, operational information.
C82D	Rus se Spruit (Wilge tributary)	C	2.5	Google Earth, land cover, water quality assessment, operational information.
C82E	Holspruit (Wilge tributary)	C	2.5	Google Earth, land cover, water quality assessment, operational information.
C82F	Grootspruit (Wilge tributary)	C	2.5	Site visited, Google Earth, land cover, water quality assessment, operational information.
C82G	Wilge (main stem)	C	2.5	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.
C82H	Wilge (main stem)	C	3	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.
C83A	Liebenbergsvlei River section in quaternary	D	2	Derived - Standard range of information used.

Quaternary catchment	River	PES EcoStatus	Confidence (0 - 5)	Source
C83A	Ash River section in quaternary	E/F	3	Derived - Standard range of information used.
C83B	Jordaans	C	2	Derived - Standard range of information used.
C83C	Liebenbergsvlei	D/E	3	Derived - Standard range of information used.
C83D	Tierkloof	C/D	2	Derived - Standard range of information used.
C83E	Tierkloof	C/D	2	Derived - Standard range of information used.
C83F	Liebenbergsvlei	D	3	Derived - Standard range of information used.
C83G	Liebenbergsvlei	D	3	Derived - Standard range of information used.
C83H	Liebenbergsvlei	D	3	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.
C83J	Wilge (main stem)	D	3	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.
C83K	Kromspruit	B	2	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.
C83L	Klip	B	2	Site visited, Google Earth, land cover, water quality assessment, operational information, fish surveys.

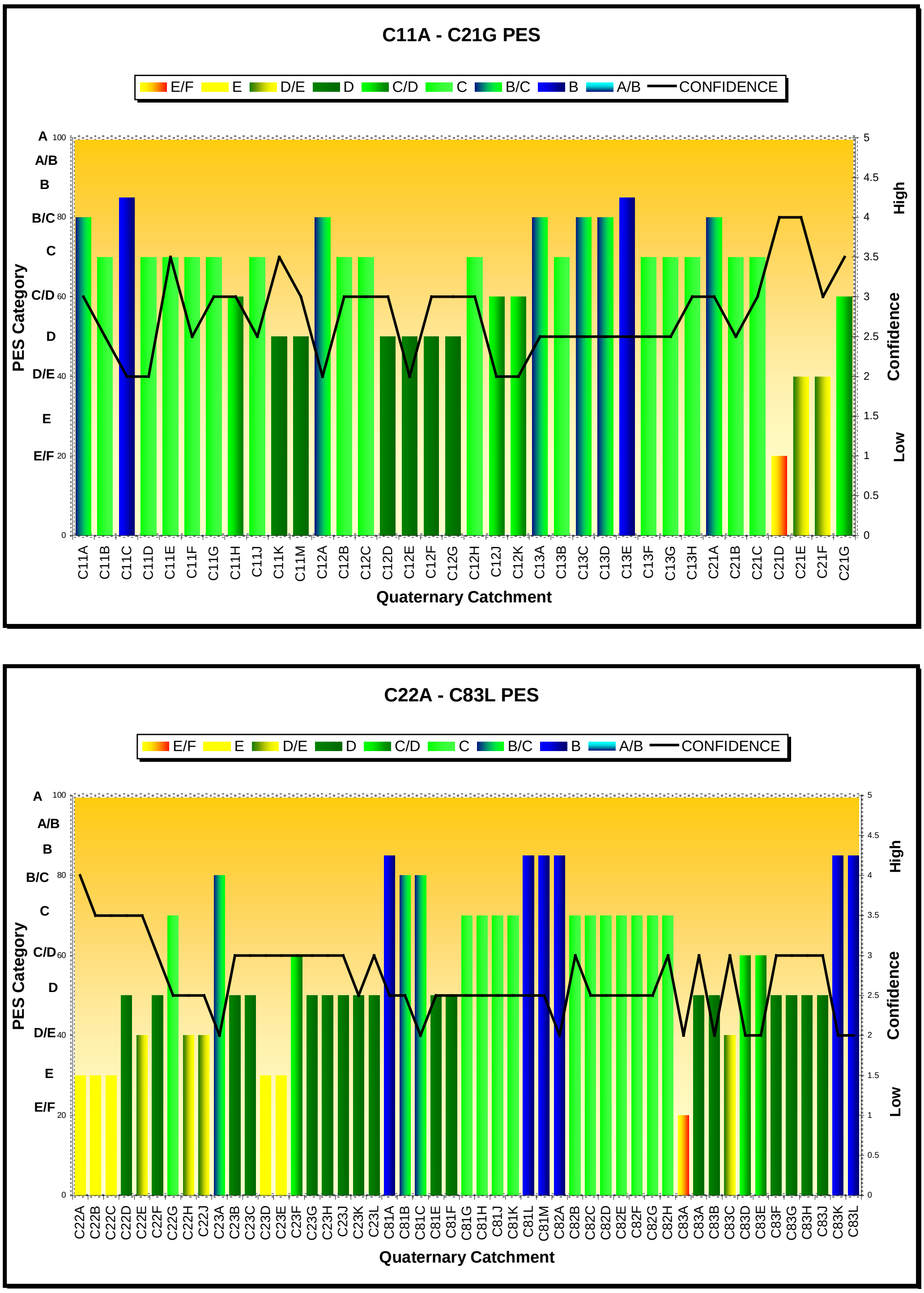


Figure 5.4 PES and confidence evaluation illustrated as bar graphs

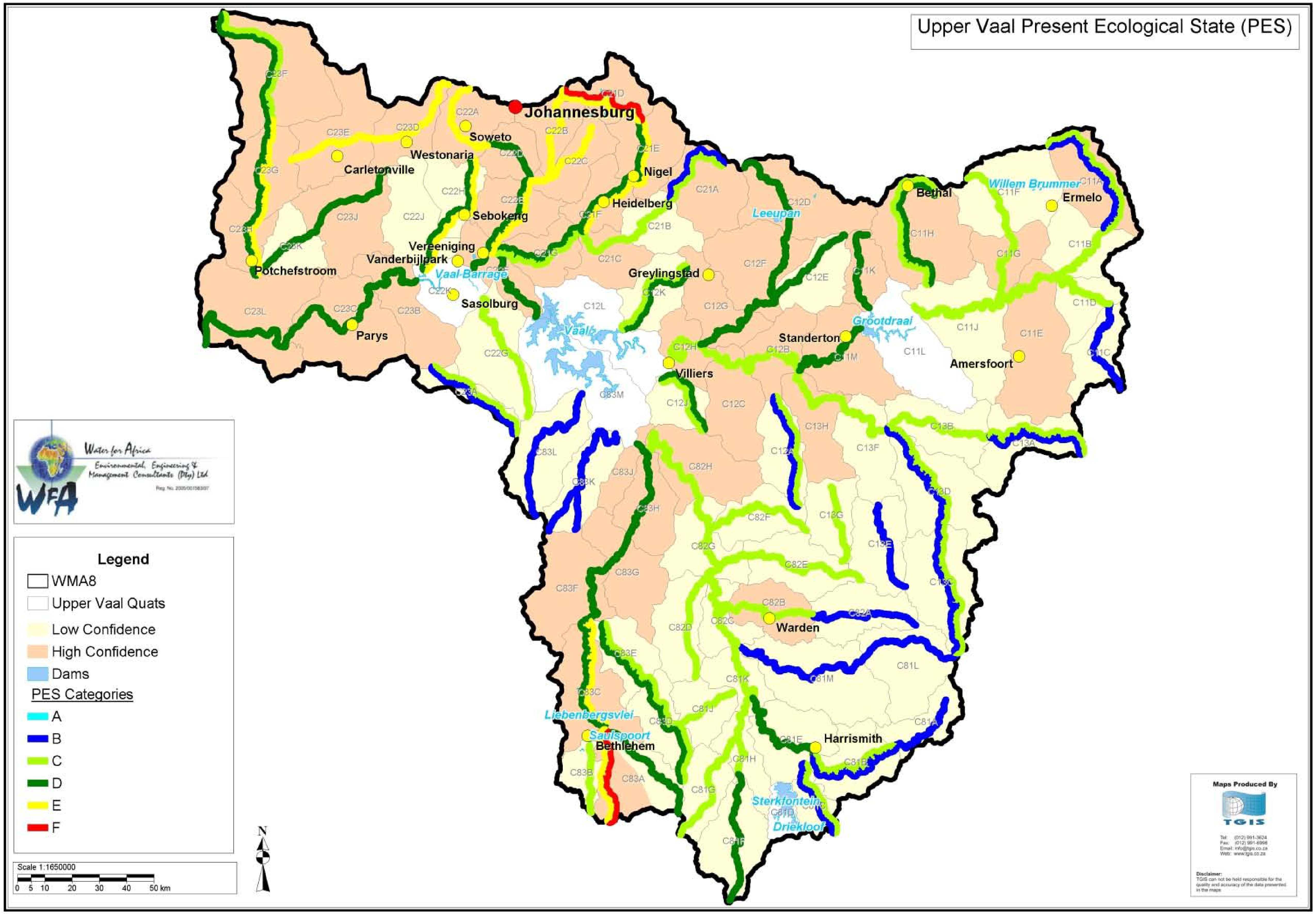


Figure 5.5 PES Map illustrating PES categories and confidence

5.4 CONCLUSIONS

The bulk of the rivers in WMA 8 are in a C, C/D and D PES. Please note again that this does not include all the smaller tributaries. The rivers in a B PESare the following:

- C11C: Klein Vaal
- C13E: Kommandospruit
- C81L & C81M: Meul
- C82A: Cornelis
- C83K: Kromspruit
- C83L: Klipspruit

This means that there are very few rivers in this large WMA which are potentially still in a good condition. The reason for this is the high utilisation of the catchment due to mining, irrigation and the urban sprawl of Gauteng. Water quality issues are prevalent in many streams as well as increased flows, i.e. more than natural.

Approximately 50% of the quaternaries have a moderate to high confidence.

6 RECOMMENDATIONS

Recommendations have been made using twomatrices(Figure 6.1 andFigure 6.2) to provide consistent answers.

6.1 INTEGRATED (ECOLOGICAL AND SOCIO-CULTURAL) IMPORTANCE

The first matrix illustrates a combination of EIS,SCI, and PES, to provide an indication of overall / integrated importance with the emphasis on the restoration potential. The restoration potential refers to the probability of achieving the rehabilitation of the river to an improved state.For example, if a river has very high overall importance, but is in bad condition, the restoration potential is often low.

However, rivers in good condition are scarce, and therefore important in their own right. A river that is in very good condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is still in good condition.

According to the matrix (note, the curves have not been fitted,but have been 'hand drawn'), an Integrated Importance value is estimated from 1 (low importance, to 4 high importance).

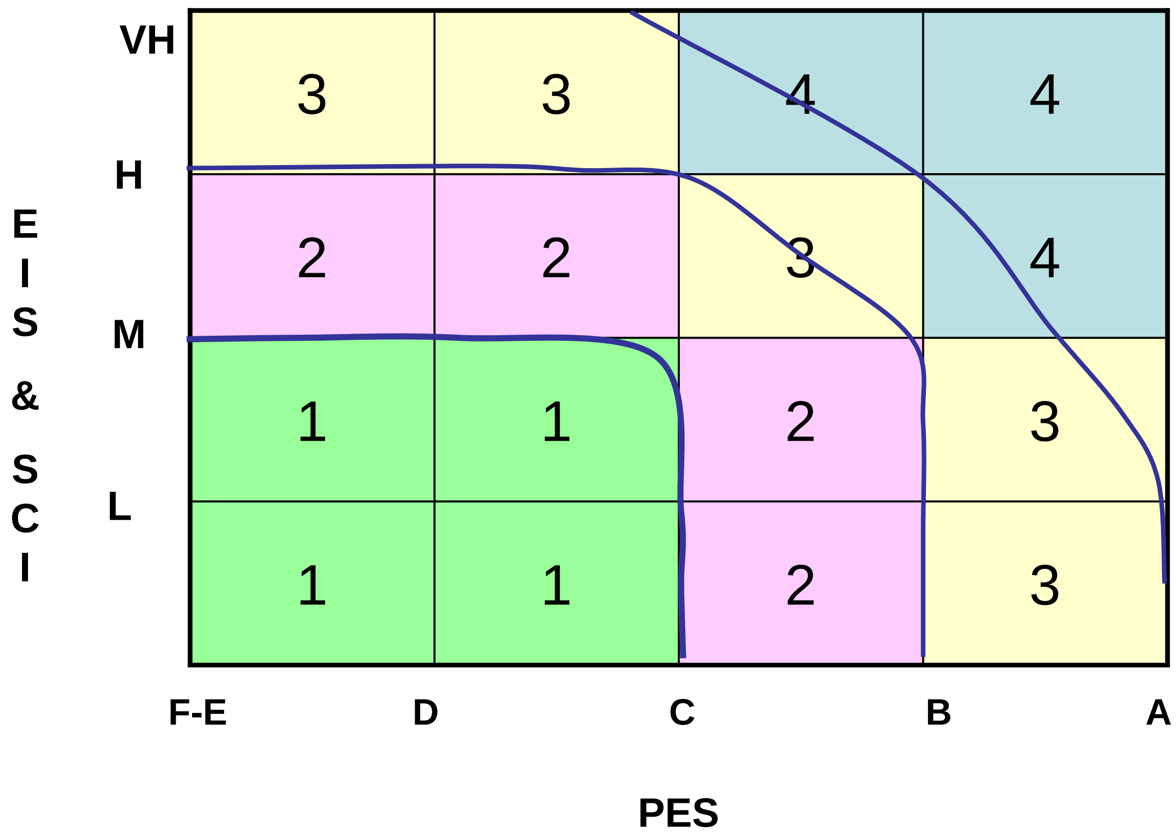


Figure 6.1 Matrix used to determine a combined EIS and PES value which provides an Integrated Importance value on a scale of 0 –4

The results of the evaluation arelisted in the Table 6.1 and illustrated inFigure 6.2. This depicts the areas of high (3) and very high (4) Integrated Importance in the quaternary catchmentson a spatial scale. The additional information provided in Figure 6-2 is the quaternary catchment where specific EIS or SCI metrics have rated a 4. These are illustrated as lines on the rivers.

Table 6.1 Quaternaries of high and very high Integrated Importance

Quaternary Catchment	River	Importance Rating (0–4)	Reasons for Evaluation
C11A	Vaal	3	Moderate EIS and B/C PES
C11C	Klein Vaal	4	Moderate EIS and B PES
C12A	Venterspruit	3	Moderate EIS and B/C PES
C13A	Sandspruit	3	Moderate EIS and B/C PES
C13C	Seekoeivlei (Klip River)	4	High EIS and B/C PES
C13D	Klip (after confluence with Modderspruit/Gansvleispruit system)	3	Moderate EIS and B/C PES
C13E	Kommandospruit	4	Moderate EIS and B PES
C21A	Suikerbosrand	3	Moderate EIS and B PES
C21C	Suikerbosrand	3	High EIS and C PES
C23A	Kromellemboogspruit	3	Moderate EIS and B/C PES
C23C	Vaal	3	High EIS and D PES
C23L	Vaal	3	High EIS and D PES
C81A	Wilge (main stem)	3	Low EIS and B PES
C81B	Wilge (main stem)	3	Moderate EIS and B PES
C81C	Modder/Fraser	3	Moderate EIS and B PES
C81L	Meul	4	Moderate EIS and B PES
C81M	Meul	4	Moderate EIS and B PES
C82A	Cornelius	4	Moderate EIS and B PES
C83E	Tierkloof	3	High EIS and C/D PES
C83K	Kromspruit	4	Moderate EIS and B PES
C83L	Klip	4	Moderate EIS and B PES

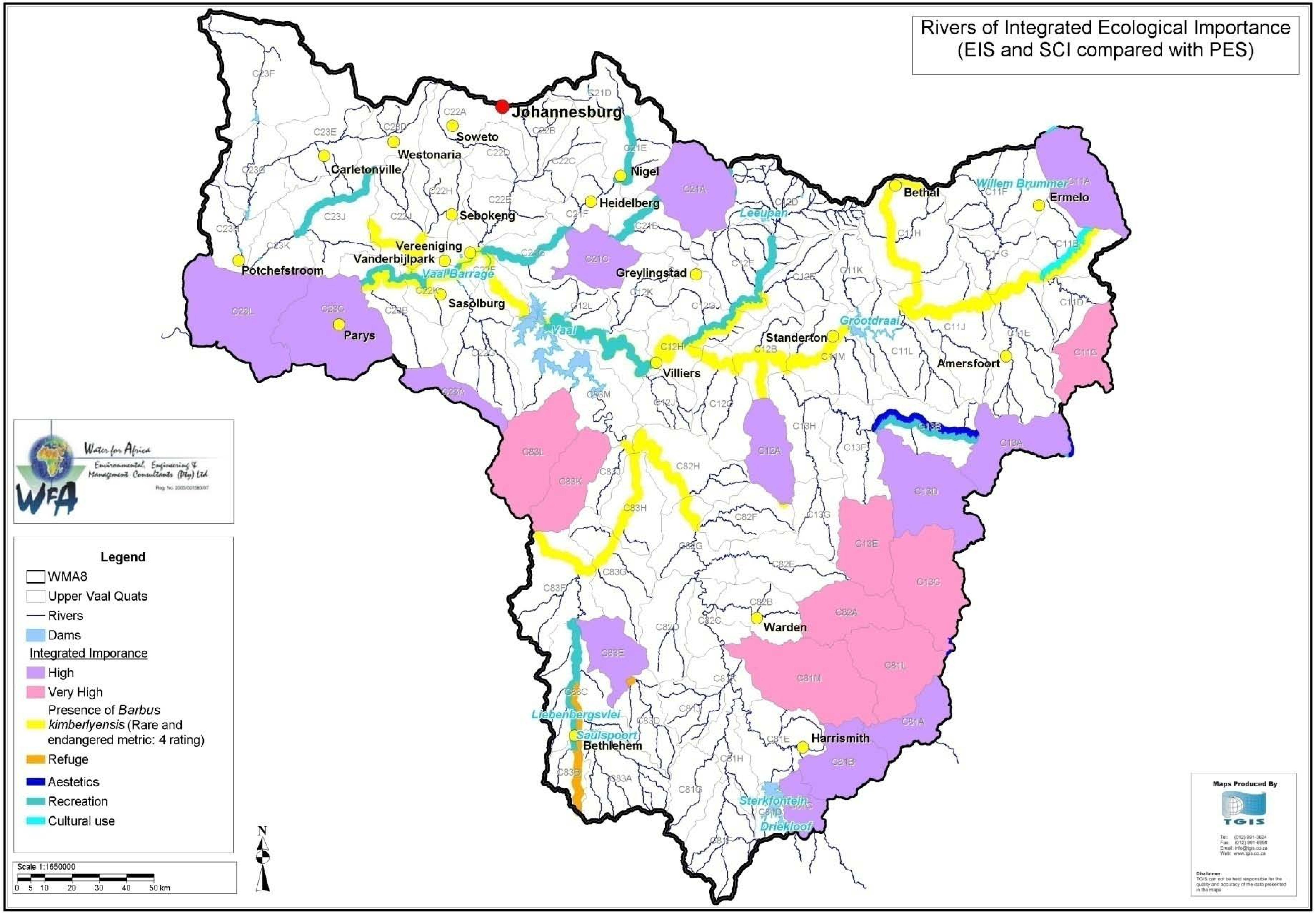


Figure 6.2 Map illustrating areas of high Integrated Importance

6.2 RECOMMENDATIONS

The second matrix has two axes (Figure 6.3). The X-axis is based on the Integrated Importance value derived from the first matrix (Figure 6.1, Table 6.1and results illustrated in Figure 6.2). The Y-axis depicts an estimate of water resource use (DWAF, 2007),with a 0 being of no importance and 4 being of very high importance (cf 6.2.1).

This second matrix was used toidentify quaternary catchments which are so called 'hotspots'. A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia.org/wiki/Biodiversity_hotspot). In the context used in the Desktop EcoClassification, the hotspot represents a quaternary catchment with a high Integrated Importance which could be under threat due to its importance for water resource use. These hotspots indicate areas where Reserve assessments should ideally result in high confidence recommendations. This then guidestheinitial estimate of the level of the assessmentsrequired,and indicates areas where detailed investigations would be required if development was being considered.It must be noted that a detailed Reserve assessment does not necessarily provide high confidence results. This is usually due to constraints such as lack of available data (hydrology, biota etc.).

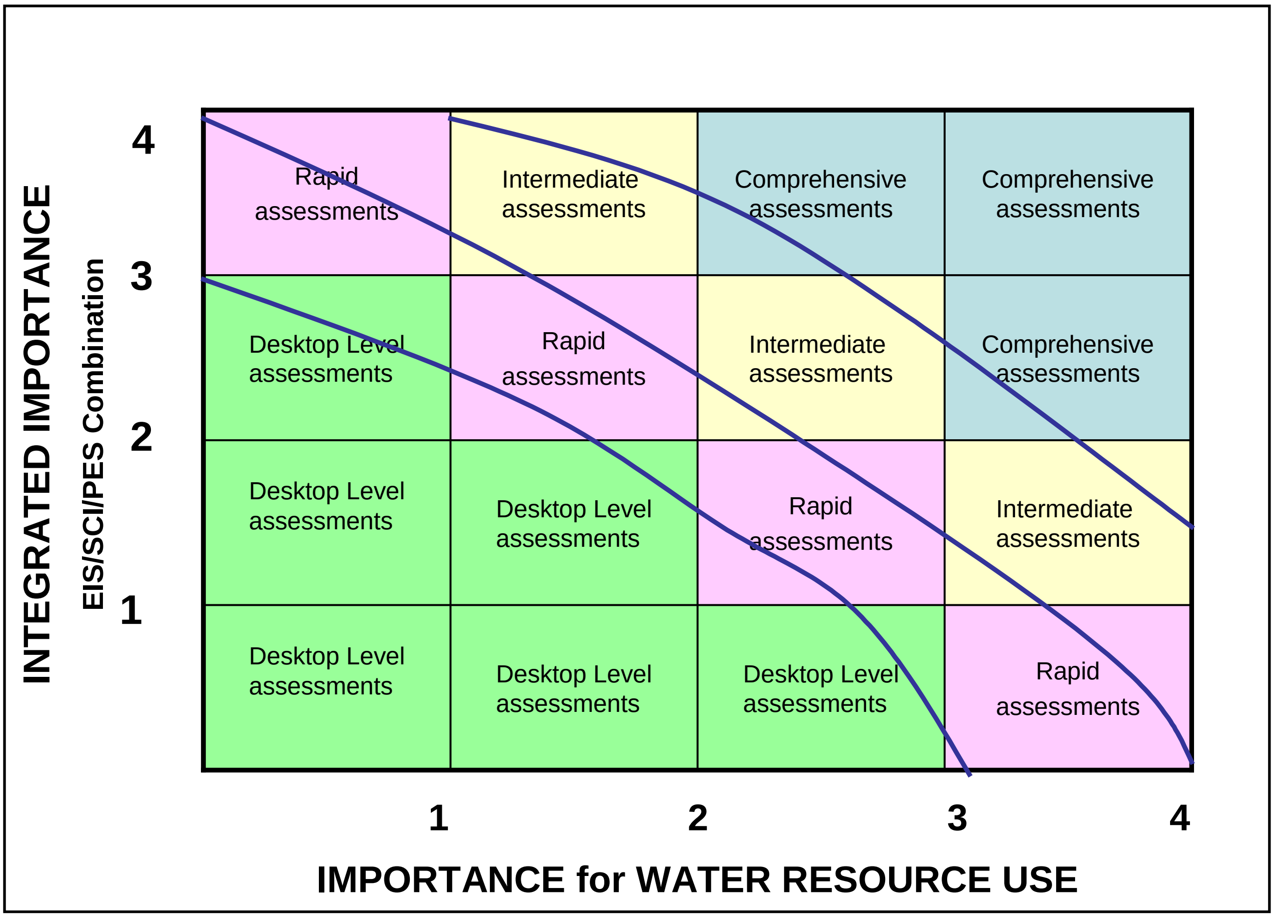


Figure 6.3 Matrix indicating the level of EWR assessments required

6.2.1 Importance of Water Resource Use

The priority rating method consists of assigning a qualitative score to a river reach for four variables or factors that represent the status of the instream flow. The scores of the four variables are combined to determine (qualitatively) an overall score which represents the importance of the river reach in terms of the water resource use and guides decision making with regard to what level of assessment is needed (Appendix A). These ratings are an indication of possible impacts in the area that can affect the PES. They are not applied in the actual models and do not contribute quantitatively to the PES, EIS or SCI.

6.2.2 Determine level of EWR

The matrix was used to compare the integrated importance with the Water Resource Use importance and the results are provided in Table 6.2 and Figure 6.4. Important water resource use areas are highlighted in green in Table 6.2.

Table 6.2 Quaternary catchments of high Integrated Importance and/or high Water Resource Use Importance

Quaternary Catchment	River	Importance Rating (0–4)	Water Resource Stress Rating	Recommendations PRIORITY RATING	Reasons for Evaluation
C11A	Vaal	3	1	2	High EIS and PES
C11B	Vaal	2	1	1	
C11C	Klein Vaal	4	1	2	High ecological importance upstream of transfer
C11D	Klein Vaal	2	2	2	Important from a transfer point of view
C11E& C11J	**Vaal**	**2**	**3**	**3**	**Transfer of water into Grootdraai Dam**
C11F& C11G	Drinkwaterspruit (Rietspruit)	2.5	2	2	Ermelo
C11H	Blesbokspruit	1.5	1	1	
C11K	Leeuspruit	1.5	1	1	
C11M, C12B, C, H	**Vaal**	**2.5**	**4**	**3**	**Transport of water to the Vaal River fromGrootdraaiDam**
C12A	Venterspruit	3	0	1	High integrated importance
C12D, F, G	Waterval (Kleinspruit)	1	2?	1	
C12E	Boesmanspruit	1	0	1	
C12J	Unnamed	1	0	1	
C12K	Molspruit	1	0	1	
C13A	Sandspruit	3	0	1	High integrated importance
C13B	Sandspruit	2	0	1	
C13C	Seekoeivlei (Klip River)	4	0	2	High integrated importance due to RAMSAR wetland
C13D	**Klip (after confluence with Modderspruit/ Gansvleispruit system)**	**3**	**2**	**3**	**Possible dam downstream**
C13E	Kommandospruit	4	0	2	High PES, moderate EIS
C13F	Klip	2.5	2	3	Possible dam downstream

Quaternary Catchment	River	Importance Rating (0–4)	Water Resource Stress Rating	Recommendations PRIORITY RATING	Reasons for Evaluation
C13G	Spruitsonderdrif	2	0	1	
C13H	**Klip**	**2.5**	**2**	**3**	**Possible dam**
C21A	Suikerbosrand	3	0	1	High PES, moderate EIS
C21B	Suikerbosrand	2	0	1	
C21C	Suikerbosrand	3	1	2	High PES, moderate EIS
C21D	Blesbokspruit	1	3	2	Water quality, and too much water
C21E	Blesbokspruit	1	3	2	Water quality, and too much water
C21F	Blesbokspruit	1	3	2	Water quality, and too much water
C21G	**Suikerbosrand**	**2**	**3**	**3**	**Water quality, and too much water**
C22A	Klip	1	4	2	Due to Water quality issues
C22B	Natalspruit	1	4	2	Due to Water quality issues
C22C	Rietspruit	1	4	2	Due to Water quality issues
C22D	Klip	1	4	2	Due to Water quality issues
C22E	Klip	1	4	2	Due to Water quality issues
C22F	**Vaal**	**2.5**	**4**	**3**	**Presence of BKIM[1] and releases from Vaal Dam**
C22G	**Taaibosspruit**	**2**	**1**	**1**	
C22H	Rietspruit	1	3	1	Due to water quality issues
C22J	Leeuspruit	1	3	1	Water quality
C22K	Taaibosspruit	1	3	1	Sasol water quality problems
C22K	Vaal	3	4	4	BKIM, high integrated importance and water use importance
C23A	Kromellemboogspruit	3	0	1	Integrated importance
C23B	**Vaal**	**3**	**4**	**4**	**BKIM, High integrated importance and water use importance**
C23C	**Vaal**	**3**	**4**	**4**	**BKIM, High integrated importance and water use importance**
C23D & E	Wonderfonteinspruit	1	3?	1	Significant radiation problems – Reserve will not address the problem, therefore low priority
C23F	Schoonspruit	1	4	2	
C23G	**Mooi**	**1.5**	**4**	**3**	**Water balance**
C23H	**Mooi**	**1.5**	**4**	**3**	**Water balance**
C23J	Loopspruit	1	1?	1	
C23K	Loopspruit	1	4	2	Water balance
C23L	**Vaal**	**3**	**4**	**4**	**BKIM, High integrated importance and water use importance**
C81A	**Wilge (main stem)**	**3**	**3**	**3**	**Proposed Braamhoek Pump Storage Scheme**
C81B	Wilge (main stem)	3	0	1	High integrated importance
C81C	Modder/Fraser	3	0	1	High integrated importance
C81E & DS quats	**Wilge**	**2.5**	**3**	**3**	**Role of transporting water from Sterkfontein Dam**
C81F	Elands	1.5	3	2	Supply to Phuthaditjaba
C81G	Klerkspruit	2	0	1	
C81H	Elands	2	0	1	
C81J	Vaalbanks	2	0	1	
C81K	**Wilge**	**2**	**4**	**3**	**Role as conduit**

Quaternary Catchment	River	Importance Rating (0–4)	Water Resource Stress Rating	Recommendations PRIORITY RATING	Reasons for Evaluation
C81L	Meul	4	0	2	High PES EIS
C81M	Meul	4	0	2	High PES EIS
C82A	Cornelius	4	0	2	
C82B	Cornelis	2	0	1	
C82C	Wilge	2	4	3	Conduit
C82D	Rus se spruit	2	0	1	
C82E	Holspruit	2	0	1	
C82F	Grootspruit	2	0	1	
C82G	**Wilge**	**2**	**4**	**3**	**Proposed pump storage scheme**
C82H	**Wilge**	**2**	**4**	**3**	**Proposed pump storage scheme**
C83A	Liebenbergsvlei	1	0	1	
C83A	Axel River	1	4	2	Limited operational possibilities and impossible to work on site
C83B	Jordaans	2	0	1	
C83C	Liebenbergsvlei	2	4	2	Water balance and operational purposes. Limited
					operational possibilities and impossible to work on site
C83D	Tierkloof	2	0	1	
C83E	Tierkloof	3	0	2	High EIS
C83F, G, H	Liebenbergsvlei	1	4	2	Water balance and operational purposes
C83K	Kromspruit	4	0	2	High PES and EIS
C83L	Klip	4	0	2	High PES and EIS

1*Labeobarbuskimberleyensis*

These areas are illustrated spatially on a map (Figure 6.4). These dark and light red quaternaries represent the main river reaches where considerable care should be taken when considering development and which would require intermediate or comprehensive EWR assessment.

This assessment guided the selection of EWR sites (See the Resource Unit report, DWAF, 2008). It will be attempted to place most of the sites within the 'Very High' and 'High' areas. The selection of EWR sites is also dependant on other factors such as the suitability of potential sites for EWR assessments and areas with a high demand for licenses.

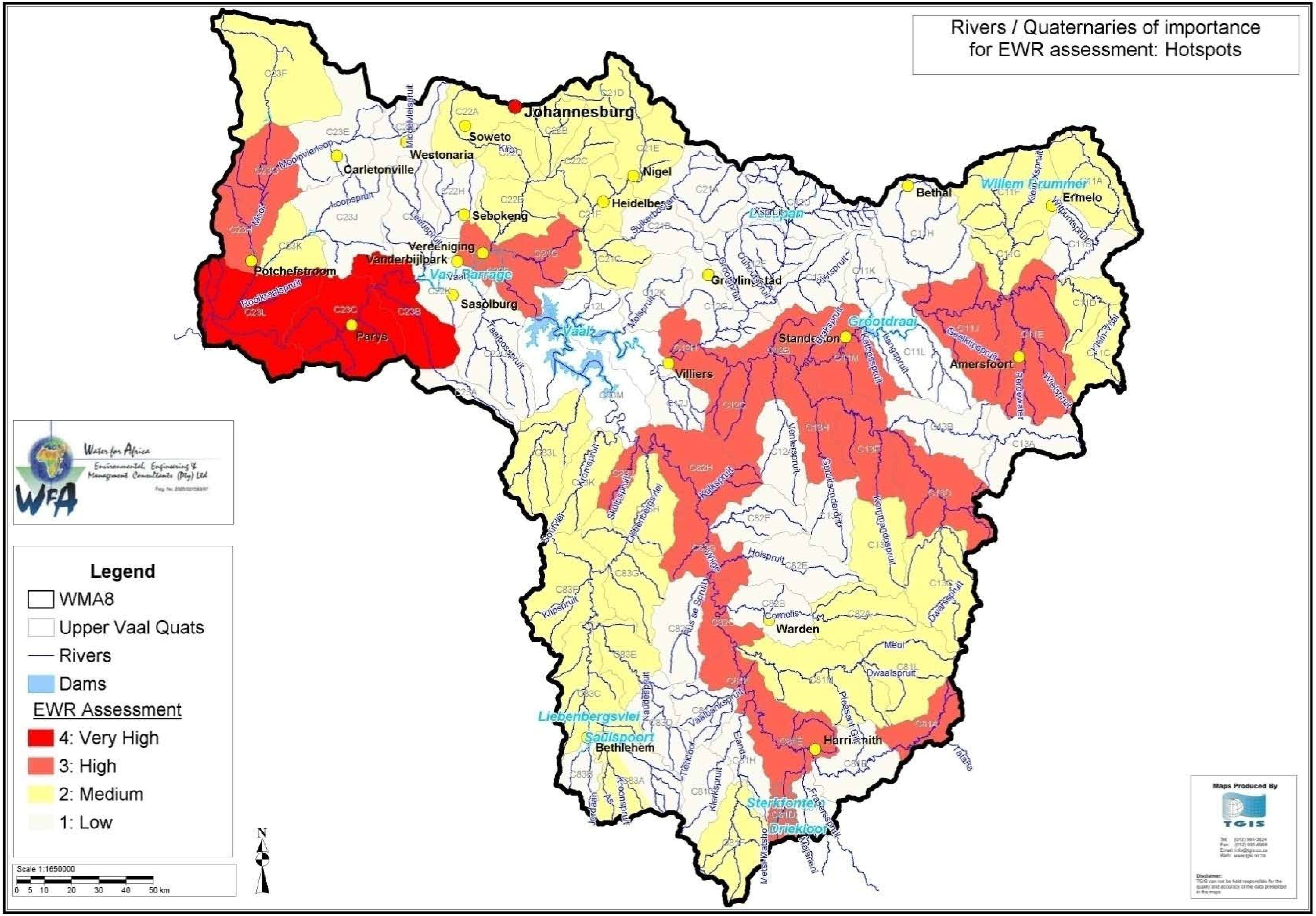


Figure 6.4 Sections in rivers which are important for Reserve assessment (Hotspots) (derived from overlaying Integrated Importance and Water Resource Use)

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APPENDIX A

WATER RESOURCE USE PRIORITY RATING OF THE RIVER REACHES IN THE VAAL RIVER SYSTEM

WRP Consulting Engineers

A1 INTRODUCTION

The purpose of this document is to describe and apply a procedure to identify the tributaries and river reaches of VaalRiver where Ecological Water Requirements (EWR) should be determined from a water resource utilisation and management perspective. The water resource use rating system also guides the selection of the appropriate EWR determination method (comprehensive, intermediate, rapid or desktop) to be carried out for the tributaries and river reaches.

The Reserve Determination Study Teams will use the assigned water resource use rating in conjunction with a rating of the ecological importance to select the location and define the Ecological Water Requirement determination method for each site.

SectionA2 of the document describes the water resource use rating system and **Section A3** presents the scores assigned to the indicated river reaches. A brief description of the function and operation of each river reach is also provided.

A2 WATER RESOURCE USE PRIORITY RATING METHOD FOR RIVER REACHES

The priority rating method consists of assigning a qualitative score to a river reach for four variables or factors that represent the status of the in-stream flow. The scores of the four variables are combined to determine (qualitatively) an overall score which represents the importance of the river reach in terms of the water resource use and guide the selection of the EWR determination method to be applied.

The variables or factors included in the rating method aim to represent the status and function of the river reach. The variables and the associated characteristics associated with a score ranging from zero to four are presented in Table A1 below.

Table A2 presents the meaning of the overall score, which indicates the EWR determination method that is recommended for the river reach in terms of the water resource use. It is important to note that the final decision in terms of the required level of detail of the Reserve Study will be based on the overall water resource use score in combination with the ecological importance of the relevant river reach.

Table A1 Water Resource Use Priority rating variables and scoring characteristics

Variables	Score range and associated characteristic descriptions	
	0	4
Current water balance of catchment contributing flow to the river reach.	Very little water use occurs in the upstream catchment. Low, maintenance and high flow is largely natural.	Significant utilisation of water from the upstream catchment. Low and maintenance flows have been reduced and/or there exists significant regulating storage in the catchment.
Utilisation of the river reach for operational purposes.	Minimum changes in the river flow due to operational purposes.	The river reach is utilised as a conveyance conduit.
Possible future developments and/or water use expected in the catchment.	No known development planned in the catchment that could change the flow in the river reach.	It is expected that future developments which could change the flow in the river could occur.
Water quality related problems, assimilative capacity.	The water quality in the river reach is excellent and large assimilative capacity is present.	The river contains very high loads of pollutants.
Overall score.	There is no reason to determine the EWR in the river reach from a water resource management perspective.	A comprehensive EWR determination is necessary from a water use point of view.

Table A2 Meaning of overall score

Overall score	Importance in terms of Water Resource Use	Typical EWR determination method (#)
0	Very low.	There is no reason to determine the EWR in the river reach from a water resource management perspective.
1	Low.	Desktop EWR determination is recommended.
2	Moderate.	Rapid EWR determination is recommended.
3	High.	Intermediate EWR determination is recommended.
4	Very high.	A Comprehensive EWR determination is recommended.

#The final EWR determination method depends on a combination of the water resource use rating and the ecological importance.

A3 RIVER REACH DESCRIPTION AND WATER RESOURCE USE PRIORITY SCORE

A3.1 LITTLE VAALRIVER (C11C)

Water is transferred from Heyshope Dam into the Little Vaal River (i.e. into the lower part of quaternary C11C). The normal operating rule is to transfer water to the VaalRiver system if Grootdraai Dam's storage decreases below 90%. The maximum transfer rate is 4.6 m^3/s. There may be limited flexibility in the transfer rate (lower than the maximum) if one or two of the three pump sets are used.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisations of the river reach for operational purposes. [1]	2
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**2**

1Transfers from Heyshope into river reach are regulated by storage within Grootdraai Dam.

A3.1.1 SkulpspruitRiver (C11E)

The transfer from Zaaihoek Dam discharges water into the Perdewaterspruit, which is a tributary of the Skulpspruit. The water is released in the river system upstream of Amersfoort Dam, which is small storage dam providing water to the town. The transfer from Zaaihoek Dam is mainly for the purpose of supplying water to Majuba Power Station and the releases to Grootdraai Dam (into Perdewaterspruit) is only the excess yield that is available in Zaaihoek Dam after Majuba's water requirement has been supplied.The water transferred into Grootdraai Dam has decreased over time due to the increasing usage from Majuba Power Station, and as the different generation units were commissioned.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes. (1)	2
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**2**

1Frequency of transfers from Zaaihoek into river reach are regulated by storage within Grootdraai Dam, whilst the transfer volumes are determined by the excess yield available from the Zaaihoek Dam Sub-system.

A3.1.2 RietspruitRiver (C11F)

MsukaligwaLocalMunicipality (former Ermelo TLC) is situated within this catchment. There are two dams, Willem Brummer and Douglas dams, in this river system supplying water to Msukaligwa(Based on information received from Trevor Coleman).There are also coal mining activities in the catchment upstream of these dams. These dams are small storage structures and it is unlikely that they have any release capabilities. The town of Msukaligwa uses all the available water from these dams and in dry periods the dams are frequently depleted.Msukaligwa also receives water from the Rietspruit-Davelpipeline (i.e. the pipeline from Jericho Dam providing water to the Usutu-Vaal Eskom Power Stations).

Variables	Score
Current water balance of catchment contributing flow to the river reach.	2
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**2**

A3.1.3 **Vaal River reach between C11M and Grootdraai Dam**

The VaalRiver reach downstream of Grootdraai Dam receives compensation water from Grootdraai Dam. This is a variable flow (dependant on the inflow) and this water is used by Lekwa LM (former Standerton TLC) as well as downstream irrigators. The yield balance of Grootdraai Dam is such that all available water is used to supply Sasol (Secunda Complex) and Eskom Power Stations. Any additional water released from the dam would result is a negative yield balance and will have an impact on the Eastern Sub-system of the Integrated Vaal River System.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.4 **SandspruitRiver (C13A and C13B)**

The Sandspruit, which is a tributary of the Klip River, should be mostly natural without any regulating storage and only minor water abstractions.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**0**

A3.1.5 **KlipRiver (including and upstream of C13H)**

The KlipRiver is largely natural and there is no large regulating storage in the catchment. The yield balance of the river system is positive. This catchment is contributing a large portion of the incremental runoff to Vaal Dam and is an important tributary of the VaalRiver, in terms of providing natural variable flow downstream of Grootdraai Dam. There is a possibility (has been investigated in past studies) of constructing a dam on the KlipRiver. The most feasible option was found to be a dam in quaternary catchment C13F (just downstream of the tributary from quaternary C13E) from where water will be transferred (pumped) to Grootdraai Dam.

Current (June 2007) information on the projected water requirements of Sasol Secundaand Eskom points to the need for further augmentation to the Eastern Vaal River Sub-system by approximately the year 2014. This required intervention is in addition to the Vaal River Eastern Sub-system Augmentation Project (VRESAP) pipeline from Vaal Dam that is currently being constructed. It is, therefore, possible that the dam on the KlipRiver could provide this additional water. This option will, however, have to be investigated further.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes. (1)	0
Possible future developments and/or water use expected in the catchment.	2
Water quality related problems, assimilative capacity.	0
Overall score	**2**

1Possible construction of dam on Klip to augment water supply to Sasol Secunda and Eskom.

A3.1.6 WilgeRiver System (upstream of quaternary catchment C82H)

This river system has Sterkfontein Dam (located in C81D) as the only regulating storage. Sterkfontein Dam receives water from the Thukela-Vaal Transfer Scheme and contains the “reserve” water for the Integrated Vaal River System.The operating rule of Sterkfontein Dam is such that water is only released from the dam when Vaal Dam is at low levels.

Eskom is planning the Braamhoek Pump-storage Scheme that will result in the construction of a dam in the upper part of quaternary C81A. According to available information, there was a EWR determination study done for this proposed dam.

In the upper portion of quaternary C81F water is abstracted from FikaPatso and MetsiMatso dams to supply the Phuthaditjaba area.Currently there are plans to further support the Phuthaditjaba area with water from Sterkfontein Dam, which is an indication that the water resources of the above-mentioned two dams are fully utilised.

The remainder of the Wilge River System is largely unregulated with only small dams for water supply to local users. Water users within this catchment comprise of both urban and irrigation user groups. The available network models simulate the Wilge River System as a unit and it is therefore not possible to give yield balances for the individual tributary catchments.

The WilgeRiver may in future be the transfer conduit to convey water from the proposed Thukela Water Project (TWP) to Vaal Dam. This proposed transfer scheme is an alternative to a possible further phase of the Lesotho Highlands Water Project.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	2
Utilisation of the river reach is for operational purposes. (1)	4
Possible future developments and/or water use expected in the catchment.(2)	1
Water quality related problems, assimilative capacity.	0
Overall score	**4**

1 Transfer conduit for proposed Thukela Water Project.
2 Support from Sterkfontein to Phuthaditjaba area.

A3.1.7 Liebenbergsvlei River (including and upstream of C83H)

The flow in the LiebenbergsvleiRiver is dominated by the transfer from the Lesotho Highlands Water Project (LHWP). The LHWP water is discharged into the river system upstream of Saulspoort Dam (located in quaternary catchment C83A).Saulspoort Dam supplieswater to the town of Bethlehem as well as to irrigation farmers. There are significant irrigation abstractions along the Liebenbergsvlei River, of which a significant portion is considered to be unlawful.

Variables	Score
Current water balance of catchment contributing flow to the river reach. (1)	4
Utilisation of the river reach is for operational purposes.	4
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

1Initiatives to eradicate unlawful irrigation water use should be implemented as a matter of urgency.

A3.1.8 WatervalRiver (including C12G and upstream)

The WatervalRiverreceives discharges from the Sasol Secunda Complex as well as treated urban wastewater.From the salinity balance done by Chris Herald as part of the Vaal River System Analysis Update (VRSAU) study, there is also evidence of mine water seepage and runoff from the paved urbanised areas contributing to the flow in the river. There are irrigators situated downstream of the above-mentioned discharges. Since the existing water resource models do not simulate this river system as a separate unit, information on the yield balance of this river system is not available. It would, therefore, be necessary to refine the modeling of this river system based on information from studies done by others (Van Veelen and/or Coleman). It is proposed that the results based on the most recent EWR study be adopted for this catchment.

A3.1.9 Vaal River, reach from Vaal Barrage to Vaal Dam

The water body created by the Vaal Barrage dam wall dominates this river reach. Management of the flow into this reach is from Vaal Dam and is influenced by the water users in and downstream of the Vaal Barrage, the urban return flows and mine dewatering discharges as well as the releases form Vaal Dam to maintain the TDS concentration at 600 mg/l. The three main tributaries (Suikerbosrand, Klip and Rietspruit rivers) discharging into the Vaal Barrage, each convey significant volumes of treated wastewater and mine discharge water.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes. (1)	4
Possible future developments and/or water use expected in the catchment. (2)	2
Water quality related problems, assimilative capacity.	4
Overall score	**0**

1 River reach receives regulated releases from Vaal Dam.
2Potential re-use of wastewater and mine discharges that could impact on water quality and inflow to river reach.

A3.1.10 Klip River (including and upstream of C22E)

This river reach receives about 200 million m^3/annum of treated urban wastewater which significantly changed the flow pattern from natural conditions. There is also significant runoff from the paved urbanised areas contributing to the flow in the KlipRiver and discharges from the mines are estimated at approximately 10 million m^3/annum. There is no storage structures that can regulate the flow in this river reach.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes. (1)	4
Possible future developments and/or water use expected in the catchment. (2)	2
Water quality related problems, assimilative capacity.	4
Overall score	**4**

1 The wastewater discharges have altered the natural flow regime of the river reach significantly
2Potential re-use of wastewater and mine discharges that could impact on water quality and inflow to river reach.

A3.1.11 SuikerbosrandRiver (C21C, C21B and C21A)

This portion of the Suikerbosrand River catchment is largely natural, there are no significant abstractions or discharges influencing the river flow, and there are no storage structures that can regulate the flow in this river reach.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**0**

A3.1.12 Suikerbosrandand Blesbokspruit rivers (including C21G, C21F, C21E and C21D)

About 50 million m^3/annum of treated urban wastewater is discharged into this river system as well as mine water discharges from Grootvlei Mine (now referred to as Petrex) of approximately 27 million m^3/annum. Furthermore, runoff from the paved urbanised areas within the Suikerbosrand catchment also contributes to the flow in the river. There is no storage structures that can regulate the flow in this river reach.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes. (1)	3
Possible future developments and/or water use expected in the catchment. (2)	2
Water quality related problems, assimilative capacity.	3
Overall score	**3**

1 Mine and wastewater discharges as well as urbanised runoff have changed the natural flow regime of the river reach.
2 Potential re-use of wastewater and mine discharges that could impact on water quality and inflow to river reach.

A3.1.13 Rietspruit (including and upstream of C22J)

This river system receives in the order of 35 million m^3/annum treated urban wastewater with the result that high base flows are present in the river. Discharges from the Far West Basin Mines that are in the order of 18 million m^3/annum are made to the Rietspruit and runoff from the paved urbanised areas also contributes to the flow in the river.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes. (1)	3
Possible future developments and/or water use expected in the catchment.(2)	2
Water quality related problems, assimilative capacity.	3
Overall score	**3**

1 Mine and wastewater discharges as well as urbanised runoff have changed the natural flow regime of the river reach.
2 Potential re-use of wastewater and mine discharges that could impact on water quality and inflow to river reach.

A3.1.14 TaaibosspruitRiver (C22K and C22G)

These catchments contain the Sasolburg industrial complex including coal-mining areas. There is no regulating storage structure and water quality is a concern in this river system. More detailed information on these catchments should be available from Catchment Management Strategy studies or detailed water quality studies.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes.	1
Possible future developments and/or water use expected in the catchment. (1)	2
Water quality related problems, assimilative capacity.	3
Overall score	**3**

1Future changes in the water use and operations at the Sasol plant will affect this river reach.

A3.1.15 KromdraaiRiver – (C23A and part of C23B)

The KromdraaiRiver catchment down to its confluence with the VaalRiver is largely natural. With the exception of relatively small irrigation water use, there are no significant abstractions or discharges influencing the river flow. There is no storage structures that can regulate the flow in this river reach.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**0**

A3.1.16 Mooi River– (C23H, Boskop and Klerkskraal dams)

Boskop Dam is located upstream of this river reach and has currently limited excess water available. This is due to significant mine water discharges into the river system. The catchment upstream of Boskop Dam is partly underlain by dolomite. The Wonderfonteinspruit is the most significant tributary of the MooiRiver. Water from the Gerhard Minnebron eye is used for irrigation purposes. Urban return flows from the Flip Human Wastewater Treatment Works are also discharged into the MooiRiver upstream of Boskop Dam. PotchefstroomTown is supplied from a small storage dam, Lakeside Dam, which is supported from Boskop Dam.Boskop Dam also supplies water to the Mooi River Irrigation Scheme. Klerkskraal Dam is located upstream of Boskop Dam in quaternary catchment C23F. There are irrigation water userssupplied directly from

Klerkskraal Dam. Under certain conditions, water is released from Klerkskraal Dam to support Boskop Dam. In order to minimise river losses these releases are, however, made via the concrete lined Klerkskraal canal system. Portions of the natural spills from Klerkskraal Dam are also routed through the right bank canal that spills into Boskop Dam.

There is currently an application for additional irrigation to supply resource poor farmers. It should be noted that there is a significant canal and pipe infrastructure conveying the urban return flows, mine discharges and irrigation water supply in this area. It is proposed that EWR sites be assessed downstream of both dams.

Variables	Score
Current water balance of catchment contributing flow to the river reach. (1)	4
Utilisation of the river reach is for operational purposes. (2)	2
Possible future developments and/or water use expected in the catchment. (3)	2
Water quality related problems, assimilative capacity.	2
Overall score	**4**

1 The assurance of supply is dependant on mine water discharges.
2 Releases made from Boskop Dam to Lakeside Dam.
3Licenceapplications to supply resource poor farmers.

A3.1.17 LoopspruitRiver – (C23K, Klipdrift Dam)

Klipdrift Dam is located upstream of this river reach and provides water to irrigators. There is significant mine dewatering entering the river system upstream of the dam. The yield balance indicates that the water available and the water requirements are in balance (this is with the mine discharges included).

Variables	Score
Current water balance of catchment contributing flow to the river reach. (1)	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	2
Overall score	**0**

1The assurance of supply is dependant on mine water discharges.

A3.1.18 Rhenoster River downstream of Koppies Dam (C70J, most downstream quaternary)

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 not excess water available. The Voorspoed Mine has recently purchased water rights from irrigators that were supplied from Koppies Dam as part of the Koppies Government Water Scheme.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.19 SchoonspruitRiver (including and upstream of C24H)

This rives has been the subject of a Catchment Management Strategy Study which also included a Reserve Determination Study. It is proposed that the information from that study be consulted and used in order to prevent duplication.

A3.1.20 ValsRiver (including and upstream of C61J)

This river system does not have storage regulation capability with release capabilities, with the result that high flow control and management is not possible. Moqhaka (previously known as Kroonstad) is supplied from Serfontein Dam, which has a small storage relative to the runoff. The yield balance situation is such that there are deficits in supply as was recently experienced in restrictions to the town of Moqhaka.

The only management measure to supply the EWRs in this system would be to reduce the water use.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.21 Sand/Vet rivers (upstream of C43D)

The available water resources in this river system are fully utilised. Allemanskraal Dam (located in quaternary C42E) on the SandRiver and Erfenis Dam (located in quaternary C41E) on the VetRiver have flow release regulating capabilities. It is recommended that EWRs be determined downstream of each of these two dams.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes. (1)	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.22 VaalRiver reach between the Vaal Barrage (C22K) and C25C

The main flow regulating capability for this reach is from Vaal Barrage with support from Vaal Dam. There are obviously contributing flows from the Schoonspruit, Mooi, Vals and Rhenoster tributary rivers. The flow in this river reach is influence by various factors as listed below:

- Return flows from mine dewatering and treated urban wastewater into this reach and upstream of the Vaal Barrage contribute to the flow in this river reach.
- In the past years a flow dilution operating rule has been applied where water is released from Vaal Dam to maintain the Total Dissolved Solids (TDS) concentration in the Vaal Barrage not to exceed 600 mg/l. These results in “spills” from Vaal Barrage and in some years can be as much as 200 million m^3/annum.
- There are significant evaporative losses in this river reach.

The location of Bloemhof Dam, at the downstream end of this river reach, provides operating flexibility in that water released from the Vaal Barrage is not necessarily a loss from the Integrated Vaal River System. There are however constraints in the volume of releases that can be made.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes.	4
Possible future developments and/or water use expected in the catchment. (1)	2
Water quality related problems, assimilative capacity.	4
Overall score	**4**

1Any additional water use will have a direct impact on the Vaal River System Yield. Potential re-use of wastewater and mine discharges could impact on water quality.

A3.1.23 VaalRiver reach downstream of Bloemhof Dam (C91B)

The flow in this river reach is dominated by the releases made from Bloemhof Dam for the Vaalharts irrigation Scheme. Vaalharts Weir serves as the structure from where the irrigation water is diverted into the canal that feeds the Vaalharts Irrigation Scheme. Bloemhof Dam has substantial flow regulation capability.

Note:
Since Bloemhof Dam is the main regulating storage structure for the lower portion of the Vaal River, it is proposed that the flow management plan be defined in the form of releases from Bloemhof Dam. It may therefore be possible to develop EWR only for one site downstream of Bloemhof Dam and to use those results to determine the required releases from Bloemhof Dam.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	4
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.24 VaalRiver reach downstream of Vaalharts Weir (C91D)

Water is released from Vaalharts Weir for irrigation and domestic users along this river reach. Vaalharts Weir has flow regulation capability of medium size freshets. Due to the negligible incremental runoff between Bloemhof Dam and Vaalharts Weir all water that has to be released from the Weir must be released from Bloemhof Dam. Any additional water released from the Weir will have an impact on the Integrated Vaal River System's water availability.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	4
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.25 **HartsRiver upstream of Wentzel Dam (C31E and upstream quaternaries)**

This river reach has no upstream regulating storage and there are substantial irrigation abstractions that are already experiencing low assurance of supply. Water is also transferred from the HartsRiver (approximately from the outlet of C31B) into Barberspan (located in quaternary C31D). This transfer will result in some of the base flow being removed from the river reach. The exact operation of this transfer is unknown (capacity of the transfer infrastructure etc.) at this point in time and is currently been investigated. The ecological benefits of not transferring the water to Barberspan should be weighed against the benefits of having the water in Barberspan. **Barberspan Nature Reserve** is positioned 16 km north east of Delareyville. It has been identified as a RAMSAR site and is a sanctuary for waterfowl.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.26 **HartsRiverdownstream of Wentzel Dam (C31F)**

Wentzel Dam is located at the outlet of quaternary C31E, and has limited release capability. The dam supplies water to WentzelTown for domestic purposes. The available yield of Wentzel Dam is fully utilised and EWR releases will result in a deficit in supply.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**4**

A3.1.27 **HartsRiver downstream of Taung Dam (C31F)**

Taung Dam is not utilised and investigations are currently underway to determine the feasibility of using the dam to supply domestic and/or irrigation water requirements from the dam. Taung Dam will have limited release capability (remedial civil works are being carried out on the release structures). The EWR downstream of the dam will have a direct influence on the water that will be available to supply the proposed water uses.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment. (1)	2
Water quality related problems, assimilative capacity.	0
Overall score	**2**

1Investigations under way to assess potential domestic and irrigation water supply from the dam.

A3.1.28 DryHartsRiver (upstream of and including quaternary C32D)

No regulation storage is present in this catchment and the flow is largely natural.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	0
Utilisation of the river reach is for operational purposes.	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	0
Overall score	**0**

A3.1.29 HartsRiver reach upstream of Spitskop Dam (C33A,C33B)

Significant flows occur in this river reach from the return flows of the Vaalharts Irrigation Scheme. The return flows have substantially changed the flow regime compared to natural conditions. This river reach receives flows from the Dry Harts River (upstream of and including quaternary C32D), which has no regulating storage structure as well as from Taung Dam located in quaternary C31F.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes. (1)	4
Possible future developments and/or water use expected in the catchment.	2
Water quality related problems, assimilative capacity.	3
Overall score	**4**

1River reach receiving unregulated return flows from the irrigated areas

A3.1.30 HartsRiverreach downstream of Spitskop Dam (C33C)

The water available in Spitskop Dam is more than the water requirements supplied from the dam. This is due to the large volume of return flows generated by the Vaalharts Irrigation Scheme located upstream of the dam. Water is released from Spitskop Dam from where it is abstracted for irrigation along the river reach.

Spitskop Dam has the capability to regulate flow releases in this river reach. Investigations are in progress to identify potential further user of the excess water available in the dam.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	1
Utilisation of the river reach is for operational purposes.	2
Possible future developments and/or water use expected in the catchment.	4
Water quality related problems, assimilative capacity.	3
Overall score	**4**

A3.1.31 Riet/Modder Rivers (upstream of quaternary C51M)

These catchments were part of a comprehensive reserve determination study and it is assumed that the site selection will be based on the work of that study.

A3.1.32 VaalRiverreach downstream of Douglas Weir (C92C)

This is the most downstream section of the VaalRiver before the confluence with the Orange River. Douglas Weir is the upstream storage structure, which has limited flow-regulating capability. Currently this river reach has no flow for most of the time and is operated to minimise flow in the reach. The river reach length is only 1 km.

This river reach is downstream of the Riet/Modder and Harts tributary rivers and would therefore receive EWR flows from these rivers. Any additional EWR in this river reach (over and above what is received from the Riet/Modder and Harts rivers) will have to be released from Bloemhof Dam via the Vaalharts Weir and will impact on the water availability of the Integrated Vaal River System.

The Douglas Irrigation Scheme is supplied from the Douglas Weir and, in addition to the runoff entering Douglas Weir from the upstream incremental catchments, water is transferred (pumped) from the Orange River into Douglas Weir. No releases are made from storage structures in the Vaal, Harts or Riet/Modder river systems to support the water requirements in Douglas Weir.

Variables	Score
Current water balance of catchment contributing flow to the river reach.	4
Utilisation of the river reach is for operational purposes. (1)	0
Possible future developments and/or water use expected in the catchment.	0
Water quality related problems, assimilative capacity.	2
Overall score	**4**