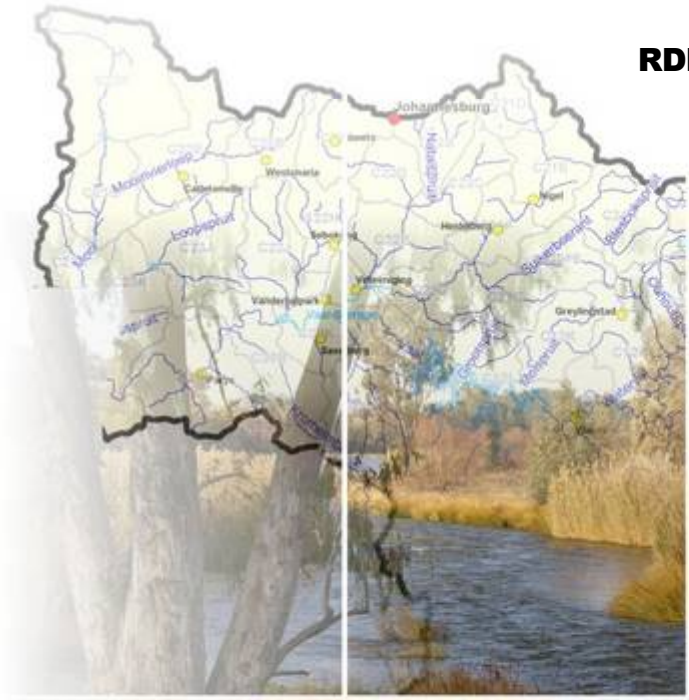
COMPREHENSIVE RESERVE DETERMINATION

INTEGRATED VAAL RIVER SYSTEM

SURFACE WATER

WETLAND REPORT

RDM/WMA8C000/01/CON/0109



TECHNICAL COMPONENT: UPPER VAAL

JULY 2010

REPORT NO.: RDM/WMA8C000/01/CON/0410
PROJECT NO.: 8829/1

water & forestry
Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

COMPREHENSIVE RESERVE DETERMINATION STUDY OF THE INTEGRATED VAAL RIVER SYSTEM

UPPER VAAL WATER MANAGEMENT AREA
TECHNICAL COMPONENT: WETLAND REPORT

Report number: RDM/WMA8C000/01/CON/0410

JULY 2010

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

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Reports as part of this project:

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Bold indicates this report

APPROVAL

TITLE:	Comprehensive Reserve determination study of the Integrated Vaal River System, Upper Vaal River Management Area. Wetland Report
DATE:	July 2010
AUTHOR	Mr. M. Rountree
EDITORS:	Ms. S Koekemoer and Ms. MD Louw
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LEAD CONSULTANT:	Koekemoer Aquatic Services and Rivers for Africa, Joint Venture
FILE NO.:	26/8/3/10/10
FORMAT:	MSWord and PDF
WEB ADDRESS:	www.dwaf.gov.za

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ACKNOWLEDGEMENTS

Ms. Jackie Jay and Mrs. Barbara Weston from the DWA, CD: RDM are thanked for the recommendations with regard to the wetland information requirements of the Department of Water Affairs. The assistance received from Mrs Nicolene Fourie (DWA: GIS Directorate) in obtaining relevant GIS layers for the desktop analysis is gratefully acknowledged. The South African National Biodiversity Institute (SANBI) kindly allowed use of their draft National Wetland Probability Map for this study.

The river Desktop Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) models, developed and provided by Dr Neels Kleynhans, were used as templates to develop similar catchment-based assessment tools to derive average PES and EIS scores for wetlands across quaternary catchment areas. Without the initial development of the river tools, modification to wetland-appropriate assessment tools would not have been easily possible. Dr Neels Kleynhans also very kindly assisted with sourcing old TPA wetland reports for the region.

The valuable reviewing and resultant comments and suggestions provided by Delana Louw and Shael Koekemoer for this report, and by Patsy Scherman, Delana Louw and Shael Koekemoer on similar wetland studies, have greatly improved this report, and their contributions are gratefully acknowledged. Mrs Nonkanyiso Zungu (currently at DWA, SD: SFRA) and Mr Adrian Pietersen assisted as trainees on this project; providing field-based and GIS-based assistance respectively.

The PES and EIS assessments of the quaternary catchments expanded the role and scope of this study from the initial proposed approach, and the patience of the project management team and client has been sincerely appreciated.

EXECUTIVE SUMMARY

BACKGROUND

This wetland assessment study focussed on wetlands in the Upper Vaal Water Management Area, one of three WMAs in the Vaal River catchment. The Upper Vaal WMA includes the Vaal, Klip, Wilge, Suikerbosrand, Blesbokspruit, Liebenbergsvlei and Mooi Rivers and extends to the confluence of the Mooi and Vaal Rivers. It covers a catchment area of 55 565 km^2.

PURPOSE OF THE STUDY

The purpose of this study was to identify the distribution and diversity of wetlands within the Upper Vaal catchment and conduct a primarily desktop assessment of the average current ecological state and ecological importance and sensitivity of these wetlands at a quaternary catchment scale. This study also included the delineation of Wetland Resource Units (WRUs). These WRUs represent a group of wetlands of similar type and functioning based on areas of geological, ecological and hydrological commonality and provides a catchment context and scoping level indication of the sensitivities of these wetlands to various activities for use in the future management of wetlands in the Upper Vaal Catchment. If any high priority wetlands (in terms of broad conservation importance, social importance and/or threats from proposed developments) were identified during the study, these were to be highlighted for further more in depth studies. This study also aimed to undertake Rapid EcoClassification assessments of at least two of these high priority wetlands, namely the Seekoeivlei and Suikerbos Wetlands.

METHODS

The most up-to-date version of the South African National Biodiversity Institute's (SANBI's) Wetland Probability Map was used as a first-level assessment of wetland occurrence within the study area. These data are not field verified, and should thus be treated with caution. Limited independent preliminary verification of the Probability Map suggests that these spatial data provide a significant underestimate of the actual occurrence and extent of wetlands. Farm dams are included in the dataset but, since most of these are located in seepage or valley bottom wetlands, they indicate locations (but not true extents) of modified wetlands. It does, however, provide an indication of relative wetland occurrence, size and density across the study area.

Since there are too many wetlands to evaluate on an individual basis, a desktop level quaternary-scale catchment assessment of the wetlands across the entire study area was undertaken. This information was used to determine (at a low confidence) the average PES and EIS categories of wetlands within each quaternary catchment. A desktop scoring system for quaternary catchment scale wetland PES and EIS determination was developed for this purpose.

A modification of a hierarchical system for the classification of South African wetlands was then used in to classify the wetlands in this study. The modified system uses the underlying hydrological processes and formative geomorphological setting as the basis of classification.

At the broadest spatial level (Level I), all inland wetlands are classified in a single unit. Nested within Level I are two classification systems that operate at smaller spatial scales, *viz*:

Level II: Broad geological groupings of wetlands based on, inter alia, underlying dominant geology and/or EcoRegions, which are referred to as Wetland Resource Units (WRUs) in this study.

Level III: Groups of wetlands based on geomorphological and hydrological criteria, referred to as hydrogeomorphic (HGM) wetland types in this study.

The common HGM wetland types within each WRU were then identified and described. The HGM wetland typology is based on the underlying hydrological processes that create and maintain the wetlands. The likely sensitivities to particular types of activities, and thus recommendations for future management, can then determined, albeit at low confidence, from this information.

WETLAND RESOURCE UNITS

Wetland density declines from the south-east to the northwest across the WMA; following the general rainfall trends. Vegetation Types and Level I and II EcoRegion boundaries were poorly correlated with wetland type, average size or density, but underlying geology distinguished the major break in wetland resource units; with a secondary split due to land use, PES and EIS attributes.

Three Wetland Resource Units were identified for the Upper Vaal Water Management Area, namely the:

- **WRU 1: Dolomitic Peatlands WRU** (low density and diversity of wetland types but very large individual wetlands generally associated with peats and usually associated with high EIS scores).
- **WRU 2: Central Sedimentary WRU** (high density of wetlands with a moderate to high diversity, many of which may provide habitat for vulnerable to endangered vegetation. These wetlands are generally associated with moderate PES and EIS scores).
- **WRU 3: Eastern Sedimentary WRU** (high density of wetlands with a high diversity many of which may provide habitat for vulnerable to endangered vegetation. These wetlands are generally associated with moderate to high PES and EIS scores).

PES AND EIS RESULTS

Results from the desktop Wetland PES and EIS assessments (at the quaternary catchment scale), and comparison with the available quaternary river PES and EIS data are provided in the table below Quaternaries with high-scoring wetland PES (A, B and B/C) and/or EIS (High and Very High) scores are shaded. The PES and EIS scores reflect the expected *average* scores of all wetlands within the quaternary catchment.

Given the high intensity of economic activity and land use activities across most of the WMA, it is not surprising that much of the WMA is characterised by wetlands in a moderate condition, with poorer condition wetland areas concentrated around the highly urbanised and industrialised north and north-western margins of the WMA (first figure). Whilst PES is generally moderate, the EIS scores range from Moderate to High. The wetlands in the headwaters of the northwest and southernmost sections of the WMA have the highest EIS scores (second figure).

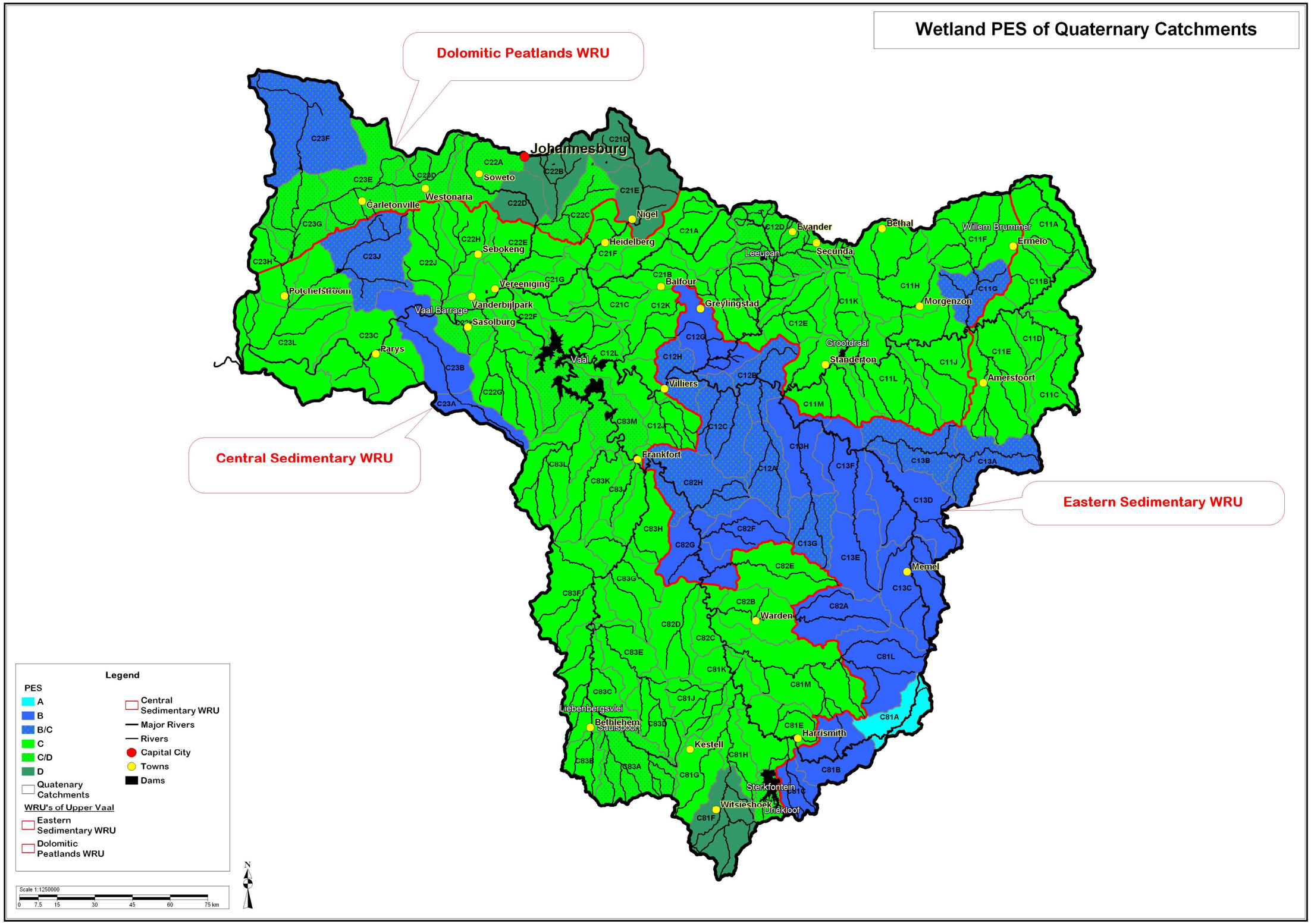
Average EIS and PES for the wetlands in quaternary catchments of the Upper Vaal WMA

Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C11A	Vaal	**HIGH**	Moderate	**C**	B/C
C11B	Vaal	**HIGH**	Moderate	**C**	C
C11C	Klein Vaal	MODERATE	Moderate	C	B
C11D	Klein Vaal (Rietspruit)	MODERATE	Low	C	C
C11E	Rietspruit	**HIGH**	Moderate	C	C
C11F	Kaffirspruit	MODERATE	Moderate	C	C
C11G	Kaffirspruit	MODERATE	Moderate	**B/C**	C
C11H	Blesbokspruit	MODERATE	Moderate	C	C/D
C11J	Vaal	MODERATE	Moderate	C	C
C11K		**HIGH**	Moderate	C	D
C11L	Grootdraai dam	MODERATE		C	
C11M	Vaal (downstream from Grootdraai)	MODERATE	Moderate	C	D
C12A	Ventersspruit	MODERATE	Moderate	**B/C**	B/C
C12B	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12C	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12D	Waterval (Kleinspruit)	MODERATE	Low	C/D	D
C12E	Rietspruit	MODERATE	Low	C	D
C12F	Waterval (Kleinspruit)	**HIGH**	Moderate	C	D

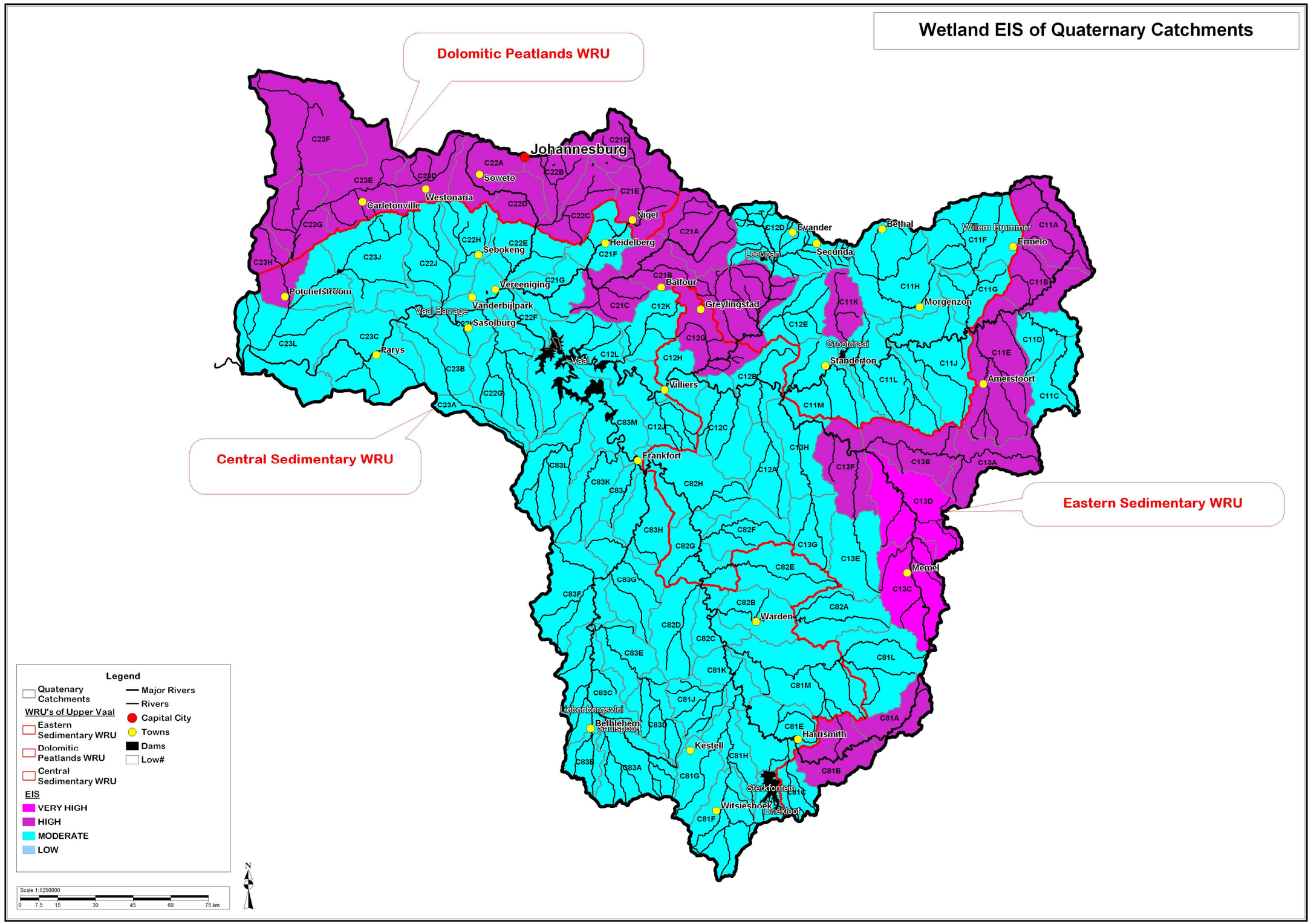
Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C12G	Waterval (Kleinspruit)	**HIGH**	Moderate	**B**	D
C12H	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12J	Unamed trib.	MODERATE	Low	C	C/D
C12K	Molspruit	MODERATE	Low	C	C/D
C12L	Vaal (Vaal dam backwater portion)	MODERATE		C	
C13A	Sandspruit	**HIGH**	Moderate	**B/C**	B/C
C13B	Sandspruit	**HIGH**	Moderate	**B/C**	C
C13C	Seekoevlei	**VERY HIGH**	High	**B**	B/C
C13D	Klip	**VERY HIGH**	Moderate	**B**	B/C
C13E	Komandospruit	MODERATE	Moderate	**B**	B
C13F	Klip	**HIGH**	Moderate	**B**	C
C13G	Spruitsonderdrif	MODERATE	Moderate	**B/C**	C
C13H	Klip	MODERATE	Moderate	**B**	C
C21A	Suikerbosrand	**HIGH**	Moderate	C	B/C
C21B	Suikerbosrand	**HIGH**	Moderate	C	C
C21C	Suikerbosrand	**HIGH**	High	C	C
C21D	Blesbokspruit	**HIGH**	Low	D	E/F
C21E	Blesbokspruit	**HIGH**	Moderate	D	D/E
C21F	Blesbokspruit (l	MODERATE	Low	C	D/E
C21G	Suikerbosrand	MODERATE	Moderate	C	C/D
C22A	Klipriver	**HIGH**	Moderate	C/D	E
C22B	Natalspruit	**HIGH**	Low	D	E
C22C	Rietspruit	**HIGH**	Low	C/D	E
C22D	Klip	**HIGH**	Moderate	D	D
C22E	Klip	MODERATE	Moderate	C	D/E
C22F	Vaal (downstream from Vaal dam)	MODERATE	Moderate	C	D
C22G	Taaibosspruit	MODERATE	Moderate	C	C
C22H	Rietspruit	MODERATE	Low	C	D/E
C22J	Leeuspruit	MODERATE	Moderate	C	D/E
C22K	Vaal (Barrage portion)	MODERATE		C/D	
C23A	Vaal	MODERATE	Moderate	**B**	B/C
C23B	Vaal	MODERATE	Moderate	**B**	D
C23C	Vaal (Parys)	MODERATE	High	**C**	D
C23D	Mooirivierloop	**HIGH**	Low	C/D	E
C23E	Mooirivierloop	**HIGH**	Moderate	C/D	E
C23F	Upper Mooi	**HIGH**	High	**B/C**	C/D
C23G	Mooi (upstream from Boskop)	**HIGH**	Moderate	C/D	D/E
C23H	Mooi (before confluence with Loopspruit)	**HIGH**	Moderate	C	D/E
C23J	Loopspruit (above Klipdrif dam)	MODERATE	Low	**B/C**	D
C23K	Loopspruit	MODERATE	Low	C	D
C23L	Vaal (downstream from Parys)	MODERATE	High	C	D
C81A	Wilge (main stem)	**HIGH**	Low	**A**	B
C81B	Wilge (main stem)	**HIGH**	Moderate	**B**	B/C
C81C	Nuwejaarsspruit (Wilge trib.)	MODERATE	Moderate	**B**	B/C
C81D	Sterkfontein Dam	MODERATE		C/D	
C81E	Wilge (main stem)	MODERATE	Moderate	C	D
C81F	Elands (Wilge trib.)	MODERATE	Moderate	D	D
C81G	Elands (Wilge trib.)	MODERATE	Moderate	C	C

Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C81H	Elands (Wilge trib.)	MODERATE	Moderate	C	C
C81J	Vaalbanks (Wilge trib.)	MODERATE	Moderate	C	C
C81K	Wilge (main stem)	MODERATE	Moderate	C	C
C81L	Meul (Wilge trib.)	MODERATE	Moderate	**B**	B
C81M	Meul (Wilge trib.)	MODERATE	Moderate	C	B
C82A	Cornelis (Wilge trib.)	MODERATE	Moderate	**B**	B
C82B	Cornelis (Wilge trib.)	MODERATE	Moderate	C	C
C82C	Wilge (main stem) - EWR 8	MODERATE	Moderate	C	C
C82D	Rus se Spruit (Wilge trib.)	MODERATE	Moderate	C	C
C82E	Holspruit (Wilge trib.)	MODERATE	Moderate	C	C
C82F	Grootspruit (Wilge trib.)	MODERATE	Moderate	**B**	C
C82G	Wilge (main stem)	MODERATE	Moderate	**B**	C
C82H	Wilge (main stem)	MODERATE	Moderate	**B/C**	C
C83A	Ash	MODERATE	Low	C/D	D/E/F
C83B	Jordaans	MODERATE	Moderate	C	C
C83C	Liebenbergsvlei	MODERATE	Moderate	C	D/E
C83D	Tierkloof	MODERATE	Moderate	C	C/D
C83E	Tierkloof	MODERATE	High	C	C/D
C83F	Liebenbergsvlei	MODERATE	Moderate	C	D
C83G	Liebenbergsvlei	MODERATE	Moderate	C	D
C83H	Libenbergsvlei	MODERATE	Moderate	C	D
C83J	Wilge (main stem)	MODERATE	Moderate	C	D
C83K	Kromspruit	MODERATE	Moderate	C	B
C83L	Klipriver	MODERATE	Moderate	C	B
C83M	Wilge (main stem) - Vaal Dam	MODERATE		C/D	

Within the Wetland Resource Units, PES and EIS attributes are generally more consistent than across the entire Water Management Area. Wetlands within the Dolomitic Peatlands WRU are characterised by low to moderate PES (first figure) but High EIS (second figure). The Central Sedimentary WRU is characterised by generally moderate PES (first figure) and EIS (second figure) scores, whereas the wetlands of the Eastern Sedimentary WRU generally have higher PES (first figure) with the same to higher EIS characteristics (second figure).



Average wetland PES scores of the quaternary catchments of the Upper Vaal WMA



Average wetland EIS scores of the quaternary catchments of the Upper Vaal WMA

PRIORITY WETLANDs

Wetlands that were deemed important by DWA and various other stakeholders were identified through a workshop process. Prioritisation criteria were identified during the same workshop, and the wetlands were assessed and ranked according to the prioritisation scores ascribed to each.

Several high priority areas requiring urgent assessment or more detailed Reserve studies were identified and are provided below. Of these, the PES and EIS of Seekoeivlei and lower Suikerbosrand (Heidelberg) Floodplain wetlands were assessed in more detail as part of this study. Rapid EcoClassification determinations were also undertaken for the Boovenste Oog Wetland (in Quaternary catchment C23F), Klip River Wetland (in Quaternary Catchment C22A, this study included a Reserve determination component) and the Bedford Wetland (in Quaternary Catchment C81A) as part of the WRC/RDM Rapid Wetland Reserve Method Development Project (the results of these studies and associated Reports can be obtained from the RDM).

Seekoeivlei is a RAMSAR site with a high (A/B) PES and Very High EIS. The wetland system is stable and there are few major current threats to this internationally recognised and protected water resource. The lower Suikerbosrand Floodplain has a low to moderate EIS and moderate (B/C) PES. The lower reach close to the Blesbokspruit confluence is currently under threat by proposed mining activities, the impacts from the surrounding cattle feedlots and upstream urbanisation of the catchment. The threats to the condition of this wetland are ubiquitous across the WMA – agricultural impacts; expansion of mining and urbanisation.

APPLICATION OF THE DATA

The approaches developed and information yielded through this assessment will be able to assist the CD:RDM in obtaining regional PES and EIS information for wetlands. This information can be used to guide more detailed Reserve studies, if required, as well as to assess the regional context of wetlands linked to WULA and EIA applications.

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ACRONYMS AND ABBREVIATIONS

CD: RDM	Chief Directorate: Resource Directed Measures
DEA	Department Environmental Affairs
D:RQS	Directorate: Resource Quality Services
DWA	Department of Water Affairs
DWAF	Department Water Affairs and Forestry
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
GIS	Geographic Information System
HGM	Hydro-Geomorphic Unit
MRU	Management Resource Units
NFEPA	National Freshwater Ecosystems Priority Areas
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
RU	Resource Unit
SANBI	South African National Biodiversity Institute
ToR	Terms of Reference
WETLAND IHI	Wetland Index of Habitat Integrity
WRU	Wetland Resource Unit

GLOSSARY

Aggradation	The filling or raising of land surface by deposition of sediment.
Anaerobic	In the absence of oxygen.
Anthropogenic	Of, relating to, or resulting from the influence of human beings on nature.
Aquatic	Consisting of, relating to, or being in water.
Aquiclude	Sediment body, rock layer, or soil horizon that is incapable of transmitting significant quantities of water under normal hydraulic gradients.
Backswamp	Extensive, marshy, or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.
Base level	The lowest level to which a stream can erode its bed.
Bedload	Transported by being rolled or bounced along the bed of the stream.
Bedrock	The solid rock that underlies unconsolidated material, such as soil, sand, clay, or gravel.
Catchment	The area drained by a single stream.
Channel	The part of a river-bed containing its main current, naturally shaped by the force of water flowing within it.
Clastic sediment	The particles of minerogenic material (clay, silt, sand, cobbles and boulders) that are moved by running water.
Deposition	The laying down of material which has been transported by running water.
Desiccation	The loss of moisture from material.
Discharge wetland	Wetlands where groundwater discharges into the wetland.
EcoRegions	Denotes areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources, and are designed to serve as a spatial framework for the research, assessment, management and monitoring of ecosystems and ecosystem components. Several levels or scales of EcoRegions can be delineated (e.g. Level I low resolution/detail; Level III high resolution and detail). In South Africa, EcoRegions form the basis of the River Health monitoring assessments with Level II delineations available for use.
EcoStatus	The overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).
Endorheic	Refers to a watershed from which there is little or no outflow of water - either on the surface as rivers, or underground by flow or diffusion through rock or permeable material.
Ephemeral wetland	Wetland or portion thereof with markedly short-lived inundation.
Erosion	Physical and chemical processes that remove and transport soil and weathered rock.
Evapotranspiration	The loss of moisture from the terrain by direct evaporation plus transpiration from vegetation.
Exorheic	Referring to externally draining water bodies that have one or more points of outflow. Most lakes are exorheic, having some throughflow that prevents the accumulation of salts.
Flood frequency	The average number of times that a wetland is flooded in a given period.
Floodplain	The floor of a valley over which a river may spread in time of flood, depositing alluvium, often resulting in the formation of longitudinal or riparian wetlands within the floodplain.
Fluvial	Related to a river.
Geomorphology	The study of the origin and development of landforms of the earth.
Groundwater	Subsurface water in the zone in which permeable rocks, and often the overlying soil, are saturated under pressure equal to or greater than atmospheric pressure.
Headwaters	The uppermost region of a catchment.
Hydric soil	Soil that is saturated or flooded long enough during the growing season to develop anoxic conditions, which favour the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrogeomorphic (HGM)	Refers to particular wetland typing ("classification") methods based on the landscape (morphological) setting and hydrological characteristics of different wetland types.
HGM Unit	A single "reach", segment or unit of a particular type of HGM wetland type.
Hydroperiod	The hydrological signature describing the seasonal pattern of water level fluctuations in a wetland.
Interflow	Water moving downslope through the soil profile (i.e. below the surface, but not yet deep enough to be considered as true groundwater). This can be perched flows (where flows in the soil create locally perched water tables due to impervious layers in the soil or geology preventing seepage to deeper groundwater aquifers).
Landform	Any distinctive geomorphological feature on the earth's surface.
Mass-balance	The accounting of all inputs and outputs to a defined system.
Overland flow	Surface flow of water.
Palustrine wetlands	All non-tidal wetlands dominated by persistent emergent plants (e.g. reeds) emergent mosses or lichens, or shrubs or trees (see Cowardin *et al*., 1979).
Pan	Circular depressions that have no connection to the drainage system via surface flow.
Peat	Is a brownish-black organic soil that is formed in acidic, anaerobic wetland conditions. It is composed mainly of partially-decomposed, loosely compacted organic matter with more than 50% carbon. The 50% carbon content is mostly applicable for the sphagnum peat moss peat deposits in the Northern Hemisphere. The South African soil classification uses a > 10% carbon content as a guideline. Inorganic soil particles are blown or washed into peatlands and also form part of the peat.
Perched water table	The upper limit of a zone of saturation in soil, separated by a relatively impermeable unsaturated zone from the main body of groundwater.
Perched wetland	A wetland where the wetland water table is higher than the local and regional water table. Such wetlands are maintained by the shallow impervious layers that create a site-specific high water table at

	or close to the surface.
Present Ecological State	The current ecological condition of the resource. This is assessed relative to the deviation from the Reference State.
RAMSAR Wetlands	These are wetlands selected and protected by international treaty, the wetlands being considered as important for the conservation of global biological diversity and for sustaining human life through the maintenance of their ecosystem components, processes and benefits/services.
Reference State	The natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development.
Rehabilitation	Restoring processes and characteristics that are sympathetic to and not conflicted with the natural dynamic.
Riparian	The physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.
Runoff	The surface discharge of water from rainfall down a slope.
Seasonally wet soil	Soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.
Terrestrial	Of or relating to or inhabiting the land as opposed to the sea or air.
Tributary	A stream that joins a larger one.
Wetland	in this report refers to the definition provided in the National Water Act; referring to “land that is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil” (National Water Act, Act 36 of 1998).
Wetland delineation	The determination and marking of the boundary of a wetland on a map. The DWAF (2005) guidelines should be employed to undertake this for field application.
Wetland Resource Unit	An area of a catchment which has wetlands with similar characteristics, processes and also broadly similar sensitivities to particular developments and impacts.

1 INTRODUCTION

1.1 BACKGROUND TO THE OVERALL STUDY

The National Water Act (NWA, Act No. 36 of 1998) mandates the Department of Water Affairs (DWA) to ensure that the water requirements for economic development do not seriously impact upon the long-term integrity of the country's water resources. Under the NWA all water resources (rivers, wetlands and estuaries) are an indivisible natural asset under the custodianship of national government. There is "no ownership of water but only a right (for environmental and basic human needs) or an authorisation for its use" (DWAF, 1997 Principle 3). The only right to priority of use is that of the 'Reserve', consisting of a 'Basic Human Needs Reserve' and an 'Ecological Reserve'. The Basic Human Needs Reserve ensures the water that is required by domestic users for drinking, food preparation and personal hygiene. The Ecological Reserve refers to the quantity and quality of water required to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource" (NWA, Ch 1, para. 1.(xviii)).

The primary tool for managing and controlling the use of water resources is through Water User Licence Applications (WULAs). Before WULAs can be granted, the Reserve needs to be determined for all significant water resources. It is therefore imperative that the Reserve be determined and requirements met before other economic activities can be satisfied. As the Department of Water Affairs (DWA) is the custodian of the nation's water resources, it is their responsibility to ensure the adequate protection and effective management of these resources. The Chief Directorate: Resources Directed Measures (CD:RDM) of DWA is tasked with the responsibility of ensuring that Reserve assessments take place before licensing can proceed.

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 so 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 DWA. This will assist the DWA to plan for the future demands for water in the Vaal system as well as make informed decisions regarding the authorisation of future water use and the magnitude of the impacts of the present and proposed developments.

Whilst the focus of Reserve studies has traditionally been on rivers and the water flowing within them, the NWA also requires the DWA to manage wetland water resources. This report presents a primarily desktop assessment of the wetlands of the Upper Vaal WMA to aid the DWA in the management of wetland water resources and to plan for more in-depth Wetland Reserve studies.

1.2 WETLANDS

Wetlands are amongst the most impacted and degraded of all ecological systems. Global assessments indicate that a large proportion of wetlands have been destroyed and the majority of remaining wetlands are degraded or under threat of degradation (Finlayson and Spiers, 1999).

South Africa is a contracting party to the Ramsar Convention on Wetlands and therefore has an obligation to promote the conservation and responsible use of wetlands. Despite this, more than half of the country's wetlands are estimated to have been destroyed or converted into areas of lower functional importance (Department of Environmental Affairs (DEA): State of the Environment, http://soer.deat.gov.za/themes.aspx?m=149). The assessment and monitoring of wetland condition is therefore an important component in managing the use of wetlands (Ramsar Convention, 2002).

In South Africa, the DWA is mandated through the National Water Act (Act 36 of 1998) to ensure the conservation, protection and sustainable utilisation of wetlands (see "What is a Wetland" below). For effective implementation of the NWA, but also for a wider range of activities such as conservation planning and management, it is important that the ecological condition, and importance and sensitivity of wetlands be determined and managed.

What is a Wetland?

As defined by the South African National Water Act (Act 36 of 1998), a wetland is "*land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Wetlands are essentially an expression of the presence of surface or near-surface water in the landscape. This water can either be static (e.g. pans) or slowly moving through the landscape. The source of the water can include surface flow, interflow (water flowing through the soil profile), groundwater (including deep and/or perched groundwater), direct rainfall, or any combination of these. Whatever the source, the water must be present for long enough to influence both the soil properties and the vegetation. In practice, the wetland boundary is defined as the position in the landscape where hydric indicators occur in the soil within 0.5 m of the surface (DWAF, 2005). Where these hydric indicators are deeper than 0.5 m, they generally do not support wetland adapted plants. Thus, the 0.5 m measurement traditionally forms the boundary between terrestrial and wetland adapted plant species.

(DWAF, 2008a)

1.3 PURPOSE OF THIS REPORT

This report focuses on the wetlands within the Upper Vaal Water Management Area (WMA), which comprises sections of the Gauteng, Mpumalanga, North West and Free State Provinces. Within this WMA, numerous pans have been recorded (Allan, 1985) and it is likely that, if all wetland types were to be included, many thousands would be counted within the WMA. However, the above is an estimate, since at present our knowledge of wetland number, type and extent across the country, and within this WMA specifically, remains poorly understood.

Due to logistical and budget limitations, this study is not designed to determine the environmental flows (Ecological Reserve) for wetlands of the Upper Vaal WMA. Instead it is intended to provide an overview of the current state and importance of the wetlands in order to supplement the Comprehensive River Reserve study undertaken on behalf of DWA, and to provide basic, low confidence information and a catchment context for WULA assessments and associated desktop RDM processes relating to wetlands.

1.4 OUTLINE OF THE REPORT

This report combines various aspects that relate to the wetlands of the Upper Vaal WMA. The chapters are summarised as follows:

1.4.1 Chapter 1: Introduction

This chapter provides background and purpose of the study.

1.4.2 Chapter 2: Study area

This chapter provides an overview of the study area.

1.4.3 Chapter 3: Methods

This chapter outlines the methods followed for the wetland component. Methods are outlined for the identification of wetlands in the study area, the classification system applied, the approach for the delineation of Wetland Resource Units, and the desktop quaternary catchment PES and EIS assessment.

1.4.4 Chapter 4: Results: Wetland Resource Units

The characteristics of the Wetland Resource Units that were identified are described. A Wetland Resource Unit is an area of a catchment that has wetlands with similar characteristics, processes and also broadly similar sensitivities to particular developments and impacts.

1.4.5 Chapter 5: Results: Desktop wetland PES and EIS

Results from the desktop PES and EIS assessments of the wetlands at quaternary catchment scale are provided.

1.4.6 Chapter 6: Priority wetlands in the Upper Vaal WMA

Priority wetland systems or regions are highlighted.

1.4.7 Chapter 7: Recommendations for wetland management

Recommendations for the management of wetlands are provided.

1.4.8 Chapter 8: Application of data

This chapter provides detail on how the data can aid in management strategies and decisions.

1.4.9 Chapter 9: References

1.4.10 Appendix A: Description of the HGM wetland types

This appendix provides a detailed description of the different Hydrogeomorphic (HGM) wetland types identified at level III of the wetland typing system employed in this study.

1.4.11 Appendix B: Detailed PES tables per quaternary catchment

These tables provide the raw data and motivations for scores for the quaternary catchment wetland PES assessment.

1.4.12 Appendix C: Detailed EIS tables per quaternary catchment

These tables provide the raw data and motivations for scores for the quaternary catchment wetland EIS assessment.

1.4.13 Appendix D: Minutes of the Wetlands Prioritisation Workshop

Minutes taken by Golder and Associates during the workshop held on 14 November 2007.

2 STUDY AREA

The Upper Vaal Water Management Area has a catchment area of approximately 55 500 km^2 and spans sections of the Gauteng, Mpumalanga, North West and Free State Provinces. The main rivers within the Upper Vaal Water are the Vaal, Klip, Wilge, Mooi, Waterval, Suikerbosrand and Blesbokspruit (Figure 2.1). Due to interbasin transfers, WMA 8 can be considered to be part of a larger water supply system, linked to adjacent WMAs and Lesotho.

The Upper Vaal WMA drains the most economically important area in Africa and in places is characterised by intensive agricultural, urban, commercial and mining activity. Several economically important towns and cities are located within the WMA (Figure 2.1), with the headwaters of its central-northern rivers arising within the City of Johannesburg's city centre and southern suburbs. There is also a high density of wetlands within the WMA, including some of the country's most significant wetland resources such as the Seekoeivlei and Blesbokspruit, two[1] of South Africa's 20 RAMSAR wetlands.

The WMA is within a summer rainfall area, although rainfall declines across the catchment from the wetter eastern and southern sections across to the drier northwest. Nine Tertiary and 91 Quaternary (Figure 2.1) catchments are found within this WMA. The topography of the WMA is relatively flat, creating conditions which would favour infiltration, slow overland flow and thus low energy flow conditions which could favour the development of wetland environments. The catchment area is a strongly seasonal, summer rainfall area exposed to high levels of frost during winter. Vegetation growth can thus be expected to be limited in the dry winter season by low rainfall and temperatures.

The study area comprises the following tertiary catchment areas:

- C11 (the headwaters of the Vaal River)
- C12 (Waterval and Vaal River mainstem)
- C13 (the Klip River in Mpumalanga)
- C21 (Blesbokspruit and Suikerbosrand River)
- C22 (the Klip River in Gauteng, Taaibosspruit and Vaal River mainstem)
- C23 (the Mooi River and Vaal River mainstem)
- C81 (the Meul River and headwaters of the Wilge River)
- C82 (Wilge River)
- C83 (Liebenbergsvlei and lower Wilge River).

[1] Whilst the Seekoeivlei RAMSAR site is assumed to be in a near pristine condition, the other RAMSAR site, the Blesbokspruit in Gauteng, was placed on the Montreux Record on the 6th May 1996; effectively being removed from the RAMSAR list due to degradation problems. This bears testimony to the widespread degradation of wetlands in the areas of the study area affected by mining activities and urbanisation.

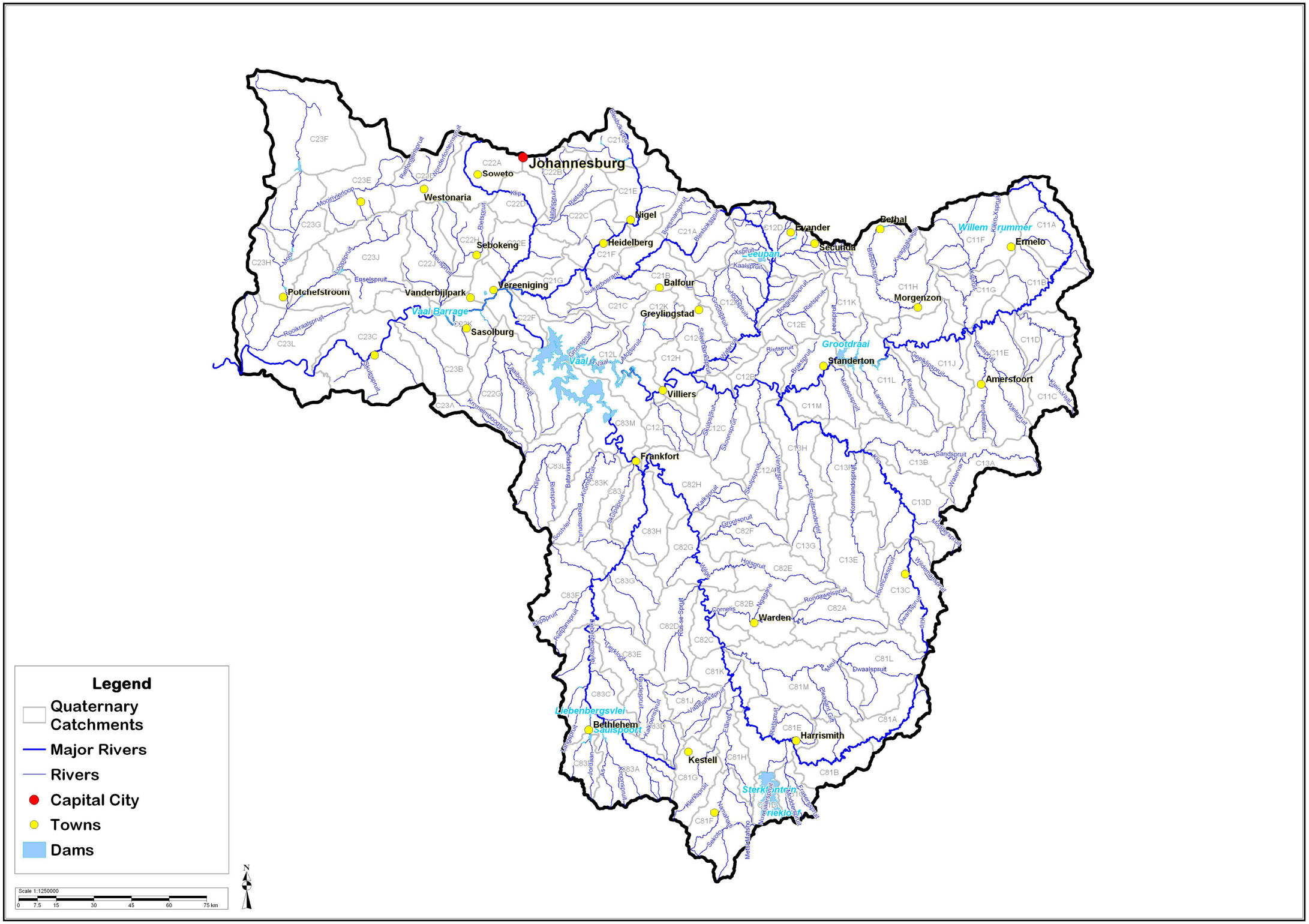

Figure 2.1 Study area

2.1 ECOREGIONS

EcoRegional classification or typing allows the grouping of rivers according to similarities based on a top-down approach. The purpose of this approach is to simplify and contextualise assessments and statements on Ecological Water Requirements, allowing for extrapolation of information from data rich systems to similar systems within the same hierarchical typing which may be poor. It is assumed that, to some extent, the same potential exists for application to wetlands, and thus EcoRegions are used to guide the delineation of wetland resource units where appropriate.

Two levels of EcoRegion classification are available for South Africa. Level I delineate boundaries at a very broad scale using attributes such as physiography, climate, rainfall, geology and potential natural vegetation. Eighteen Level I EcoRegions were identified across South Africa (Kleynhans *et al*., 2005). Most of the Upper Vaal WMA falls within a single EcoRegion – the Highveld Level I EcoRegion (Figure 2.2). Small sections of the WMA fall into the Eastern Escarpment Mountain EcoRegion. The Level II EcoRegion classification provides a higher resolution of expected biological units (Kleynhans *et al*., 2007) and consequently a greater complexity of EcoRegional units (Figure 2.3).

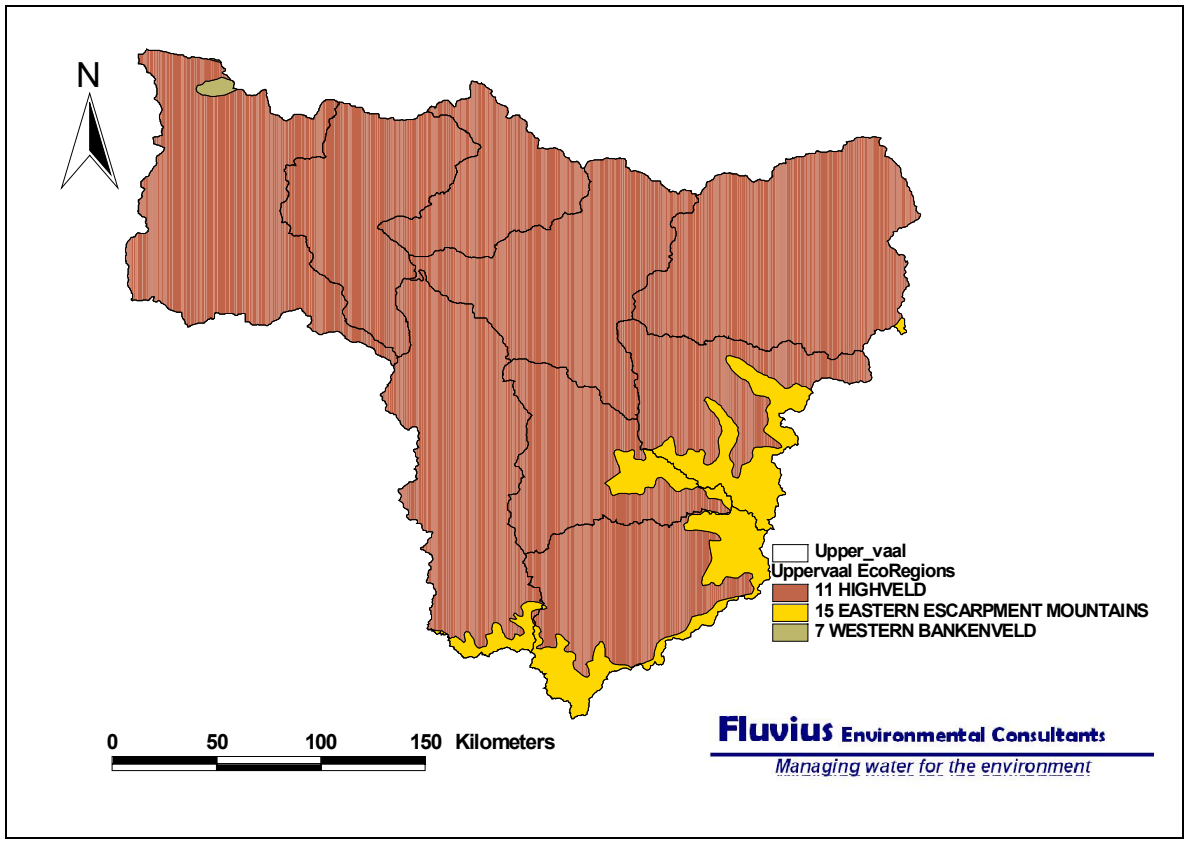

Figure 2.2 Level I EcoRegions of the Upper Vaal WMA (Kleynhans *et al*., 2005)

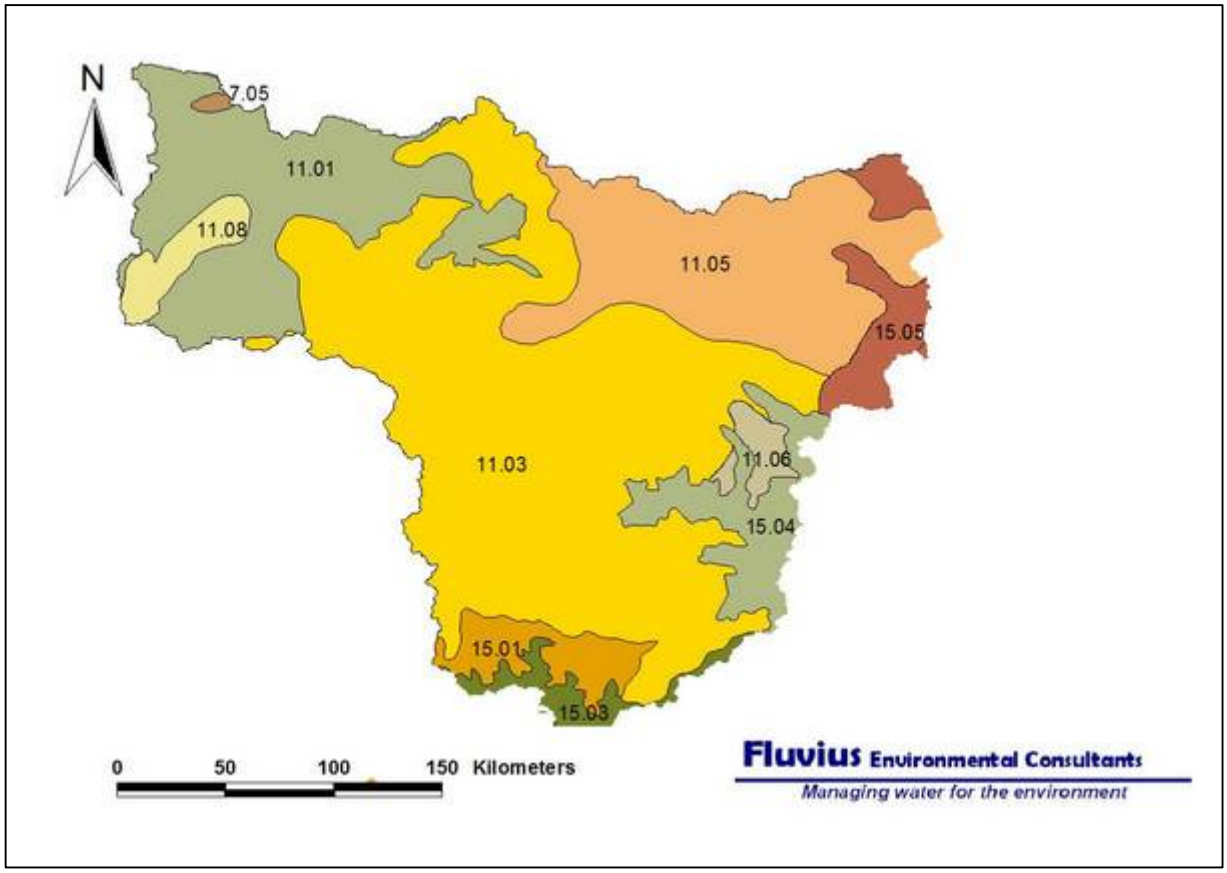

Figure 2.3 Level II EcoRegions of the Upper Vaal WMA (Kleynhans *et al*., 2005)

2.2 GEOLOGY

Underlying geology can be a determining factor in the wetland types and densities found within a region, since the geology controls the landscape slopes, valleys and hills or mountains which occur; the distribution of groundwater (dependent on the porosity of the underlying rock) and indirectly controls infiltration though the soils which weather from the underlying rocks. The soils and landscape morphology can either promote or inhibit the occurrence of wetlands through high or low soil infiltration (and resultant interflow importance) capacities respectively.

Much of the Upper Vaal WMA is underlain by sedimentary rocks, with an extensive zone of mudstones occurring in the southern section of the catchment (Figure 2.5). These sedimentary rocks are intruded by frequent dolerite dykes; a rock much more resistant to weathering than the sedimentary sand- and mudstones in to which they intrude. Sandstones and the associated dolerite dyke and sill intrusions can form localised groundwater compartments, and large resistant dolerite intrusions can create local key points along drainage lines, where the upstream softer sandstones erode to create flat, low energy water courses that are dammed by the resistant dolerite outcrops. Floodplains or other valley bottom wetlands develop upstream of the dolerite key points (Figure 2.4). The most notable example of this process is the Seekoeivlei floodplain wetlands.

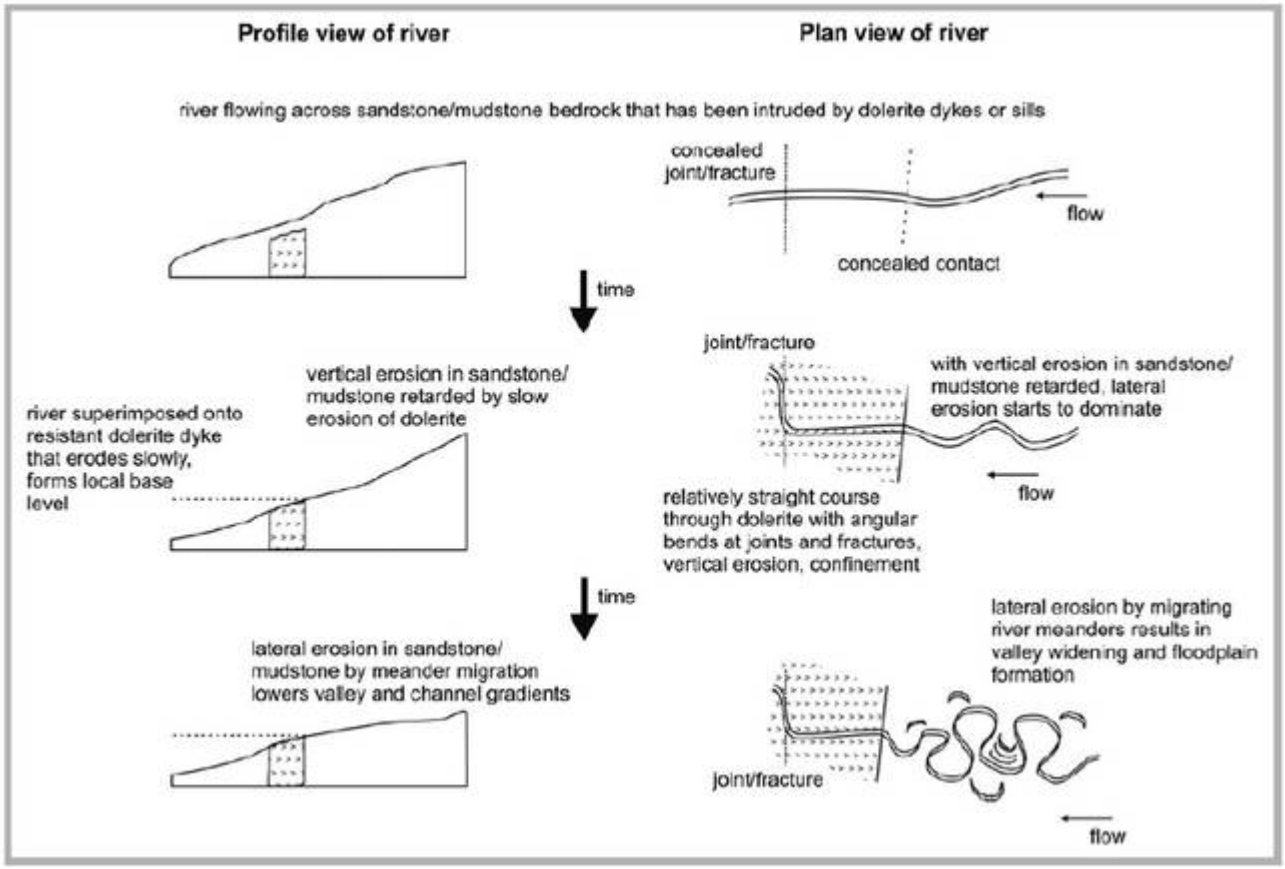

Figure 2.4 A model to demonstrate how wetlands develop in karoo sediments upstream of large dolerite intrusions (after Tooth *et al.*, 2004)

The granites, shales and extensive dolerites in the northern section of the WMA are more resistant rock formations, and result in differing potential for wetland formation, and the formation of different wetland types. Granites weather and tend to produce shallow sandy soils underlain by clays. This association of sandy upper and clay-rich lower soil horizons creates ideal conditions for perched subsurface water flows (interflow). Where the valley side and longitudinal gradients are sufficiently flat, granitic catchments can create extensive seepage and wide valley bottom wetlands. The conglomerate formations in comparison are relatively impervious, and these areas tend to have lower densities of wetlands than occurs in the granitic zones of the study area. Quartzites and shales are relatively resistant and form ridges or steep valley slopes. The steep slopes and shallow soils do not favour infiltration and would not favour wetland development.

In the north and north-western sections of the catchment is an extensive east-west outcrop of dolomite. Dolomites yield well-drained soils that often allows for direct recharge of the extensive aquifers for which this geology is known. Groundwater emergence is often focussed at a few strongly flowing springs or eyes. The permanent high base flows and generally good water quality emerging from the eyes in this area of the catchment have resulted in extensive valley bottom wetlands strongly associated with peat formation. The upper Mooi and upper Klip (in Soweto) Rivers are drainage lines where such wetlands have developed.

The geology in the west of the WMA is complex and the pattern thereof is strongly arced – this pattern surrounds the impact area of a meteor that created the Vredefort Dome. In the central and north-western sections of the WMA, quartzite outcrops are responsible for the defined ridges that run east-west across the top of the catchment. Small patches of granite and other igneous rocks are scattered across the WMA. In the northeast of the WMA the geology is dominated by

extensive dolerites – these having created extensive resistant ridges – and various sedimentary (Aernite) rock formations.

The porosity and depth of the soils, which weather from the underlying geology, is critical to the development of wetlands. Geology thus controls the topography, soils (and thus infiltration) and the presence and emergence of groundwater. Groundwater specialists tend draw a distinction between deep groundwater reserves, mainly in secondary aquifers, and the shallower, near-surface flows that occur in the primary aquifers. For the purposes of this wetland report, a distinction is drawn between the relatively deep geological ***groundwater*** (water flowing in the rocks of the primary and secondary aquifers) versus very shallow ***interflow*** (which is water moving through the soil profile in a downslope direction). The inflows from runoff, groundwater and interflow create the driving conditions behind the different types of wetlands.

The relevance of understanding the underlying driving conditions maintaining different wetland types may become apparent when, for example, evaluating the impacts of proposed developments or WULAs. Wetlands that are maintained by interflow can be expected to have a relatively small catchment, but would be highly sensitive to developments within that immediate topographically-defined catchment area. Wetlands maintained by regional groundwater however could be expected to be less sensitive to individual developments in the immediate vicinity of the wetland, but to be more sensitive to cumulative impacts of regional development. Abstraction through boreholes several kilometres from an interflow-dominated wetland may not be expected to have a significant impact (since this is maintained by the immediate catchment), but if the wetland was groundwater-dependent, then abstraction, even if far from the wetland, may affect the regional groundwater aquifer and thus the “downstream” wetland; albeit that the impact point and groundwater-maintained wetland may not be connected by surface hydrological processes, nor located immediately adjacent to one another.

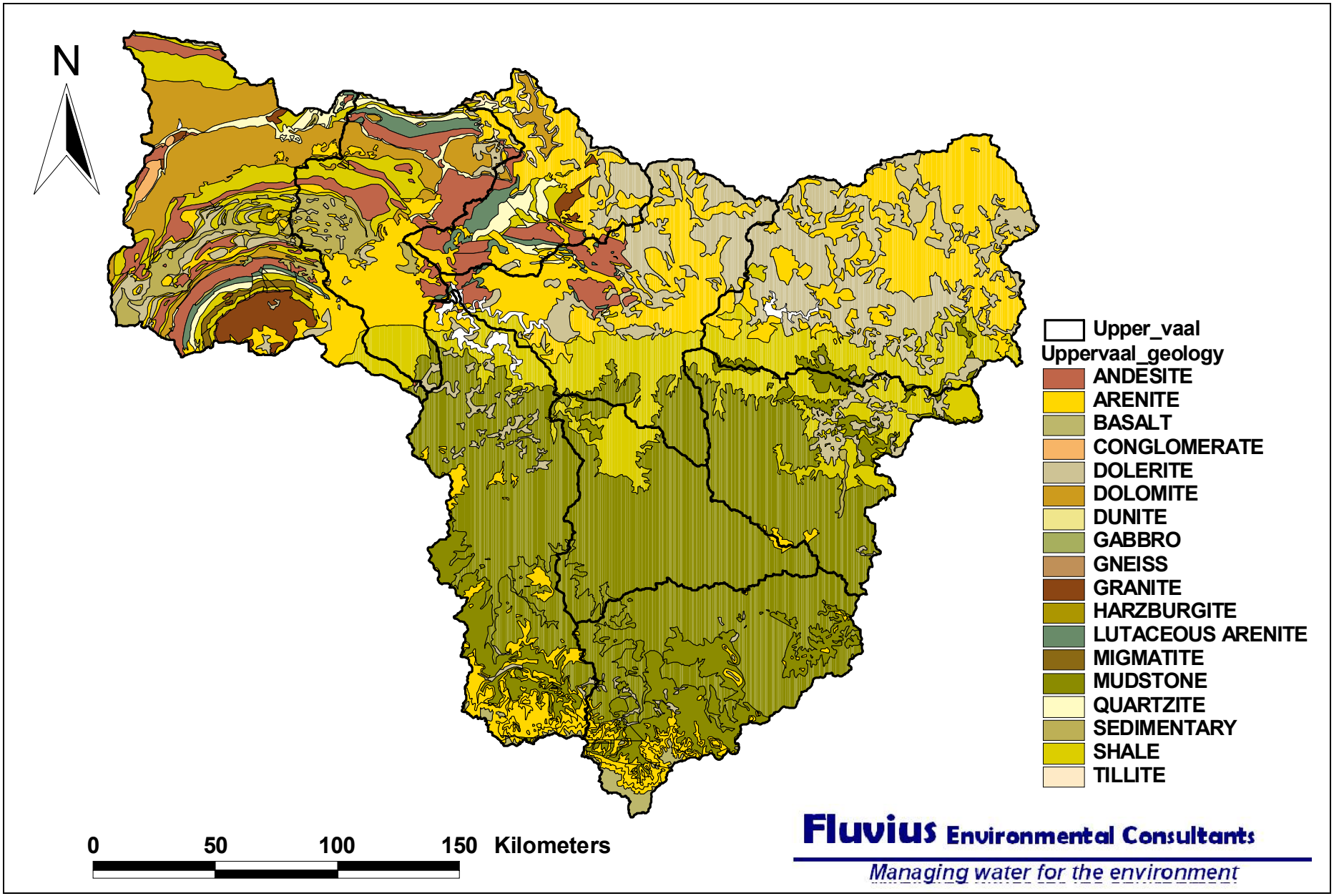

Figure 2.5 Simplified Geology of the Upper Vaal WMA (sourced from DWA:GIS)

2.3 VEGETATION

At a broad scale, the WMA is composed of primarily of grasslands, with relatively small patches of Savanna vegetation in the extreme north east of the WMA (Figure 2.6). These broad vegetation units have been sub-divided into several vegetation types by Mucina and Rutherford (2006). Predictably dominated by grassland communities (Figure 2.7), several are regarded as endangered due to land use conversion. The vegetation of the southern half of the WMA is regarded as Endangered (Figure 2.8) due to widespread conversion of the grasslands to planted pastures or crop agriculture. Similarly an arc of endangered vegetation has been identified along the northern section of the catchment coinciding with the heavily urbanised/industrialised areas within the WMA.

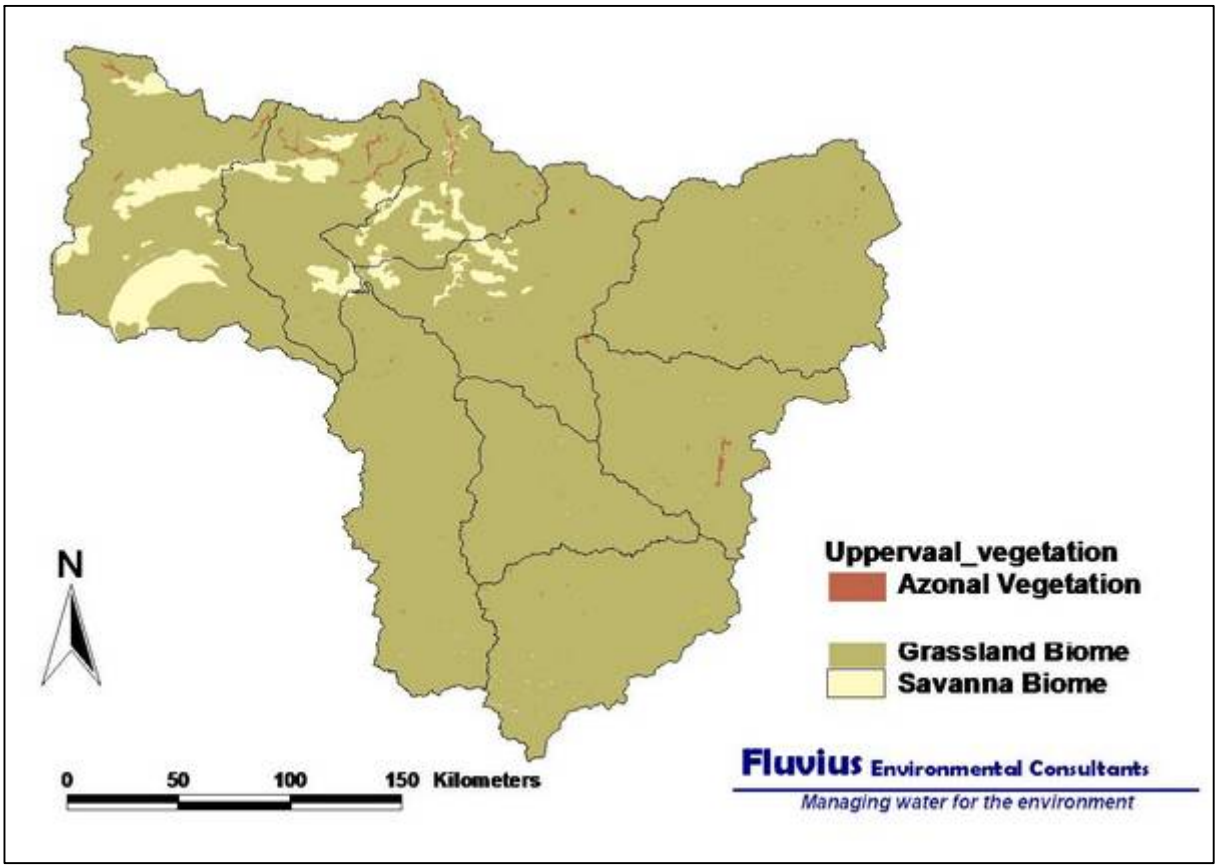

Figure 2.6 Biomes of the Upper Vaal WMA (after Mucina and Rutherford, 2006)

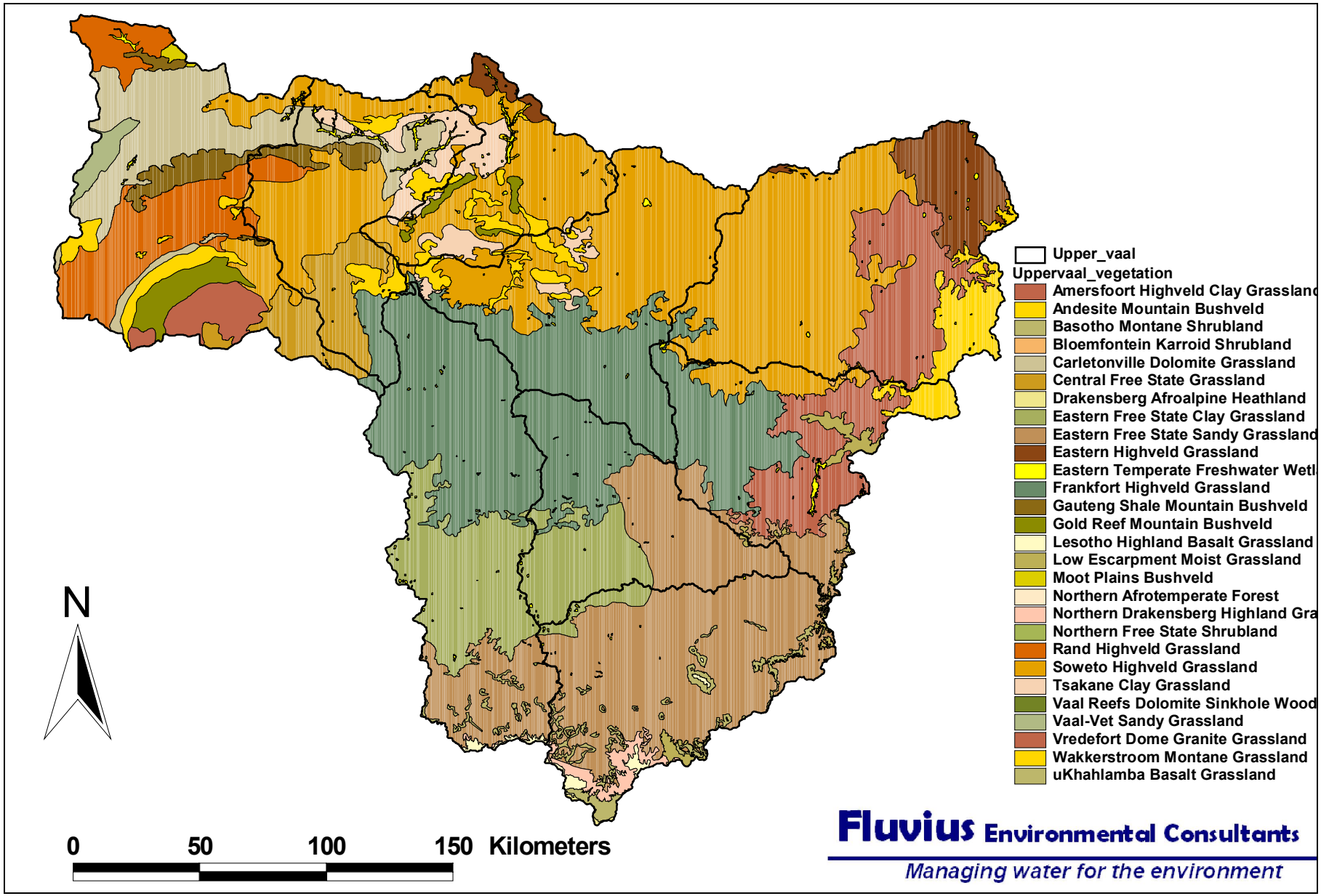

Figure 2.7 Vegetation types across the Upper Vaal catchment (after Mucina and Rutherford, 2006)

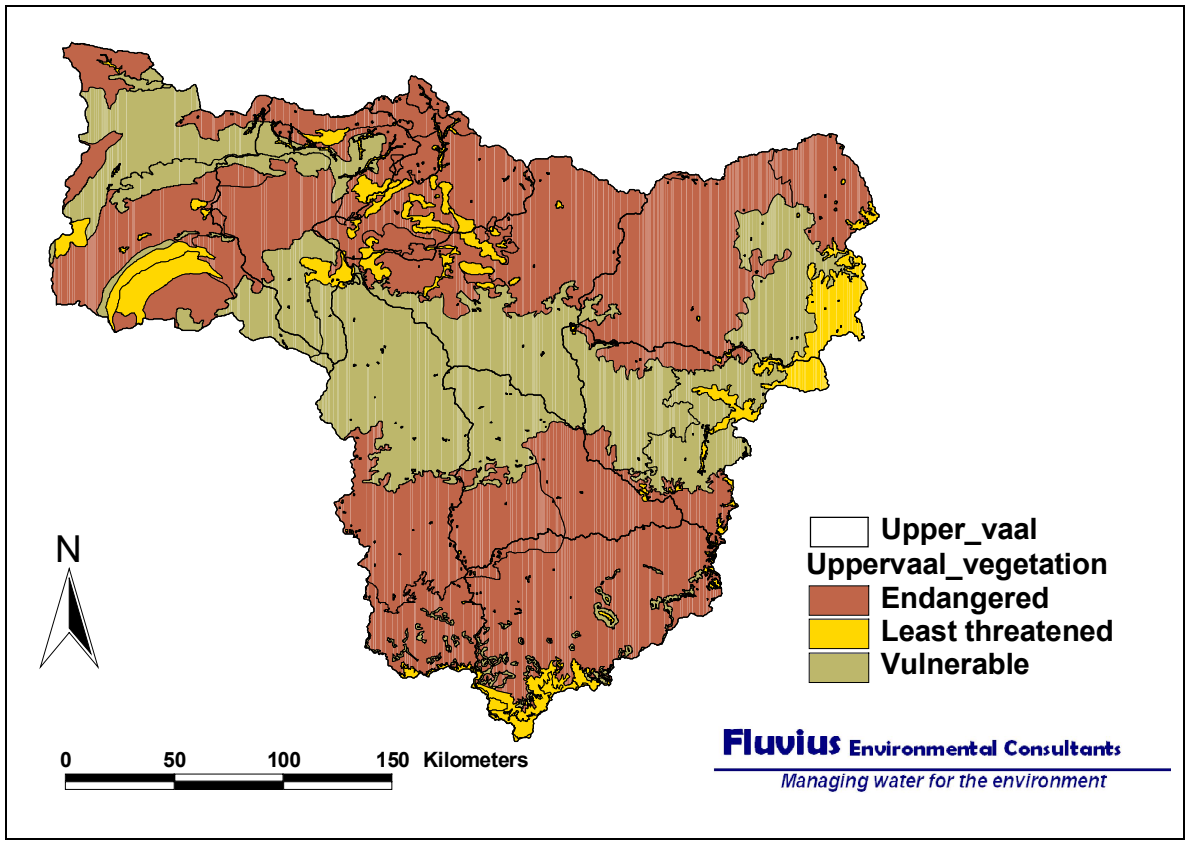

Figure 2.8 Conservation Status of Vegetation Types within the WMA (after Mucina and Rutherford, 2006)

3 METHODS

The purpose of this study was to identify the major wetland types within the catchment and conduct a primarily desktop EcoClassification assessment of wetlands within the Upper Vaal WMA. The study was constrained to a largely desktop assessment due to the very extensive size of the study area, the large number of wetlands within the catchment, and the limited resources that were available to conduct the study.

The following approach was proposed:

- Identification and mapping of the wetlands in the catchments to provide a broad overview of the extent wetlands.
- Classification of the wetland units using the Hydro-Geomorphic (HGM) method, specifically grouping wetland systems into functional units that can be used to provide indications of their functions in the landscape.
- A description of the general reference conditions of the wetlands in the catchment was to be developed.
- Due to budgetary and logistical constraints, it would be impossible to conduct the detailed field assessments required to determine the Present Ecological State (PES) for each wetland unit. Instead, general assessments of the overall condition of the different HGM wetland types would be undertaken, and statements of the impacts and threats acting upon the wetlands will be described.
- EIS criteria will be adapted from previous wetland studies to assess the general Ecological importance and Sensitivity (EIS) of the wetlands in the catchment.
- For some important wetland systems, statements relating to the EcoSpecs for these systems might be developed.
- In addition to these tasks, priority wetlands for possible pilot testing of the draft Rapid Reserve methods for wetlands would be identified.

Subsequent to the initiation of the study, two initiatives from other studies enabled the focus of the approach to be broadened to provide more appropriate information to the RDM.

Firstly, The South African National Biodiversity Institute allowed for a draft wetland probability map to be employed in this study. This enabled a large catchment overview of the extent, number and density of wetlands to be derived from this dataset for the Upper Vaal WMA. The second was the development of quaternary catchment scale wetland PES and EIS tools in parallel DWA:RDM studies in the Outeniqua and Inkomati Reserve studies. These developments enabled this assessment to yield PES and EIS information specific for each quaternary catchment in the WMA instead of the more general assessments of the entire WMA which have up to now been generated in previous wetland assessments at this scale. The quaternary catchment based assessments facilitated the development and provision of (albeit primarily desktop level) information on the wetlands within the study area that can be used as for RDM and other DWA processes. This desktop information is used to provide input to and catchment context for RDM desktop and associated WULA assessments, to guide future, more detailed wetland assessments and to identify catchments or individual wetlands where detailed EWR determinations may be required.

The final approach that was used is illustrated in the flow diagram below.

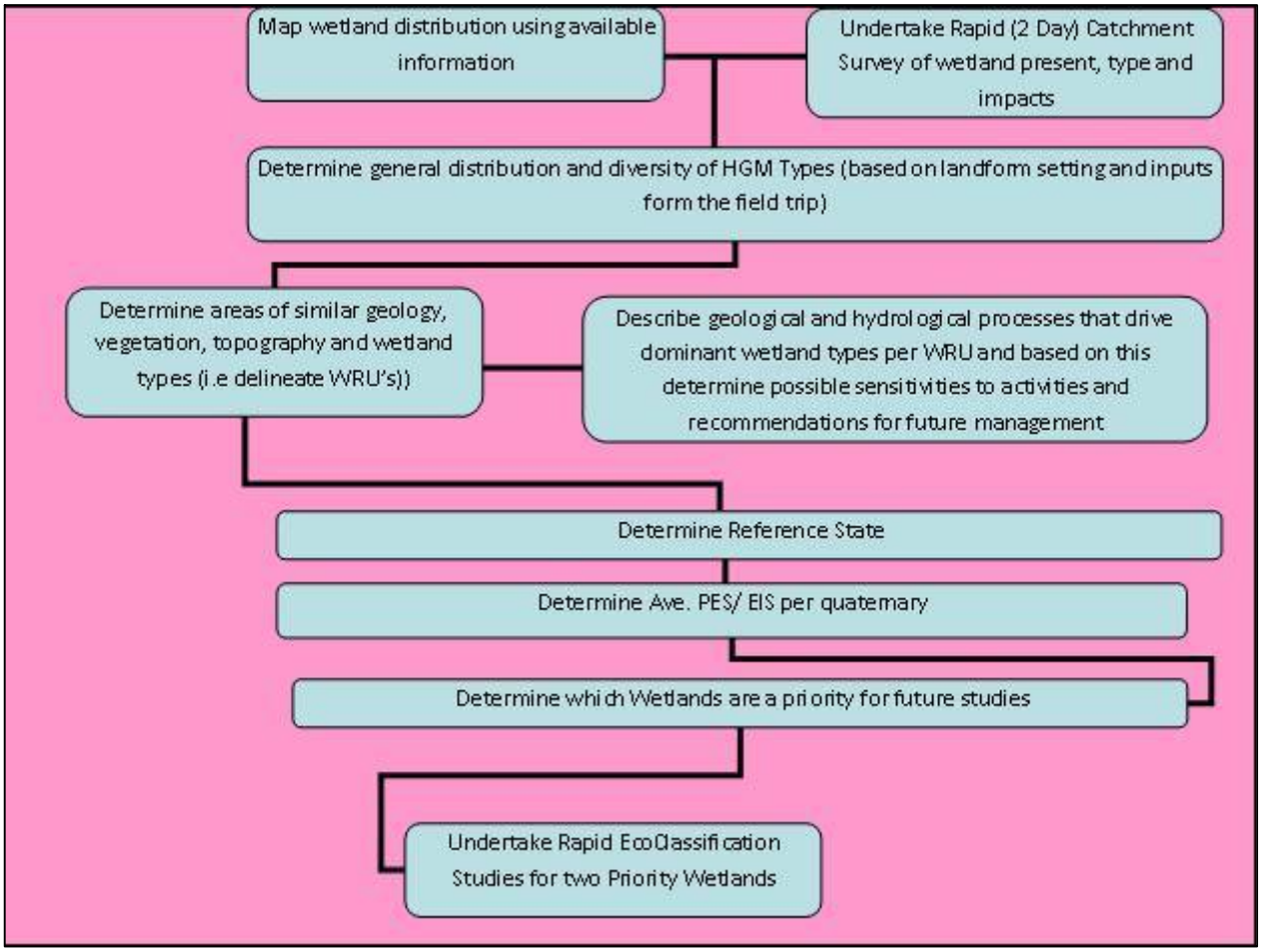

Figure 3.1 Approach used in this study

3.1 EXTENT OF WETLANDS IN THE CATCHMENT

The most up-to-date version of the South African National Biodiversity Institute's (SANBI) Wetland Probability Map (WPM; SANBI, in prep.) was used as a first-level assessment of wetland occurrence within the study area. These data are not ground-truthed, and should thus be treated with caution. The Reserve study precluded a catchment-wide wetland identification, classification and mapping exercise but the available SANBI map does provide a good indication of relative wetland occurrence, size and density across the study area. This information was used combined with improved understanding of the wetland distributions, types and sizes obtained from 1:50 000 topographical maps, Google Earth and a rapid field verification trip. These information sources were used to identify Wetland Resource Units across the catchment.

3.1.1 Rapid field assessment for Desktop verification

A rapid (2 day) ground-truthing trip was undertaken during October 2009 to verify the presence and type of wetlands identified in the desktop component of the study. This field verification entailed criss-crossing the catchment and making notes of the type, location and condition of wetlands within the sub-catchments as well as rapidly assessing the types and severity of impacts that are imposed by the surrounding land use practices.

The findings of the field verification were used to refine the understanding generated from the desktop component of the study, and to inform the description of wetland types; impacts and general condition; the quaternary PES and EIS assessments and the delineation of the Wetland Resource Units.

3.1.2 Description of HGM Wetland Types

Landform (geomorphological setting or landscape position) and wetland hydrology (the way water flows into, through and out of a wetland system; Table 3.1) are commonly acknowledged as the fundamental determinants of the existence of wetlands (Brinson, 1993; Semeniuk and Semeniuk, 1995; Finlayson *et al.,* 2002; Jones, 2002; Kotze *et al.*, 2005, Ellery *et al.*, 2005), and are the foundation for hydrogeomorphic (HGM) classification systems for wetlands (e.g. Brinson, 1993; Semeniuk and Semeniuk, 1995).

Table 3.1 A wetland typing system for inland wetlands of South Africa (Rountree and Batchelor, in prep.)

Landscape setting		Flow pattern within wetland	HGM Wetland Type
Valley Bottoms	Confined	Channeled	River
		Standing water	Lake
	Unconfined	Diffuse	Unchanneled Valley Bottom
		Channeled (parallel to valley)	Channeled Valley Bottom
		Channeled (meandering across valley; Sinuosity Index > 1.5)	Meandering Floodplain
Slopes		Diffuse => diffuse	Seepage (isolated)
		Diffuse => surface/channel	Seepage (connected to channel)
Crests		Diffuse flow => standing water	Seepage (connected to pan)
		Standing water	Pan
Flats		Standing water	Wetland flat

Wetland classification systems based on geomorphic and hydrologic aspects are regarded as more robust and consistent than those based on other criteria (Finlayson *et al.*, 2002) – because they describe the fundamental reason for the existence of a wetland in a landscape and, accordingly, provide the primary point of departure for wetland classification.

The HGM classification systems described above have previously undergone some adaptations for application in South African Palustrine wetlands (Marneweck and Batchelor, 2002; Jones and Day, 2003; Kotze *et al*., 2005; Ewart-Smith *et al.*, 2006). For a review of these adaptations refer to DWA (2007). The classification system proposed here should be robust and simple enough to allow for application by DWA and DEA technicians and regional staff. Correct identification of the wetland type is expected to carry a number of consequences for management decisions (for instance, such as how, and at what level, WULAs are to be handled).

Thus on the basis of desktop information and interpretation thereof, it is possible to distinguish a number of different wetland types according to the landscape position in which they are found, and on the assumed flow patterns or hydrological characteristics that typify those HGM wetland types (Table 3.1). This typing system identifies 8 groupings of wetland types (seepage wetlands are grouped into a single unit), which can be identified at a broad desktop level. These eight HGM wetland types are described in Appendix A.

3.2 DESKTOP QUATERNARY CATCHMENT SCALE ASSESSMENTS

Since there are too many wetlands to evaluate on an individual basis, a desktop level quaternary-scale catchment assessment of the wetlands across the entire study area was undertaken. This information was used to determine the average PES and EIS categories of wetlands within each quaternary catchment. A desktop scoring system for quaternary catchment scale PES and EIS determination was developed during this and a parallel (DWA, 2009) study for this purpose.

3.2.1 Quaternary catchment-scale desktop PES wetland assessment

Low confidence desktop assessments of the Wetland PES was conducted for each of the quaternary catchments of the study area, using approaches based on similar desktop assessments of quaternary scale for rivers and tributaries (Kleynhans, 2000). These were done to provide an overview of the present ecological state of wetlands across the study area.

The impact criteria from the Wetland Index of Habitat Integrity (Wetland IHI) PES assessment tool (DWAF, 2007) were divided into those that needed to be considered at the catchment scale and those that needed to be assessed at the individual wetland unit (i.e. within-wetland) scale (Table 3.2). Each was rated on a scale of 0 (no impact evident) to 5 (the maximum possible extent or intensity of impact possible) for each quaternary catchment. An average weighted score for each quaternary catchment was then calculated and PES categories (Table 3.3) assigned using the approach of Kleynhans (2000). These results yield an average PES category for all wetlands within the relevant quaternary catchment.

Table 3.2 Criteria (potential impacts) assessed for the desktop wetland PES assessment

Criteria assessed at the quaternary catchment scale
Afforestation/Invasive plants
Dams, irrigation, other flow reduction activities
Extent of Urbanisation/catchment hardening
Mining/urban/cropping – water quality factors
Criteria assessed within the wetlands:
Invasive plants
Land use activities (mining-cropping-grazing)
Altered hydrology (drains/dams)
Erosion of wetlands

Table 3.3 Generic ecological categories for EcoStatus components (after Kleynhans, 1996 and Kleynhans, 1999)

PES Category	Description
A	Unmodified, natural.
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst cases the basic ecosystem functions have been destroyed and the changes irreversible.

3.2.2 Quaternary catchment-scale desktop EIS wetland assessment

The river quaternary desktop EIS assessment tool (Kleynhans, 2000) was adapted for use in determining the EIS of wetlands at the quaternary catchment scale. Criteria that could be assessed using available desktop information were identified (Table 3.4). These were rated from low (score of 1) to very high (score of 4).

Assessment of site-specific criteria and/or those that require field-data such as direct human benefits (e.g. grazing, subsistence agriculture, etc.) and the potential hydrological functional

importance of wetlands (such as flood attenuation) were precluded from the desktop assessment because these could not be reliably assessed at the quaternary catchment scale.

Table 3.4 The list of criteria used to derive the quaternary scale EIS scores for wetlands. Each criterion was rated from 1 (none) to 4 (very high)

Ecological Importance and Sensitivity criteria
Diversity of wetland types
Density of wetlands
Unique wetlands - size; type etc.
Species Richness
Importance of conservation and natural areas
Migration route/corridor - links to other systems
Rare/endangered/unique populations
Sensitivity to water quality changes
Sensitivity to upstream flow changes
Dependence on Groundwater

An average weighted score for each quaternary catchment was then calculated and EIS categories assigned (Table 3.5).

Table 3.5 Description of the DWAF Ecological Importance and Sensitivity scores (after Kleynhans, 1999)

Median Score	Description of the category
>3 and <=4	Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.
>2 and <=3	High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.
>1 and <=2	Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.
>0 and <=1	Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.

3.3 IDENTIFICATION OF WETLAND RESOURCE UNITS

There are thousands of wetlands in South Africa, and it would be difficult, if not impossible, to manage each wetland individually as many are small, some are cryptic (i.e. not be easily identified) and others have been extensively modified, thus making their identification and delineation difficult. Even if all the wetlands within a region could be identified and mapped, their sheer number would preclude a site-specific approach to wetland management.

There is thus a need for an approach to classify wetlands with similar characteristics so that these can be grouped into Wetland Resource Units (WRUs). Such WRUs may then offer the opportunity to identify assemblages of wetlands rather than the many individual wetland systems. Through the use of WRUs, DWA and other natural resource managers can manage wetlands on the basis of similar characteristics, driving processes, and sensitivities to developments and other impacts.

A modification of a hierarchical system for the classification of South African wetlands (Ewart-Smith *et al.*, 2006, with updates by SANBI, 2009) was used in to classify the wetlands in this study. The

modified system (DWAF, 2007; Rountree and Batchelor, in prep.) uses the underlying hydrological processes and formative geomorphological setting as the basis of classification.

At the broadest spatial level (Level I – note, these do not refer to EcoRegion levels), all inland wetlands are classified in a single unit (Table 3.5). Nested within Level I are two classification systems that operate at smaller spatial scales*, viz:*

Level II: Broad groupings of wetlands based on, *inter alia*, underlying dominant geology and/or EcoRegions, which are referred to as Wetland Resource Units (WRUs) in this study.

Level III: Groups of wetlands based on geomorphological and hydrological criteria, referred to as hydrogeomorphic (HGM) wetland types in this study.

Level II: Wetland Resource Units (Table 3.5) were identified using the following information:

- Level I (Kleynhans *et al*., 2005; Figure 2.2) and Level II (Kleynhans *et al*., 2007; Figure 2.3) EcoRegion information.
- Regional geological series (Figure 2.4).
- Vegetation distribution data (Mucina and Rutherford, 2006, Figure 2.6).
- 1:50 000 topographical maps.
- Information on relative wetland density (Figure 4.1), size, type and condition (as derived from Google Earth imagery and results of the rapid field verification trip).

This required that the common HGM wetland types across the study area be identified and described. The HGM wetland types are distinguished according to their underlying hydrological processes that create and sustain the different types of wetlands. The likely sensitivities to particular types of activities, and thus recommendations for future management, can be determined, albeit at low confidence, from this information.

Table 3.6 The nested hierarchical classification system

Level I: System	Level II: Wetland Resource Units	Level III: Wetland HGM Types
INLAND	Informed by: - EcoRegions - Dominant Geology - Vegetation Types - Topography - Wetland Density and variety of HGM types represented	River
		Lake
		Meandering Floodplain
		Channeled Valley Bottom
		Unchanneled Valley Bottom
		Hillslope seepages (connected)
		Hillslope seepages (isolated)
		Pan
		Flat

3.4 IDENTIFICATION OF PRIORITY WETLANDS

Based on the information obtained in this study as well as from inputs from a regional Vaal wetlands prioritisation workshop held in 2007, wetlands or regions which are regarded as important and which are deemed to be at risk from current or expected future developments in the catchment have been identified. These should be prioritised for future Reserve Determinations or other similar assessment studies to provide strategic information for their management, protection and regulation of use.

4 RESULTS: WETLAND RESOURCE UNITS

4.1 GENERAL DESCRIPTION OF WETLANDS IN THE UPPER VAAL CATCHMENT

The SANBI wetland probability map indicated that the Upper Vaal WMA is characterised by a generally high density of wetlands (Figure 4.1). The relatively high rainfall and generally low relief across the catchment area promotes the development of wetlands. Wetland development is favoured in flatter landscapes since the flatter landscapes tend to promote increased infiltration and storage of water in the landscape and inhibit rapid drainage and high flow velocities. Under these conditions, low energy drainage systems (valley bottom wetlands) develop.

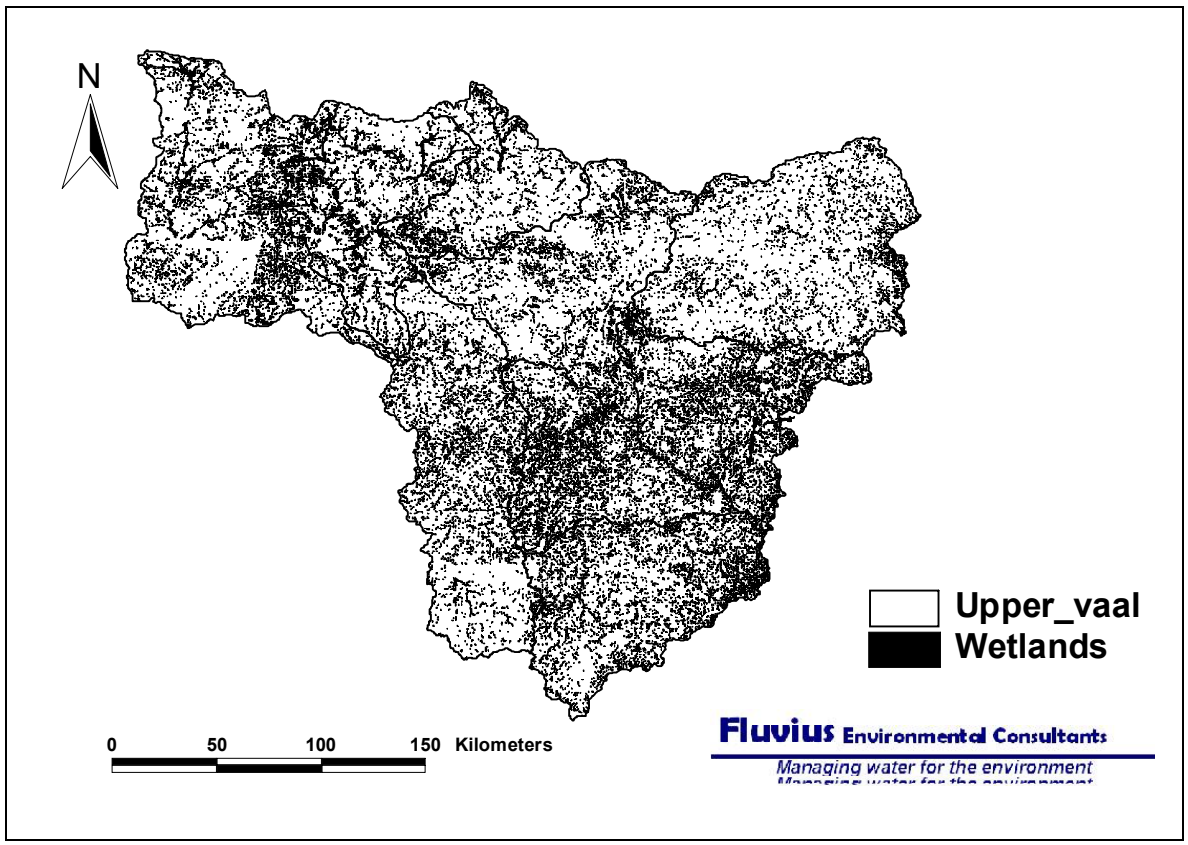

Figure 4.1 Distribution (as identified in the SANBI wetland probability map) of wetlands across the Upper Vaal catchment

Due to issues of scale and the modelling approach that was used, the SANBI wetland probability map does not provide an exact database of all wetlands, and their precise extents, across the WMA, but does provide a good approximation of the relative sizes and densities of wetlands that can be expected to occur within the study area. Thus comparisons can be made regarding average wetland size, density and association of wetlands with other features (specific geology, vegetation types and/or catchments) and these initial findings can be verified using other data sources (such as Google Earth imagery) or field assessments.

More detailed desktop assessments and the field verification component confirmed that a variety of wetland types, and differing densities, are encountered across the WMA. The aim of delineation of Wetland Resource Units (WRUs) is to simplify the complexity of different wetland types and the variety of underlying driving processes to enable easier assessment of the wetlands and for more effective and appropriate management decisions to be reached.

The relevance of understanding the underlying driving conditions maintaining different wetland types may become apparent when, for example, evaluating the impacts of proposed developments or Water User Licence Applications (WULAs). Wetlands that are maintained by interflow[2] can be expected to have a relatively small catchment, but would be highly sensitive to developments within that immediate topographically-defined catchment area. Wetlands maintained by regional groundwater however could be expected to be less sensitive to individual developments in the immediate vicinity of the wetland, but to be more sensitive to cumulative impacts of regional development. Abstraction through boreholes several kilometres from an interflow-dominated wetland may not be expected to have a significant impact (since this is maintained by the immediate catchment), but if the wetland was groundwater-dependent, then abstraction, even if far from the wetland, may affect the regional groundwater aquifer and thus the "downstream" wetland; albeit that the impact point and groundwater-maintained wetland may not be connected by surface hydrological processes, nor located immediately adjacent to one another.

4.2 WETLAND RESOURCE UNITS OF THE UPPER VAAL WMA

Wetland type and density was found to be poorly correlated with either the Level I (Figure 4.2) or Level II (Figure 4.3) EcoRegions, and similarly correlations between Vegetation Types and wetland density/size/type were also limited (Figure 4.4).

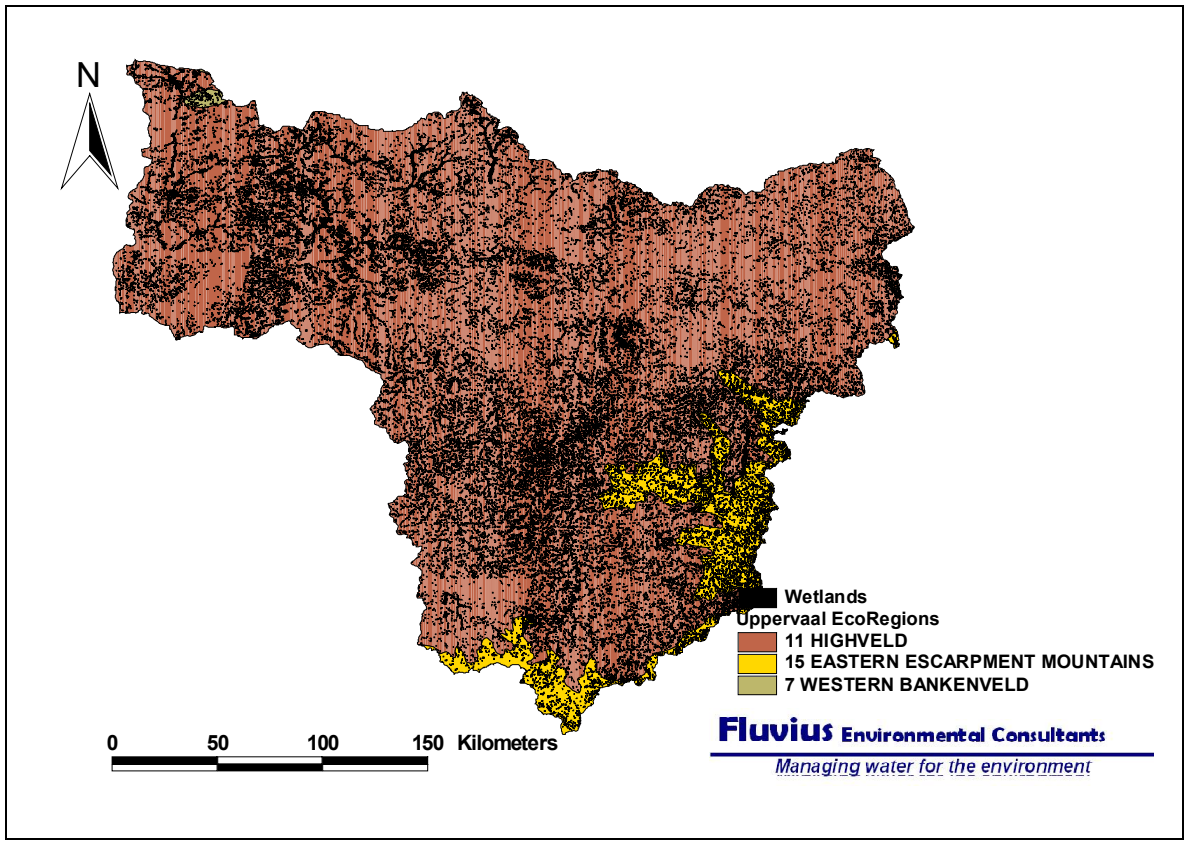

Figure 4.2 Relationship between wetland density and Level I EcoRegions

[2] For the purposes of this wetland report, a distinction is drawn between the relatively deep geological ***groundwater*** (water flowing in the rocks of the primary and secondary aquifers) versus very shallow ***interflow*** (which is water moving through the soil profile in a downslope direction).

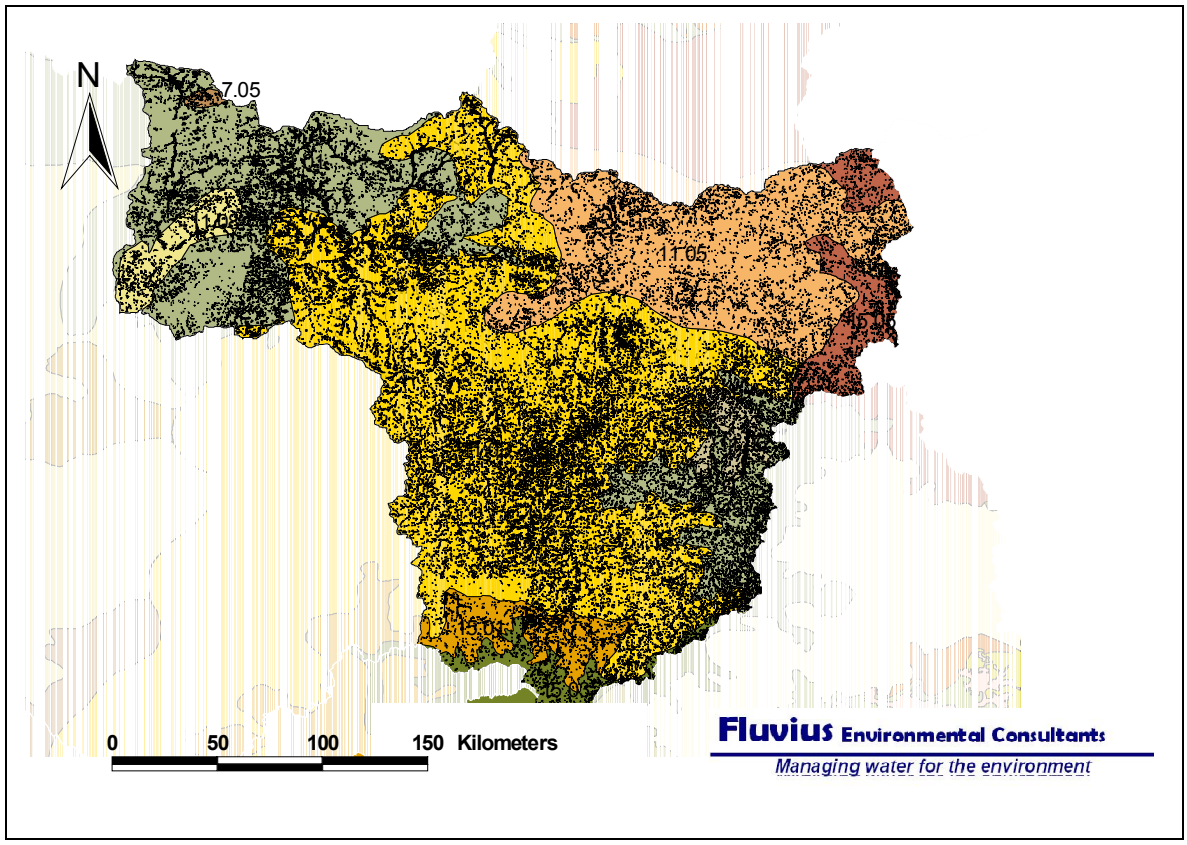

Figure 4.3 Relationship between wetland density and Level II EcoRegions

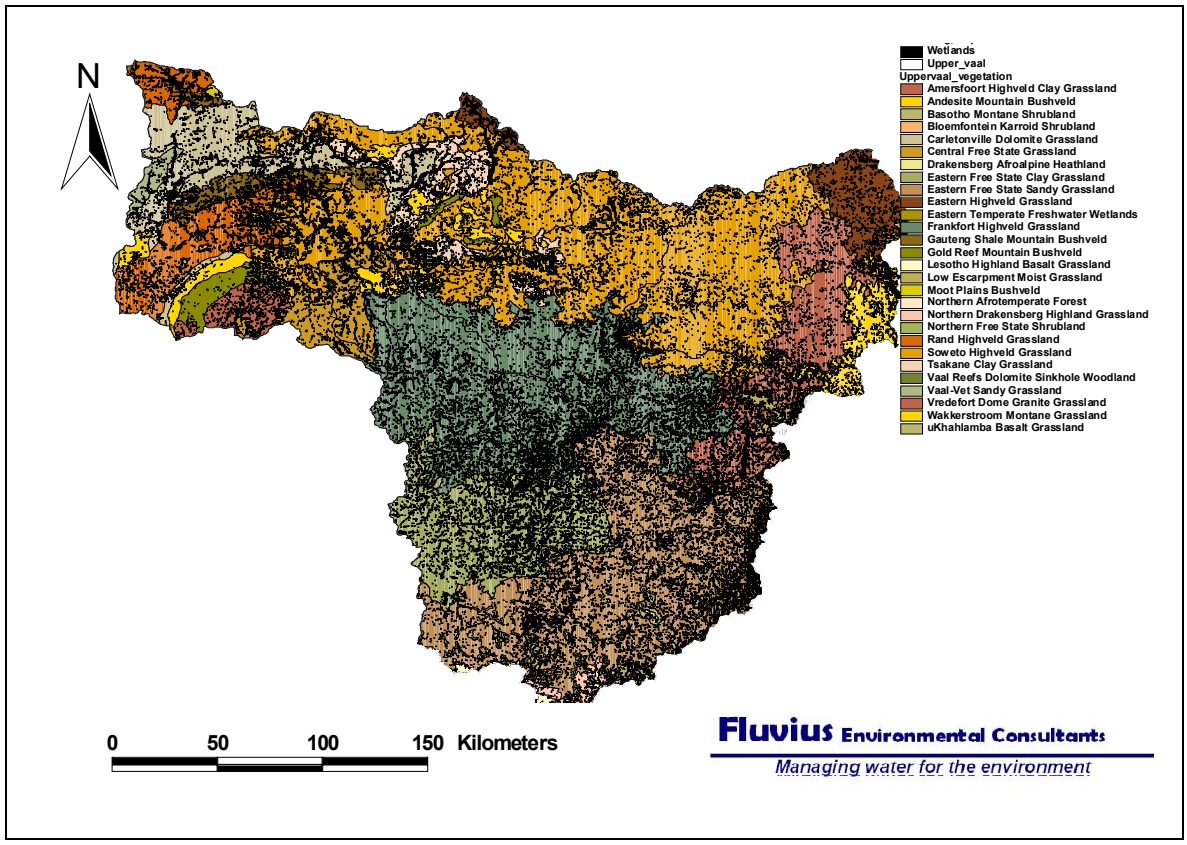

Figure 4.4 Relationship between vegetation types and wetland densities

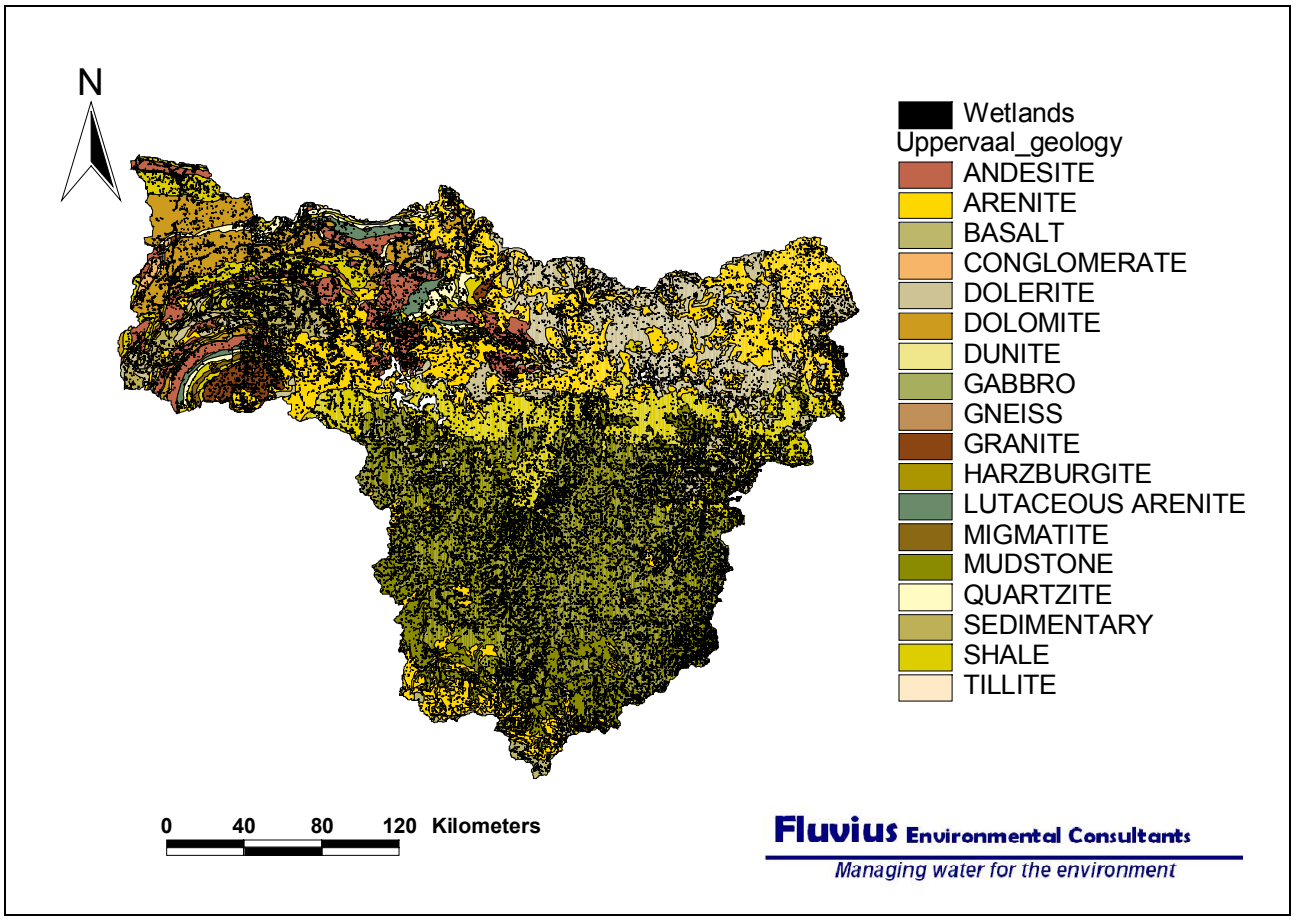

Figure 4.5 Relationship between wetland density and underlying geology

Some correlation is apparent between underlying geology and wetland densities (Figure 4.5), where extensive dolerites, shales and dolomites tend to be associated with low wetland densities. Dolerites and shales are relatively impervious, resistant rocks and tend to inhibit deep infiltration and extensive interflow across the landscape. Limited interflow means that fewer wetland areas are likely to form, since most precipitation runs of the landscape and this favours the development of rivers (higher energy) rather than wetlands (low energy) in the drainage lines of the landscape

Generally the highest density of wetlands is in the southern section of the WMA. This area of the WMA is associated with the mudstone deposits (Figure 2.4) and the higher elevation sections of the catchment (Figure 4.6). Whilst the general drop in wetland density from south to north is probably associated with the declining rainfall from south to northwest across the WMA, this pattern may also be indicative of decreasing interflow in the landscape due to differing underlying geology and the increasingly dissected (incised) landscape.

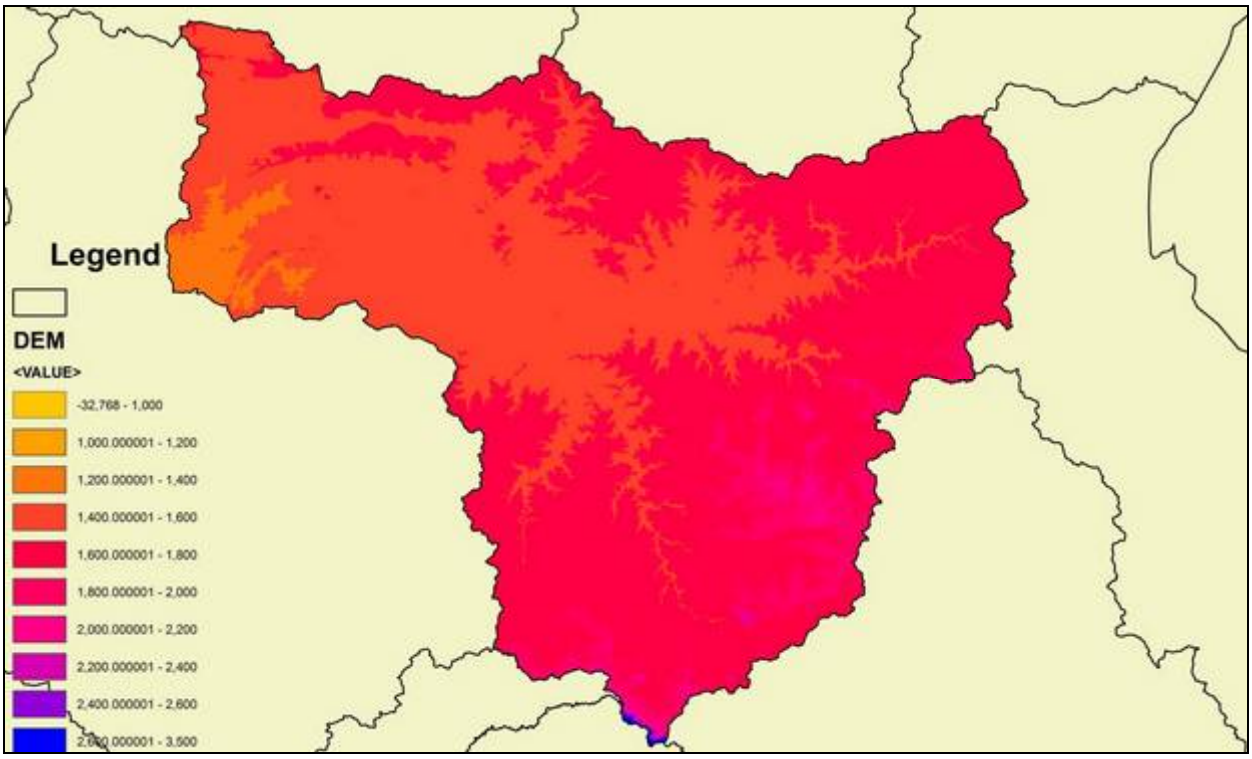

Figure 4.6 Topography of the Upper Vaal WMA. High density wetland areas (Figure 4.1) are associated with the southern higher lying areas

In river studies, EcoRegions often form the basis for delineating Resource Units. In wetland studies the key factor in delineating regions of similar wetland types and processes is often the underlying geology, since this dictates the topography of the landscape that develops and the hydrological behaviour of surface, interflow and groundwater due to the soil and geology of the site.

In the case of the Upper Vaal WMA, geology and topography have been used together with land use of the catchment to delineate the Wetland Resource Units. In this case, EcoRegions have not played a strong role in the delineation, but it should be borne in mind that this may merely be a consequence of the fact that almost the entire study site is represented by a single Level I EcoRegion, and thus the similarity of biota across the WMA rather than a weakness of EcoRegions *per se* may be why geology in this case plays a stronger role in the delineation of the WMUs. The underlying geology was used in conjunction with the PES and EIS results to delineate resource units for wetlands.

Three main Wetland Resource Units (Figure 4.7) were delineated, namely the:

- WRU 1: Dolomite Peatlands WRU
- WRU 2: Central sedimentary WRU, and the
- WRU 3: Eastern sedimentary WRU.

Within each of the three WRUs, wetland types can be distinctive to the WRU (Table 4.1). For example, very large unchannelled valley bottom wetlands are primarily found within WRU 1 (Dolomite Peatlands WRU), whilst the extensive seepage and wide, largely unchannelled valley bottom wetlands and floodplains are located within the Central (WRU 2) and Eastern (WRU 3) Sedimentary WRUs. The Central and Eastern Sedimentary WRUs are however quite similar in terms of HGM wetland types, but have been distinguished because of the generally higher density

and importance of wetlands, generally higher PES condition, and often larger size of the floodplain and valley bottom wetlands in the Eastern Sedimentary WRU as compared to the Central WRU.

Table 4.1 Common HGM wetland types associated with the different Wetland Resource Units

Level II: Wetland Resource Units	Level III: Dominant Wetland Types within the WRU
Dolomitic Peatlands WRU - Low density of wetlands, but where present they are very large valley bottom systems - Peats are common - Dependence on groundwater is high	River
	Channeled Valley Bottom (common)
	Unchannelled Valley Bottom (common)
Central Sedimentary WRU - Very high density of wetlands. - Wetlands generally small, but high diversity - Dependence on interflow is high	River
	Meandering floodplains (small pockets common)
	Channelled Valley Bottom (common)
	Unchannelled Valley Bottom (uncommon)
	Hillslope seepages - connected (common)
	Hillslope seepages - isolated (common)
	Pans (uncommon)
Eastern Sedimentary WRU - Very high density of wetlands. - Wetlands generally small, but high diversity - Dependence on interflow is high	River
	Meandering floodplains (large floodplains present)
	Channelled Valley Bottom (common)
	Unchannelled Valley Bottom (common)
	Hillslope seepages - connected (common)
	Hillslope seepages - isolated (common)
	Pans (uncommon)

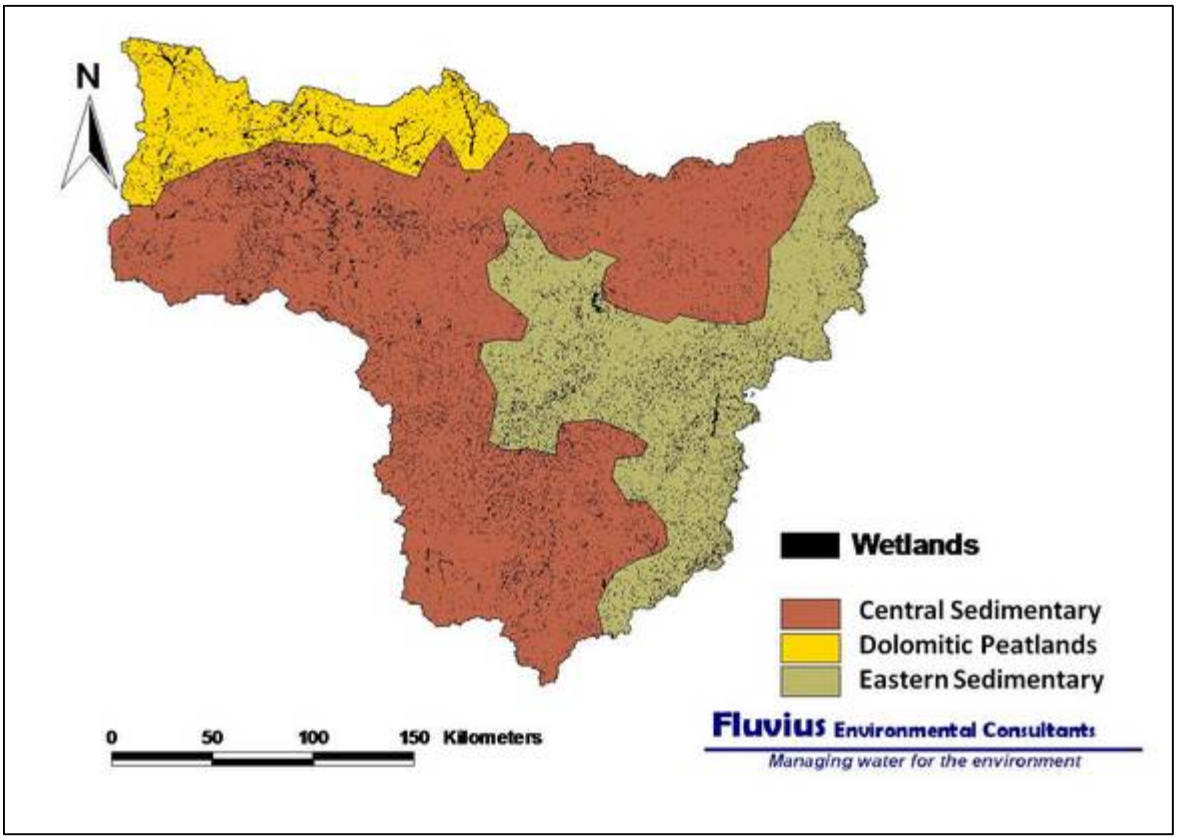

Figure 4.7 Wetland Resource Units within the Upper Vaal Water Management Area

4.2.1 WRU 1: Dolomitic Peatlands

This WRU is characterised by a low density (Figure 4.7) and diversity (Table 4.1) of wetland types, but the wetlands that are present are large, unchannelled or weakly channelled valley bottom wetlands (Figure 4.8) characterised by deep peat deposits which is very unusual for this part of South Africa. Extensive seeps are largely absent, and pans are restricted to the uppermost catchment areas. Vegetation diversity within the wetlands is generally low in the main wetland, but is higher in the seasonally flooded marginal areas. Some of the vegetation types found within this WRU are considered to be endangered (Mucina and Rutherford, 2006).

Figure 4.8 Unchannelled Valley Bottom wetland in a dolomitic zone

4.2.2 WRU 2: Central Sedimentary

This WRU has a very high density of wetlands; characterised by large seepage wetlands, both unchannelled and channelled valley bottom wetlands, and occasional small floodplains (Figure 4.9). Although uncommon, pans are present. The underlying sedimentary rocks promote infiltration and interflow. The vegetation types which characterise the Central Sedimentary WRU are considered to be Vulnerable or Endangered (Figure 2.6).

Figure 4.9 Meandering floodplain with ox-bows and backwaters

4.2.3 WRU 3: Eastern Sedimentary

In most respects the wetlands found in this WRU are similar to those characterising the Central Sedimentary WRU, but the wetlands tend to be larger and are more abundant. Very large floodplain systems (Figure 4.10) are present within this WRU. The vegetation types which characterise the Eastern Sedimentary WRU are generally Endangered (Figure 2.6), and many red data avifauna are associated with the wetlands of this WRU. Large unchannelled valley bottom wetlands occur in the foothills of the Drakensberg.

Figure 4.10 A large meandering floodplain reach of the Upper Wilge River within WRU 3

5 RESULTS: QUATERNARY CATCHMENT WETLAND PES AND EIS

The purpose of the quaternary scale PES and EIS assessments is to provide some low confidence information on wetland condition and importance across the WMA. There are thousands of individual wetlands within the WMA (Figure 4.1), and the DWA may be called upon to evaluate any one of these as part of standard WULAs or as a requirement to incorporate wetlands into catchment management planning. It is not feasible to conduct individual PES and EIS assessments on all wetlands within the WMA, so a quaternary-scale desktop assessment was developed to provide low confidence assessments of the expected average PES and EIS of all wetlands within the quaternary catchment.

Since the quaternary catchments are nested within the WRUs, the characteristics of the latter can be used to inform the expected PES and EIS characteristics; specifically with regard to the likely sensitivities of the specific wetland types within each WRU to the different land use impacts observed within the quaternary catchment.

PES and EIS scores per quaternary catchments relate to the estimated average score of all wetlands within the quaternary catchment, with scores reported in the standard Ecological Categories and Importance and Sensitivity Categories (Table 5.3 and 5.5) for PES and EIS respectively.

5.1 PES AND EIS ATTRIBUTES OF THE UPPER VAAL WMA WETLANDS

Land use transformations invariably degrade the surrounding and downstream wetlands through a combination of:

- Increased fires and grazing pressures.
- Channelization, erosion, infilling and drainage of wetlands.
- Effluent and stormwater disposal, and
- Water abstraction from the wetlands, and groundwater abstraction which has indirectly reduced water supply.

The degradation of wetlands reduces biodiversity, ecosystem services (such as flood attenuation and water quality amelioration) and results in loss of harvestable resources. In poorer communities, especially those in former homeland areas, goods and services derived from wetlands can be used to buffer the effects of poverty. However, the increasing density and extent of these urban and peri-urban areas is also impacting negatively on wetlands. The degradation of wetlands and associated reduced goods and service provision therefore necessitates a dependence on other more expensive materials or sources of food.

In the Upper Vaal WMA, a large proportion of the catchment has been modified or transformed from its natural condition. The dominant land use is agriculture (pasture, dryland or irrigated cultivation), but there are also extensive urban settlements as well as industrial and mining areas. These extensive catchment-wide impacts account for much of the generally moderate to poor condition wetlands identified across the WMA (Figure 5.2).

Good condition wetlands are dominant in the central-eastern and southern margins of the WMA – these are areas where agricultural land use has been less intensive than the rest of the catchment. Wetlands along the northern margin of the WMA are generally in very poor condition – these catchments drain the highly urbanised and industrially developed areas of the WMA. The average

wetland EIS per quaternary catchment within the WMA has been determined (at desktop level) and are illustrated in Figure 5.3. The results are also tabulated in Table 5.1, including comparisons between river and wetland PES and EIS scores per quaternary catchment. A reasonable correlation (Figure 5.1) exists between quaternary scale river EIS and wetland EIS scores, and many of the areas within the WMA highlighted as important in this study (Figure 5.3) correlate well with the draft National Freshwater Ecosystems Priority Areas (NFEPA) results (Figure 5.4) for this area – both studies highlighted the eastern and northern sections of the WMA in terms of wetlands.

Results presented below pertaining to the PES and EIS attributes of the Wetland Resource Units are based on the results from the quaternary catchments nested within the WRUs. Specific detail per quaternary catchment is provided in Appendices B and C for the PES and EIS attributes respectively.

Table 5.1 Average EIS and PES for the wetlands within the quaternary catchments of the Upper Vaal WMA (Quaternary catchments with a high PES or EIS Score are highlighted in grey)

Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C11A	Vaal	**HIGH**	Moderate	**C**	B/C
C11B	Vaal	**HIGH**	Moderate	**C**	C
C11C	Klein Vaal	MODERATE	Moderate	C	B
C11D	Klein Vaal (Rietspruit)	MODERATE	Low	C	C
C11E	Rietspruit	**HIGH**	Moderate	C	C
C11F	Kaffirspruit	MODERATE	Moderate	C	C
C11G	Kaffirspruit	MODERATE	Moderate	**B/C**	C
C11H	Blesbokspruit	MODERATE	Moderate	C	C/D
C11J	Vaal	MODERATE	Moderate	C	C
C11K		**HIGH**	Moderate	C	D
C11L	Grootdraai dam	MODERATE		C	
C11M	Vaal (downstream from Grootdraai)	MODERATE	Moderate	C	D
C12A	Ventersspruit	MODERATE	Moderate	**B/C**	B/C
C12B	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12C	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12D	Waterval (Kleinspruit)	MODERATE	Low	C/D	D
C12E	Rietspruit	MODERATE	Low	C	D
C12F	Waterval (Kleinspruit)	**HIGH**	Moderate	C	D
C12G	Waterval (Kleinspruit)	**HIGH**	Moderate	**B**	D
C12H	Vaal (main)	MODERATE	Moderate	**B/C**	C
C12J	Unamed trib.	MODERATE	Low	C	C/D
C12K	Molspruit	MODERATE	Low	C	C/D
C12L	Vaal (Vaal dam backwater portion)	MODERATE		C	
C13A	Sandspruit	**HIGH**	Moderate	**B/C**	B/C
C13B	Sandspruit	**HIGH**	Moderate	**B/C**	C
C13C	Seekoevlei	**VERY HIGH**	High	**B**	B/C
C13D	Klip	**VERY HIGH**	Moderate	**B**	B/C
C13E	Komandospruit	MODERATE	Moderate	**B**	B
C13F	Klip	**HIGH**	Moderate	**B**	C
C13G	Spruitsonderdrif	MODERATE	Moderate	**B/C**	C
C13H	Klip	MODERATE	Moderate	**B**	C

Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C21A	Suikerbosrand	**HIGH**	Moderate	C	B/C
C21B	Suikerbosrand	**HIGH**	Moderate	C	C
C21C	Suikerbosrand	**HIGH**	High	C	C
C21D	Blesbokspruit	**HIGH**	Low	D	E/F
C21E	Blesbokspruit	**HIGH**	Moderate	D	D/E
C21F	Blesbokspruit (l	MODERATE	Low	C	D/E
C21G	Suikerbosrand	MODERATE	Moderate	C	C/D
C22A	Klipriver	**HIGH**	Moderate	C/D	E
C22B	Natalspruit	**HIGH**	Low	D	E
C22C	Rietspruit	**HIGH**	Low	C/D	E
C22D	Klip	**HIGH**	Moderate	D	D
C22E	Klip	MODERATE	Moderate	C	D/E
C22F	Vaal (downstream from Vaal dam)	MODERATE	Moderate	C	D
C22G	Taaibosspruit	MODERATE	Moderate	C	C
C22H	Rietspruit	MODERATE	Low	C	D/E
C22J	Leeuspruit	MODERATE	Moderate	C	D/E
C22K	Vaal (Barrage portion)	MODERATE		C/D	
C23A	Vaal	MODERATE	Moderate	**B**	B/C
C23B	Vaal	MODERATE	Moderate	**B**	D
C23C	Vaal (Parys)	MODERATE	High	**C**	D
C23D	Mooirivierloop	**HIGH**	Low	C/D	E
C23E	Mooirivierloop	**HIGH**	Moderate	C/D	E
C23F	Upper Mooi	**HIGH**	High	**B/C**	C/D
C23G	Mooi (upstream from Boskop)	**HIGH**	Moderate	C/D	D/E
C23H	Mooi (before confluence with Loopspruit)	**HIGH**	Moderate	C	D/E
C23J	Loopspruit (above Klipdrif dam)	MODERATE	Low	**B/C**	D
C23K	Loopspruit	MODERATE	Low	C	D
C23L	Vaal (downstream from Parys)	MODERATE	High	C	D
C81A	Wilge (main stem)	**HIGH**	Low	**A**	B
C81B	Wilge (main stem)	**HIGH**	Moderate	**B**	B/C
C81C	Nuwejaarsspruit (Wilge trib.)	MODERATE	Moderate	**B**	B/C
C81D	Sterkfontein Dam	MODERATE		C/D	
C81E	Wilge (main stem)	MODERATE	Moderate	C	D
C81F	Elands (Wilge trib.)	MODERATE	Moderate	D	D
C81G	Elands (Wilge trib.)	MODERATE	Moderate	C	C
C81H	Elands (Wilge trib.)	MODERATE	Moderate	C	C
C81J	Vaalbanks (Wilge trib.)	MODERATE	Moderate	C	C
C81K	Wilge (main stem)	MODERATE	Moderate	C	C
C81L	Meul (Wilge trib.)	MODERATE	Moderate	**B**	B
C81M	Meul (Wilge trib.)	MODERATE	Moderate	C	B
C82A	Cornelis (Wilge trib.)	MODERATE	Moderate	**B**	B
C82B	Cornelis (Wilge trib.)	MODERATE	Moderate	C	C
C82C	Wilge (main stem) - EWR 8	MODERATE	Moderate	C	C
C82D	Rus se Spruit (Wilge trib.)	MODERATE	Moderate	C	C
C82E	Holspruit (Wilge trib.)	MODERATE	Moderate	C	C
C82F	Grootspruit (Wilge trib.)	MODERATE	Moderate	**B**	C
C82G	Wilge (main stem)	MODERATE	Moderate	**B**	C
C82H	Wilge (main stem)	MODERATE	Moderate	**B/C**	C

Quat. Catchment	Main river/s	Average Wetland EIS of the Quaternary	River EIS	Average Wetland PES of the Quaternary	River PES
C83A	Ash	MODERATE	Low	C/D	D/E/F
C83B	Jordaans	MODERATE	Moderate	C	C
C83C	Liebenbergsvlei	MODERATE	Moderate	C	D/E
C83D	Tierkloof	MODERATE	Moderate	C	C/D
C83E	Tierkloof	MODERATE	High	C	C/D
C83F	Liebenbergsvlei	MODERATE	Moderate	C	D
C83G	Liebenbergsvlei	MODERATE	Moderate	C	D
C83H	Libenbergsvlei	MODERATE	Moderate	C	D
C83J	Wilge (main stem)	MODERATE	Moderate	C	D
C83K	Kromspruit	MODERATE	Moderate	C	B
C83L	Klipriver	MODERATE	Moderate	C	B
C83M	Wilge (main stem) - Vaal Dam	MODERATE		C/D	

Quaternaries with high-scoring wetland PES (B/C and B) and/or EIS (High and Very High) scores are shaded.

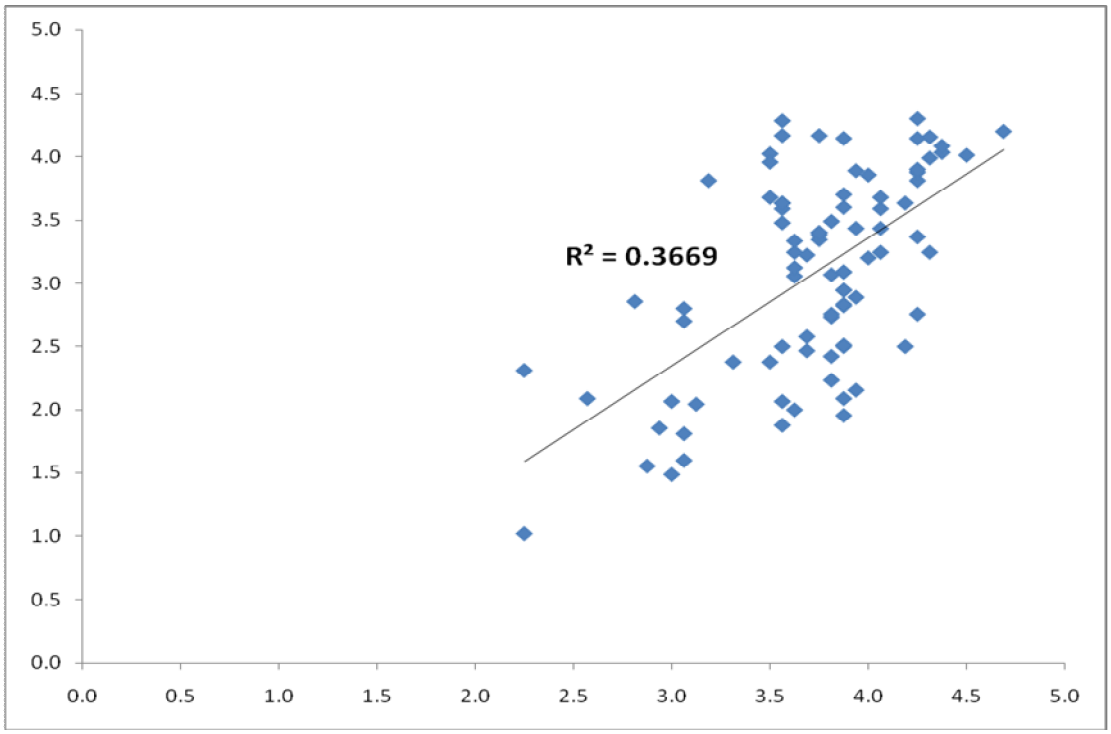

Figure 5.1 Correlation between quaternary catchment scale river and wetland EIS scores

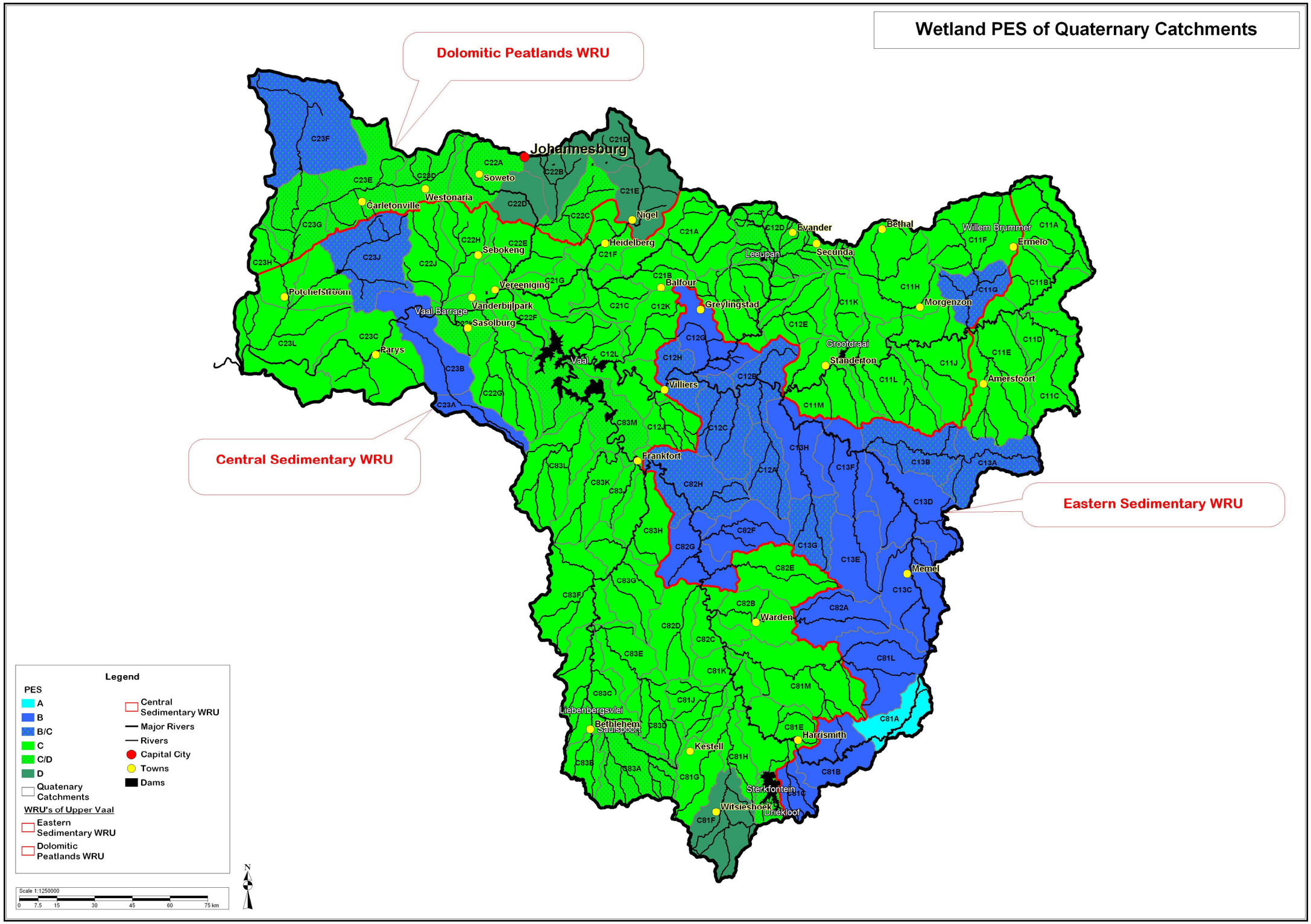

Figure 5.2 The average wetland PES per quaternary catchment

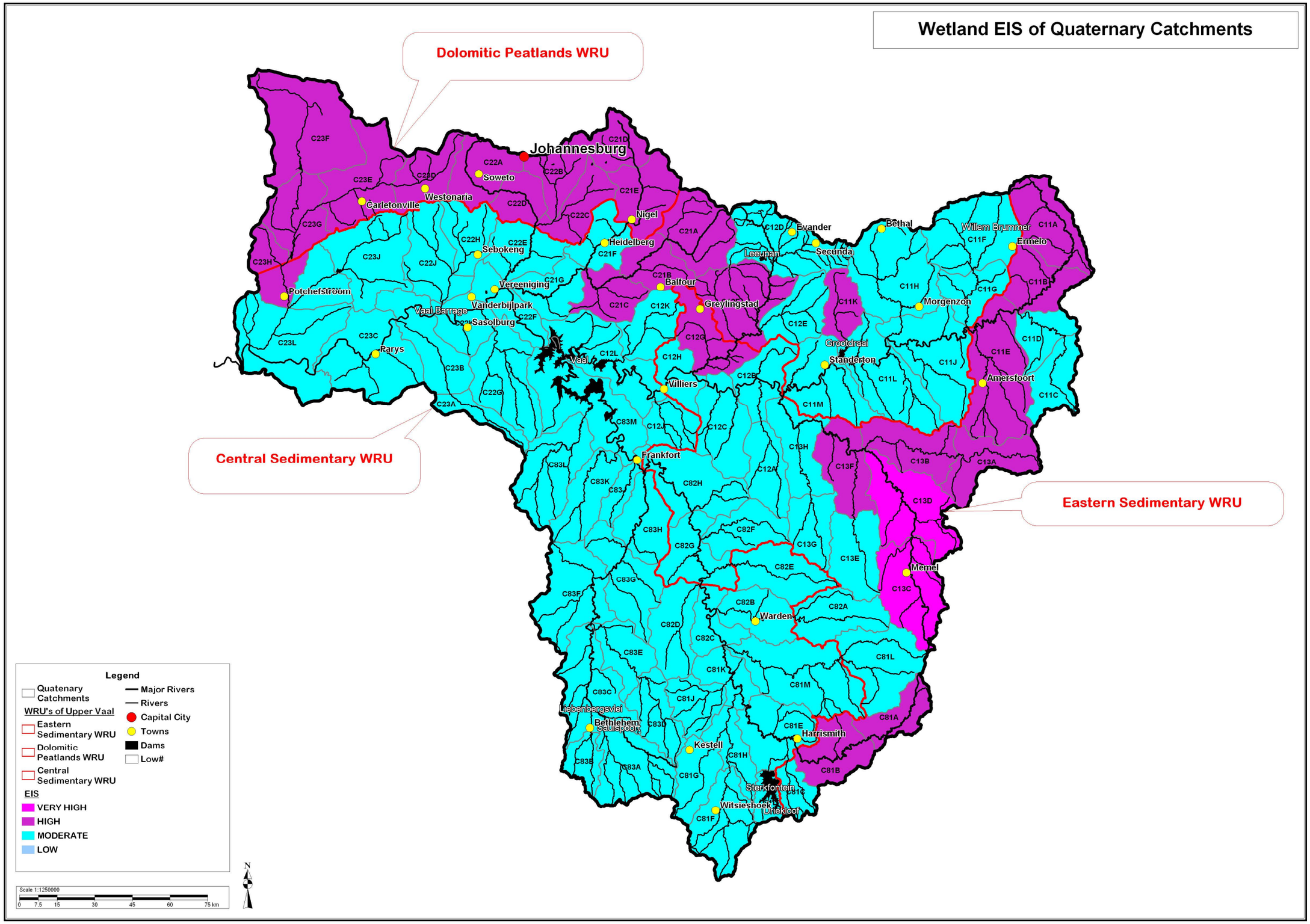

Figure 5.3 The average wetland EIS per quaternary catchment

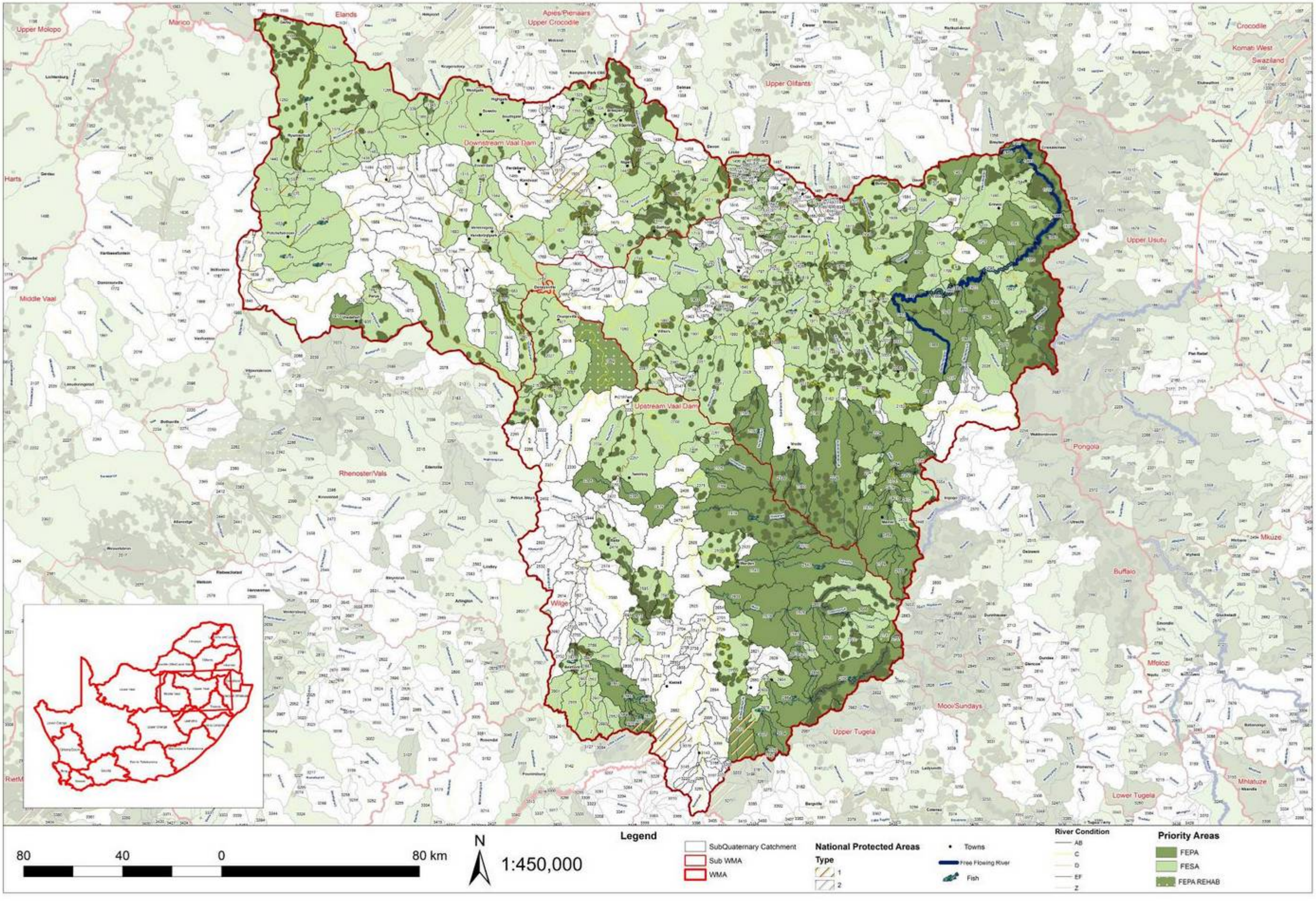

Figure 5.4 Draft NFEPA results for the Upper Vaal WMA. Circles highlight important wetlands (SANBI, draft)

5.2 LAND USE, PES AND EIS OF WRU 1

Urban and agriculture are the dominant land uses within the Wetland Resource Unit. There are also extensive industrial and mining areas exposed within this WRU. The quaternary catchments located within the Dolomitic Peat WRU tend to have ***High EIS*** scores (Figure 5.3). This is because:

- The size of the wetlands are generally very large and this size is unusual for the region;
- The wetlands tend to be associated with large peat deposits are almost exclusively dependent on groundwater; and are sensitive to water quality and quantity impacts (where excessive extraction may lead to drying out and combustion of peat beds); and
- The vegetation type characterising this WMU is regarded as "Endangered" and it can be assumed that the wetland-dependent species within this vegetation type are similarly threatened.

Although there is a RAMSAR site (the Blesbokspruit) within this WRU, this wetland system was placed on the Montreux Record due to the changes in ecological character that have occurred. Increased pollution and elevated flows as well as the change in surrounding catchment land use have reduced the effectiveness of this wetland and its value for avifauna. The EIS thus scores as High, but not Very High due to the reduced effectiveness.

The impacts discussed above on the Blesbokspruit are widespread across the WRU. Impacts within this WRU are primarily associated with the widespread expansion of urban and agricultural areas, but also impacts from mining – which has in some catchments affected groundwater inflow quality and quantity – and direct peat mining of the wetlands. The **Present Ecological State** of wetlands within the quaternary catchments of this WRU is thus **generally moderately to largely modified**, with PES scores ranging from C/D to D Ecological Categories (Figure 5.2). A notable exception is the C23F catchment – the upper Mooi River – which is still considered to be in a relatively good (B/C) ecological condition. Some sections of wetlands within this quaternary are in near Reference condition (Figure 4.8).

Across the rest of the WRU however, land use changes in the catchment as well as direct impacts have caused extensive degradation of the wetlands. Historic agricultural practices associated with channelization and draining of wetlands (McCarthy *et al*, 2007), direct mining of peat from the wetlands; increases in volume of flows due to waste water return flows, groundwater decanting in mines, increased flood peak runoff from the urbanising catchments, and widespread water quality problems arising from waste water (sewage effluent) return flows and mining areas have resulted in severe declines in water quality (McCarthy and Venter, 2006).

Uranium and other heavy metals, washed out of surrounding gold tailings dams, are trapped within the peat of these wetlands, but these can be mobilised if the peat is exposed to air (which can occur if the peats are eroded, drained, mined out or otherwise desiccated). The wetlands here thus play a major role in stabilising historic and contemporary pollutants. The increasingly eroded wetland condition in this WRU is however reducing the effectiveness of this ecosystem function.

Figure 5.5 Dolomitic wetland that has been peat mined

Figure 5.6 Channelised section of a wetland. Inundation and saturation of the adjacent wetland areas is likely to have reduced as a result of the channelization

Figure 5.7 Excavation of a peat wetland above Klerkskraal Dam in the Mooi river catchment. The naturally weakly channelled wetland (left) has had channels dug into it for recreational use (right). This raises the risk of desiccation of the wetland through increased drainage, and in wetlands where heavy metals are immobilised in the anaerobic sediments, this can cause remobilisation of these toxic metals

5.3 LAND USE, PES AND EIS OF WRU 2

Almost all of the quaternary catchments located within the Central Sedimentary WRU (Figure 5.3) have ***Moderate EIS*** scores (Table 5.1). This is because:

- Although wetland density is high, diversity of types tends to be moderate, and
- The vegetation types characterising much of this WMU are regarded as "Vulnerable", but not Endangered, and it can be assumed that the wetland-dependent species within this vegetation type are less likely to be critically threatened.

The C21A, C21B, C21C, C12F, C12G and C11K catchments are notable exceptions; all having High EIS scores. In these catchments diversity of wetland types is higher than the rest of the WRU – there are often large pans and/or floodplains within the catchment in addition to the channelled and unchannelled valley bottoms and seep wetlands that characterise this WRU. In the case of C12G, there are unusually large valley bottom wetlands within this quaternary.

Land use impacts within this WRU tend to be less severe than for WRU 1and these are reflected in the generally moderate to PES scores (Figure 5.2). In WRU 2, PES scores range from B to D, but on average are a C across the WRU (moderately impacted).

Impacts within this WRU are primarily associated with agriculture, although some mining, urban and industrial areas are located within the WRU. Encroachment of agricultural lands into wetlands, as well as impacts such as increased runoff; trampling and grazing, have caused a decline in the PES relative to the reference conditions. In some areas erosion, invasion by alien vegetation, urban, industrial and mining impacts have caused further declines in the PES.

5.4 LAND USE, PES AND EIS OF WRU 3

EIS scores for this WRU range from Moderate to Very High (Figure 5.3). Although the diversity and densities of wetlands within this WRU are similar to WRU 2, the EIS is higher because:

- Wetland diversity is higher than the rest of the WMA, and particularly high where EIS scores are High (Figure 5.3);
- The vegetation types characterising some sections of this WMU are regarded as Endangered, and it can be assumed that the wetland-dependent species within this vegetation type be similarly important for conservation purposes;
- Very High EIS scores are associated with the RAMSAR-listed Seekoeivlei floodplain wetlands of the upper Klip River in catchments C13C and C13D, and very high ("A") PES scores associated with the upper Wilge floodplain (Figure 5.8).

Land use impacts within this WRU tend to be less severe than even the Central Sedimentary WRU. Land use activities appear less intensive – the proportion of land converted to agriculture is less than that generally encountered in the Central Sedimentary WRU. The PES scores reflect the better land management and lower intensity land use activities – the ***average PES scores for the quaternaries of this WRU is a B Ecological Category*** (Figure 5.2), although individual scores per catchment range from an A to a C Ecological category.

Impacts within this WRU are primarily associated with agriculture, although some mining, urban and industrial areas are located within the WRU. There has been extensive land transformation due to the widespread cropping, leading to encroachment of agricultural lands into wetlands, as well as impacts such as runoff; trampling and grazing, have caused a decline in the PES relative to the Reference Conditions. In some areas erosion, invasion by alien vegetation, urban, industrial and mining impacts have caused further declines in the PES.

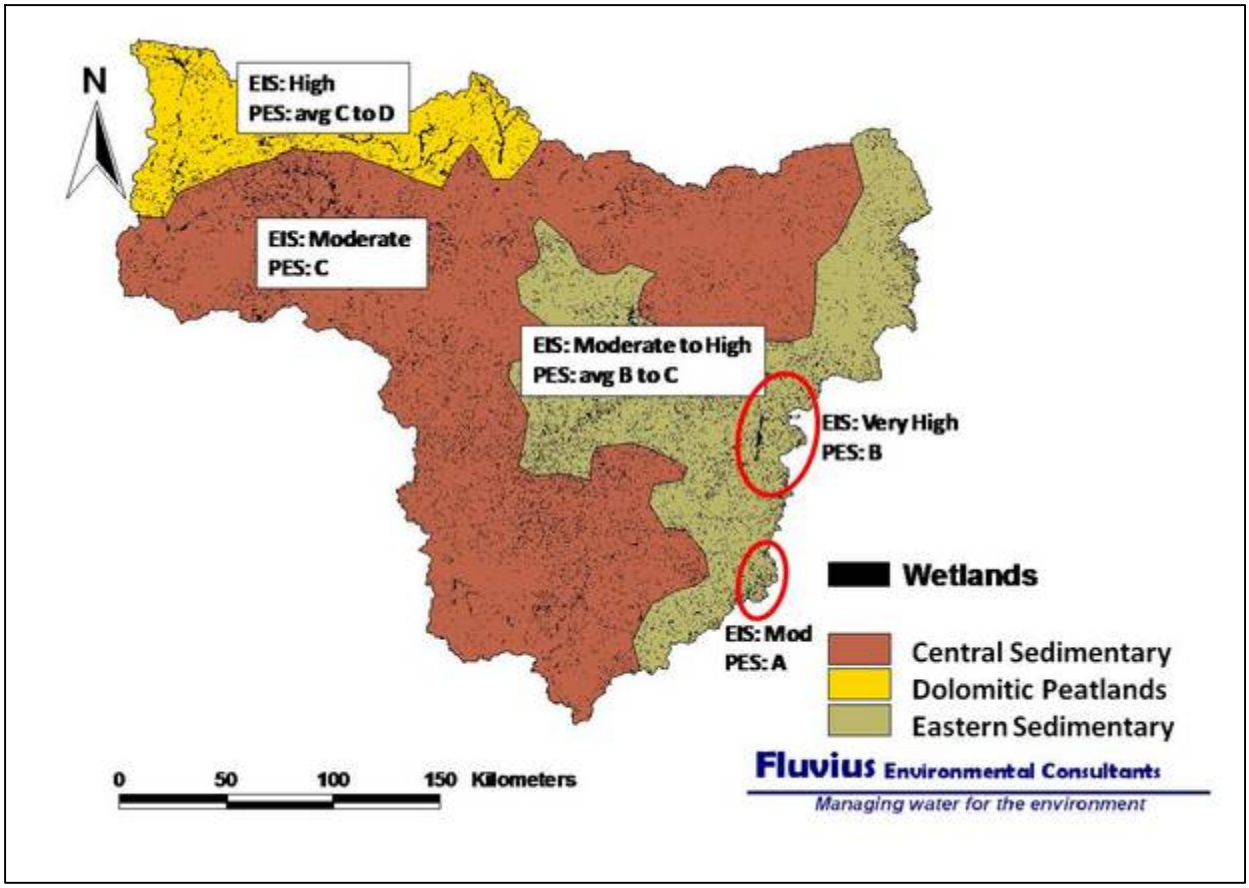

Figure 5.8 Summary of the PES and EIS attributes across the different Wetland Resource Units

6 PRIORITY WETLANDS IN THE UPPER VAAL WMA

6.1 CANDITATE LIST OF PRIORITY WETLANDS

A workshop with stakeholders was held in November 2007 to develop a candidate list of potential priority wetlands within the Upper Vaal WMA (Appendix D). This workshop yielded the following candidate list of priority wetlands for WMA 8 (Upper Vaal):

- Gerhard Minnebron
- Blaau Pan System
- Benoni pans
- Boovenste oog
- Seekoeivlei – RAMSAR status
- Suikerbos floodplain complex – peat wetlands
- Blesbokspruit – RAMSAR status
- Klip River wetland – low ecological status, high functionality, flood retention, water quality.
- Vanger peat wetland - white winged fluff tails, currently good PES (near pristine).
- Murphy's Rust – white winged fluff tail, currently good PES
- Braamhoek: breeding Wattled Crane, White-winged Flufftail, peat wetland. Question around environmental flows from the dam
- Wonderfonteinspruit

Brief descriptions of the candidate priority wetlands and status of associated studies are provided below.

6.1.1 Seekoeivlei

This is a large meandering floodplain wetland in the upper Klip catchment along the Free State/Mpumalanga border. A sizeable portion (4750 ha) is a designated RAMSAR wetland (wetland of international importance). The wide, meandering floodplain is considered one of the best examples of its HGM wetland type in the country.

6.1.2 Suikerbos floodplain complex

These floodplain pockets along the Suikerbosrand River contain occasional isolated peat deposits which are unique. Proposals for open-cast mining on the floodplain, and water quality impacts within the river, place these wetlands at risk.

6.1.3 Blesbokspruit

The Blesbokspruit is a former RAMSAR wetland that drains eastern Gauteng. Extremely poor water quality combined with artificially elevated flows from mine and sewage discharges have completely altered the condition of the wetland from its reference condition.

BLESBOKSPRUIT (26° 17' S; 28° 30' E)

Blesbokspruit is situated near Springs on the East Rand in Gauteng Province. In the 1930s the Blesbokspruit was a small stream with few reedbeds along its banks. Later, road and other crossings across the wetland combined with large artificial inputs of water (especially from mines, but also sewage treatment works) created vast permanently flooded areas. These eutrophic waters became colonized by *Typha* and *Phragmites* and the Blesbokspruit developed into the largest permanent wetland in the region. The exotic South American water fern (*Azolla filiculoides*) is also present. Numerous birds began to depend on this

wetland, including up to 4,000 Yellow-billed Duck (*Anas erythrorhyncha*); 1,000 Spur-winged Goose (*Plectropterus gambensis*); Greater Flamingo (*Phoenicopterus ruber*); Lesser Flamingo (*Phoeniconaias minor*); Avocet (*Recurvirostra avosetta*); Purple Heron (*Ardea purpurea*); Spoonbill (*Platalea alba*); Glossy Ibis (*Plegadis falcinellus*) and Yellow-billed Stork (*Mycteria ibis*). Over 3,500 herons are known to roost at the wetland.

The Blesbokspruit joins the Suikerbosrand River and then flows into the Vaal River Barrage which is an important source of potable water for the greater Gauteng area. Dolomites, representing an important groundwater resource, underlie large parts of the catchment. Maintaining good quality water in the Blesbokspruit is therefore important, but due to the extensively urbanized catchment which also includes large mining and agricultural activities, water quality is, not surprisingly, poor: gold mines and sewage works in the vicinity discharge their polluted water into the Blesbokspruit wetlands causing high sulphate, phosphate, nitrite/nitrate and ammonia concentrations. Both gold and coal mining have occurred along the margins of the wetland and large tailing dams remain along the margins. Although the wetland does have some purification capacity, this is being overwhelmed by the volume and concentration of nutrients and heavy metals being introduced to the river. Draining of the reeds reduces water residence time and likely reduces the ability of the wetland to purify the water.

A section of the wetland was designated as a RAMSAR wetland, but in 1996 it was placed on the Montreux Record of priority sites for conservation action, effectively removing it from RAMSAR designation. The primary cause of the degradation of the Ramsar site is Grootvlei mine, which continues to discharge polluted water into the wetland. The poor water quality and constant high artificial discharges have resulted in:
(1) Habitat diversity reduction through severe *Phragmites* reed encroachment and
(2) An associated decline in the abundance and diversity of aquatic and wetland-dependent animal species.

The Gauteng Directorate of Nature Conservation has initiated a number of pilot projects aimed at finding a feasible means of controlling reed encroachment, whilst DWA has commenced a study on the Blesbokspruit catchment with the aim of producing a catchment management plan.

http://www.ewisa.co.za/misc/Wetlands/defaultwetBlesbokspruiti.htm

6.1.4 Klip River Wetland (Gauteng)

The Klip River and its tributaries drain southern and western Johannesburg, including Soweto and nearby mining areas. Very high pollution levels in the reed beds, and ongoing incision and draining of the wetland, are reducing the ability of the wetlands to ameliorate water quality.

KLIP RIVER WETLAND, GAUTENG

The Klip River wetland south of Johannesburg drains through Soweto and eventually flows in to the Vaal Barrage. The upper catchment is highly urbanized, including large gold mine tailings dumps. Some research has suggested that the Klip River wetland is one of the most economically important wetlands in Africa because of the water quality improvement function it is purported to play.

Initially the river was used as a source of water, although latterly it is more important as a purifier of polluted water that arises from the western section of the Witwatersrand urban-industrial-mining complex. The wetland was an extensive drainage network of weakly channeled valley bottom wetlands dominated by Phragmites reeds, maintained by discharges from the dolomites. Deep peat deposits have accumulated over several thousand years (McCarthy and Venter, 2006). The upper portions of the wetland (those which receive the bulk of the polluted water from gold mines) remains in fairly good morphological condition, but the lower reaches – more heavily affected by peak urban runoff, the effects of historic drainage and subsequence donga formation within the wetland, and excessive groundwater abstraction – are in an advanced state of collapse. The degradation of the wetlands has impaired the ability of the wetland to remove phosphates and nitrates from the water. Without intervention, this is likely to continue and cause

additional eutrophication problems in the downstream barrage. It is further anticipated that degradation and desiccation of the extensive marginal reed beds will release further heavy metals and phosphates into the Vaal River system (these being currently immobolised in the anoxic reed beds and saturated wetland soils.

6.1.5 Vangar Wetland

This is a small (30ha) site which is considered important for birding. This privately owned Natural Heritage Site (27°52'S 29°40'E) lies about 30 km south-east of Memel. The Red data White-winged Flufftail (*Sarothrura ayresi*) is known to utilise this site.

6.1.6 Murphy's Rust

This small (58 ha) site is located about 20 km east of Harrismith. The little remaining natural grassland on the slopes is grazed by sheep and cattle, and the wetland on the property is dominated at by beds of *Phragmites*; *Eleocharis*, and some stands of *Typha* and *Leersia* as well as *Cyperus*, with *Schoenoplectus* at the edges. This is considered an important birding area (BirdLife International, 2009). The Red data White-winged Flufftail is known to utilise this site.

6.1.7 Bedford Wetland

The Bedford wetlands are located on a tributary of the upper Wilge River. Wattled cranes breed at this site, and White-winged Flufftail (Endangered Red Data bird species) are present. There are some peat sections within the wetlands. A new reservoir – part of a pumped storage scheme for Eskom - is being built within the wetland, although much of the wetland will be downstream of this reservoir. A Rapid Reserve determination study was undertaken for this wetland in February 2010.

6.1.8 Gerhard Minnebron Peatland

This is a large peat wetland that has been subject to extensive peat mining. An EWR study has previously been undertaken for this wetland at a rapid level and it was recommended that a higher confidence study be undertaken. The PES is low due to mining within the wetland.

6.1.9 Blaaupan pan system (Boksburg)

Several pans east of the OR Tambo airport are being encroached upon by urban and suburban sprawl. A Reserve study has already been completed for Parkhaven Pan, one of the pans within this wetland complex.

6.1.10 Benoni Pans

Several pans spread out across the suburbs of Benoni have been historically heavily impacted by the surrounding urban development. Opportunities for restoration/rehabilitation are limited.

6.1.11 Boovenste Oog

A peat wetland within the dolomitic north-west of the WMA and a Rapid EcoClassification study was completed in 2007 for this wetland system.

6.1.12 Wonderfonteinspruit

This infamous, heavily polluted stream has high levels of radioactive Uranium, as well as other toxic heavy metals, trapped within the reed beds. A catchment-wide remediation programme is required to address this wetland.

6.2 RANKING CANDIDATE PRIORITY WETLANDS

The budget and available resources precluded detailed assessments of all the candidate wetlands. Candidate wetlands thus needed to be ranked against one another in order to prioritise the limited resources.

The candidate list of priority wetlands was evaluated against criteria developed at a stakeholder workshop (Appendix D) in order to identify the key priority wetlands within the WMA. Each wetland was scored on a 1 - 5 scale for the selected criteria in order to enable ranking of the candidate list (Table 6.1) and thus identify the key priority wetlands.

Table 6.1 Prioritisation scoring for the candidate wetland sites

SCORING (PRIORITISATION) CRITERIA	Benoni Pans	Blaau Pan System	Blesbokspruit	Boovenste Oog	Braamhoek	Chrissiesmeer	Gerhard Minnebron	Klip River wetland	Murphy's Rust	Seekoeivlei	Suikerbos floodplain complex	Vanger peat wetland	Wonderfonteinspruit
PES, EIS, RARETY	**2.4**	**2.6**	**3**	**3.8**	**3.8**	**4.7**	**3**	**3.2**	**2.9**	**4.6**	**3.3**	**3.2**	**2.8**
Rarity - size and/or type	2	2	4	4	4	5	4	4	2	5	4	2	2
Sensitivity to flow changes	3	3	2	4	3	5	3	4	3	3	3	3	2
Desktop PES/Ecological Condition	2	3	2	4	4	4.5	2	3	4.5	4.5	3.5	4	4
EIS - Rarity, vulnerability, resilience	2	2	2	4	4	4.5	3	3	3	4.5	3	4	4
Research, RAMSAR, habitat refugia	3	3	5	3	4	4.5	3	2	2	5	3	3	2
FUNCTIONALITY	**1.7**	**2.1**	**4**	**3.5**	**3**	**3.4**	**3.4**	**3.6**	**2.8**	**4.2**	**3.3**	**2.7**	**3.1**
Socio, cultural and economic	2	2	4	3	2	3	3	4	2	4	3.5	2	3
Hydrological functions of the wetland	2	2	4	3.5	3.5	3	3	4	2	5	3	2	3
Ecological functions	2.5	3.5	3	3	4.5	4	3	2	4	5	3	3.5	3.5
Groundwater linkages	1	1	5	4	2	4	4	4	3	3	3	3	3
Connectivity to other wetlands/rivers - migration routes	1	2	4	4	3	3	4	4	3	4	4	3	3
THREATS AND REHABILITATION	**3**	**3.3**	**4**	**2.8**	**3.2**	**2.5**	**2.5**	**3.7**	**2**	**3.3**	**3.3**	**2**	**2**
Current and proposed water use/threats - development, erosion, alien species, management practices (EMP)	3	4	5	4	5	3.5	3.5	4	1	4.5	4.5	3	2
Adjacent land use practices	4	4	5	2	2	2	3	5	2	2.5	2.5	1	2
Rehabilitation activities/potential	2	2	2	2.5	2.5	2	1	2	3	3	3	2	2
TOTAL SCORE (/5)	**2.4**	**2.7**	**3.7**	**3.4**	**3.3**	**3.5**	**3**	**3.5**	**2.6**	**3.6**	**3.3**	**2.6**	**2.6**

6.3 PRIORITY WETLANDS IN THE UPPER VAAL WMA

Priority wetlands in the Upper Vaal WMA are listed in order of the importance (priority) scored according to the criteria identified at the stakeholder workshop (Table 6.1). Possible actions for each of the priority wetlands were considered. The actions required to address the management concerns of the prioritised wetlands were identified (Table 6.2) and considered against the available budget and scope of this study. Several highly ranked priority wetlands could not be addressed within the confines of the current study, but the prioritisation undertaken here did enable key wetlands to be identified and prioritised for further assessments in parallel studies.

The two highest ranked priority wetlands that could be feasibly accommodated within the scope of this study were the Seekoeivlei and the Suikerbos floodplain complex. The other higher priority ranked wetlands required a larger scope of study than this study could provide in order to be adequately assessed; these were subsequently addressed through parallel but separate studies.

The lower ranked priorities were not assessed further as either the risks were deemed low, or the scope of work to assess these could not be accommodated within this or the parallel DWA studies.

Table 6.2 Wetlands ranked according to prioritisation assessment, and description of actions required to address concerns

Rank	WETLAND NAME	Quat	SCORE (/5)	ACTION
1	Blesbokspruit	C21E	3.7	A separate study already underway focused on this wetland.
2	**Seekoeivlei**	C13C	3.6	**Priority for Assessment (this is a RAMSAR site). Wetland Index of Habitat Integrity assessment undertaken in this study.**
3	Chrissiesmeer	W55A	3.5	Excluded from this study as the bulk of this wetland complex is in the Usutu WMA.
4	Klip River wetland	C22A	3.5	Following the priority identification, a Rapid Reserve Study was recently (2010) completed for this wetland system though a parallel study.
5	Boovenste Oog	C23F	3.4	A separate desktop study was undertaken on this wetland system – PES and EIS were determined.
6	Bedford Wetland	C81A	3.3	Following the priority identification, a Rapid Reserve Study was recently (2010) completed for this wetland system though a parallel study by the RDM.
7	**Suikerbos floodplain complex**	C21F	3.3	**A stand-alone RDM water quality study is underway on this wetland, but addition of Wetland IHI and EIS assessment was undertaken through this study to improve overall confidence**
8	Gerhard Minnebron	C23D	3.0	Needs comprehensive remediation and management plan – beyond the scope of this study, and not within the Upper Vaal study area.
9	Blaau Pan System	C21D	2.7	A separate study is required for this pan. EWRs already determined for one of the pans within this wetland complex.
10	Vanger peat wetland	C13C	2.6	Low priority – no current threats.
11	Wonderfonteinspruit	C23D	2.6	Needs comprehensive remediation and entire basin management plan – beyond the scope of this study.
12	Murphy's Rust	C81B	2.6	Low priority – no current threats.
13	Benoni pans	C21D	2.4	Low priority – little remediation possible for most pans.

6.4 ASSESSMENT OF PRIORITY WETLAND 1: SEEKOEVLEI

Seekoeivlei is a meandering floodplain wetland (Figure 6.1) on the upper Klip River in the north-eastern corner of the Free State, stretching from Memel northwards for approximately 20 km to the Mpumalanga border. It is the largest floodplain on the Highveld (approximately 3 700 ha), of which 2800ha is within a protected area (27^{o} 27' to 27^{o} 41'S, 29^{o} 34' to 29^{o} 37' E) that has been designated as a RAMSAR site – a wetland of international importance.

Figure 6.1 Seekoeivlei meandering floodplain. Numerous oxbows, cut-off meanders and backwaters are present within the floodplain

The floodplain contains numerous small oxbow lakes that are seasonally flooded. In addition to the ox-bow lakes there are backwaters, seasonally flooded grasslands and peatlands. Although several Red Data plant species are found the wetland, the wetland does not have a very high plant diversity. It is however highly important for avifauna. Migratory waterfowl and a number of red data species utilize the site. Five Red Data bird species (Little Bittern *Ixobrychus minutus*, Yellow-billed Stork *Mycteria ibis*, the endangered Wattled Crane *Bugeranus carunculatus*, White-winged Flufftail *Sarothrura ayresii*, and Grass owl *Tyto capensis*) are found at the site, with the whiskered terns, Crowned, Blue and the endangered Wattled Cranes breeding within the site. Additionally, one Red Data fish species (Rock barble *Austroglanis sclateri*) are found in this section of the Klip River (http://www.ngo.grida.no/soesa/nsoer/resource/wetland/seekoeivlei_ris.htm).

This site is underlain by sediments of the lower Beaufort and upper Ecca Groups of the Karoo Sequence. Dolerite dykes and sills cut through the sediments. The dolerite dykes and outcrops create resistant key points, upstream of which the softer sandstones are eroded and wide floodplains are created (Figure 6.2).

Figure 6.2 The transition from sandstones (bottom right) to dolerites (top left) causes an abrupt change in morphology of the Klip River. The wide, meandering floodplain reaches form in the sandstone zones whereas linear, confined river reaches develop within the dolerite zones

6.4.1 Approach

A primarily desktop assessment was conducted for the lower Suikerbos Floodplain. This enabled a low confidence PES and EIS of the lower reach of the floodplain to be determined. The PES of the Seekoeivlei floodplain was determined using the Wetland Index of Habit Integrity (DWAF, 2007). Desktop information was verified during a short (one day) site visit during January 2010.

6.4.2 Present Ecological State

Canals dug by farmers starting in the 1890's drained the wetland, but rehabilitation in the area is ongoing and aims to reinstate much of the natural hydrology. Catchment impacts at present are relatively low and are largely restricted to the risks associated with:

- Increased cultivated area and urban expansion (with the associated increased risk for nutrients and trampling).
- Vegetation removal and uncontrolled fires spreading from adjacent areas in to the wetland.
- Invasion of exotic plants, and
- Increased sediment and nutrient loads due to poor farming practices.

The Seekoeivlei Wetland is considered to be close to the reference condition and the Wetland IHI assessment scored it in an ***A/B Ecological Category.*** Although agricultural areas surround the wetland, there are few major impacts within the wetland itself. Hydrology in the catchment is largely natural except for the impacts of small farm dams and abstraction. The floodplain wetland

is driven and maintained by large floods, and these would not be impacted upon by the low flow abstraction and small farm dam impacts.

6.4.3 Threats and trends of PES

The overall PES is stable.

6.4.4 Importance and Sensitivity

Seekoeivlei is one of the largest and best condition wetlands in the grassland biome. Its RAMSAR status additionally distinguishes it as one of the most important wetlands in South Africa. In addition to the important biodiversity support functions, the wetland also provides a large, high quality water supply to the downstream Vaal catchment.

The floodplain and oxbows are in very good condition and provide habitat for a variety of fauna, including endangered bird species. The wetland is very uniquely large for the type of wetland within the Upper Vaal WMA.

Wetland importance and sensitivity was assessed using the EIS tool from the Rapid Wetland Reserve suite of Reserve Determination methods currently under development (Rountree *et al*, 2010). Given the international protection and biodiversity status of this wetland, it is not surprising that the ***Ecological Importance and Sensitivity is Very High*** (Table 6.3). Direct Human Benefits (Table 6.4) and Hydrological values (Table 6.5) of the wetland indicate low to moderate importance.

Table 6.3 Ratings (scores) and motivations of the criteria evaluated for the EIS for the Seekoeivlei floodplain

ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Ecological Importance	**Score (0 - 4)**	**Confidence (1 - 5)**	**Motivation**
Biodiversity support	**4**	3.33	
Presence of Red Data species	4	4	Several Red Data avifauna, 1 fish species.
Populations of unique species	2	2	Large flocks of waterfowl.
Migration/breeding/feeding sites	4	4	Breeding area for numerous waterfowl.
Landscape scale	**4**	3	
Protection status of the wetland	4	5	RAMSAR status.
Protection status of the vegetation type	2	3	Vulnerable vegetation status.
Regional context of the ecological integrity	4	3	One of the best condition floodplains.
Size and rarity of the wetland type/s present	4	2	Largest floodplain in the grassland biome.
Diversity of habitat types	3	2	Backwaters, oxbows, seasonal grasslands.
Sensitivity of the wetland	**2**	3.33	
Sensitivity to changes in floods	4	5	Very high - it is driven by floods.
Sensitivity to changes in low flows/dry season	0.5	3	Limited as there is little connection.
Sensitivity to changes in water quality	2	2	Moderately sensitive.
ECOLOGICAL IMPORTANCE & SENSITIVITY	**4**	**3.2**	

Table 6.4 Scores and motivations of the criteria evaluated for the hydrological/ functional importance of the Seekoeivlei floodplain

	Hydrological/Functional Importance			Score (0 - 4)	Confidence (1 - 5)
Regulating & supporting benefits	Flood attenuation		Floodplain wetland good for flood attenuation	**4**	3
	Streamflow regulation		limited regulation function	**2**	2
	Water Quality Enhancement	Sediment trapping/Erosion control	overtopping floods would deposit large amounts of sediment	**4**	3
		Phosphate assimilation	Phosphates accreted in the sediments - may mitigate agricultural runoff	**2**	2
		Nitrate assimilation	limited role during low flow periods	**1.5**	2
		Toxicant assimilation	limited role since most of the time all flow is in the main river, but may trap during floods	**2**	2
	Carbon storage		very limited - associated with very small peat patches	**1**	2
OVERALL SCORE:				**2**	**2**

Table 6.5 Scores and motivations for the criteria evaluated for the Direct Human Benefits importance of the Seekoeivlei floodplain

Direct Human Benefits			Score (0 - 4)	Confidence (1 - 5)	Motivation
Subsistence benefits	Water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.	**0**	3	None.
	Harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.	**2**	3	Grazing.
	Cultivated foods	Areas in the wetland used for the cultivation of foods.	**0**	2	No subsistence agriculture occurs.
Cultural benefits	Cultural heritage	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants.	**1**	2	None known.
	Tourism and recreation	Sites of value for tourism and recreation in the wetland often associated with scenic beauty and abundant birdlife.	**3.5**	3	RAMSAR, birding area.
	Education and research	Sites of value in the wetland for education or research.	**3**	3	Academic studies of the floodplain are ongoing.
OVERALL SCORE:			**1.6**	**3**	

6.4.5 Recommendations for the management of Seekoeivlei Wetland

Wetlands in the Upper Vaal water management area are on average in a moderate Ecological Category, and tend to also have moderate importance. The High EIS of the Seekoeivlei Wetland, its international designation as a RAMSAR site, and high PES condition dictate that this system should continue to be prioritised in future.

Large dams within the catchment upstream of the site would cause a decline in PES, since these would affect the size and frequency of floods and thus reduce overtopping and recharge events. Dams and weirs upstream of the wetland, or along tributary arms entering the wetland, will also reduce sediment inputs. This would raise the risk of erosion within the wetland area.

Road and rail crossings should be promoted through dolerite (confined river) reaches rather than sandstone (floodplain) reaches, since the impact upon the site and downstream is minimised if floodplain crossings are avoided.

6.5 ASSESSMENT OF PRIORITY WETLAND 2: SUIKERBOS FLOODPLAIN

6.5.1 Description of the wetland

The lower reach of the Suikerbosrand River before its confluence with the Blesbokspruit has a floodplain wetland associated with the river. Although the river is naturally within a well defined river channel, infrequent overtopping events occasionally inundate the floodplain along the river. It is likely that flows from the side slopes and small drainage lines play a very important role in maintaining the seasonal and temporary wetland grassland areas and ox-bow lakes (Figure 6.3) on the floodplain, especially during low flow periods when overtopping may not regularly occur. In some sections of this floodplain groundwater-fed peat wetlands have been reported. These are highly unusual systems and indicate the presence of an artesian aquifer and springs. It is possible that some parts of the floodplain (in addition to the patches of peat wetlands) are maintained by groundwater discharge.

Figure 6.3 Meandering channel across the lower Suikerbos floodplain

6.5.2 Approach

A primarily desktop assessment was conducted for the lower Suikerbos Floodplain. This enabled a low confidence PES and EIS of the lower reach of the floodplain to be determined. The PES of the lower Suikerbos floodplain was determined using the Wetland Index of Habitat Integrity (DWAF, 2007). Desktop information was verified during a short (half day) site visit in February 2010.

6.5.3 Present Ecological State

The main problems in the Suikerbos and lower Blesbokspruit floodplains arise from the poor water quality flowing in from upstream reaches. It was indicated that wastewater treatment works in the Balforspruit tributary are not working adequately, and raw sewage flows in to this tributary and then into the Suikerbos. Low flows have been reported as being reduced from natural and this is likely to exacerbate the water quality problems due to effluents, since dilution capacities are reduced. Moderate floods that overtop the channel banks and inundate the floodplain are probably reduced due to farm dam attenuation effects, but this may be compensated for the higher base flows in the Blesbokspruit (as the latter may create better backup conditions).

Geomorphology and hydrology within the wetland and across the catchment remain relatively unimpacted. Although there has historically been vegetation alteration of the floodplain, the lower Suikerbos floodplain that was assessed is used as a nature reserve, so there is limited grazing. The current land use of the site creates conditions which favour some natural, reference condition areas of the floodplain. Despite the water quality problems upstream, the overall the PES of the floodplain is considered to be in a ***B/C Ecological Category.***

6.5.4 Threats and trends in PES

A section of the site evaluated is being considered for open cast coal mining, and another section of the floodplain is likely to be further affected by runoff from the extension to an already large, intensive cattle feedlot. Whilst the PES under current conditions is relatively stable, in the future the future of this section of floodplain will decline if the proposed developments proceed.

6.5.5 Importance and Sensitivity

The floodplain and oxbows are in relatively good condition and provide habitat for a variety of fauna. More bird species are found here than at the nearby RAMSAR Blesbokspruit wetland – 13 waterfowl species have been reported at the site, 8 of which use the floodplain for breeding. However the site is small for the type of wetland and not a particularly unique or unusual system in the Upper Vaal WMA.

Wetland importance and sensitivity was assessed using the EIS tool from the Rapid Wetland Reserve suite of Reserve Determination methods currently under development (Rountree *et al*, 2010). Ecological Importance and Sensitivity (Table 6.6) of this wetland is considered to be low to moderate; whilst the Direct Human Benefits (Table 6.7) and Hydrological values (Table 6.8) of the wetland both indicate low importance.

Table 6.6 Ratings (scores) and motivations of the criteria evaluated for the EIS for the Lower Suikerbos floodplain

ECOLOGICAL IMPORTANCE AND SENSITIVITY			
Ecological Importance	**Score (0 - 4)**	**Confidence (1 - 5)**	**Motivation**
Biodiversity support	**2**	1.67	
Presence of Red Data species	1	1	None known.
Populations of unique species	1	1	None known.
Migration/breeding/feeding sites	4	3	Breeding area for 8 species of waterfowl.
Landscape scale	**0.4**	1.8	
Protection status of the wetland	1	2	Lower area is informally protected in a private Nature Reserve.
Protection status of the vegetation type	-	1	Not protected.
Regional context of the ecological integrity	-	2	Many similar systems exist in better condition.
Size and rarity of the wetland type/s present	-	2	Not unique in terms of size or type.
Diversity of habitat types	1	2	Limited diversity.
Sensitivity of the wetland	**1.83**	2.33	
Sensitivity to changes in floods	3	2	Floodplain.
Sensitivity to changes in low flows/dry season	0.5	3	Naturally channelled, so not very sensitive.
Sensitivity to changes in water quality	2	2	Moderately sensitive.
ECOLOGICAL IMPORTANCE & SENSITIVITY	2	1.9	

Table 6.7 Scores and motivations of the criteria evaluated for the hydrological/ functional importance of the Lower Suikerbos floodplain

	Hydrological/Functional Importance			Score (0 - 4)	Confidence (1 - 5)
Regulating & supporting benefits	Flood attenuation		Floodplain wetland good for flood attenuation	**3**	3
	Streamflow regulation		limited regulation function	**2**	2
	Water Quality Enhancement	Sediment trapping/Erosion control	overtopping floods would deposit lots of sediment	**2**	3
		Phosphate assimilation	Phosphates accreted in the sediments - may mitigate agricultural runoff	**1.5**	2
		Nitrate assimilation	limited role during low flow periods	**1**	2
		Toxicant assimilation	limited role since most of the time all flow is in the main river, but may trap during floods	**1**	2
	Carbon storage		very limited - associated with very small peat patches	**0.5**	2
OVERALL SCORE:				**1.6**	**2**

Table 6.8 Scores and motivations for the criteria evaluated for the Direct Human Benefits importance of the Lower Suikerbos floodplain

Direct Human Benefits			Score (0 - 4)	Confidence (1 - 5)	Motivation
Subsistence benefits	Water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.	**0**	3	None.
	Harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.	**2**	2	Fishing and grazing.
	Cultivated foods	Areas in the wetland used for the cultivation of foods.	**0**	2	No subsistence agriculture occurs.
Cultural benefits	Cultural heritage	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants.	**1**	2	None known.
	Tourism and recreation	Sites of value for tourism and recreation in the wetland often associated with scenic beauty and abundant birdlife.	**2**	2	Very limited birding.
	Education and research	Sites of value in the wetland for education or research.	**3**	2	Study of unusual peat systems.
OVERALL SCORE:			**1.3**	**2**	

6.5.6 Recommendations for the management of the Suikerbos Floodplain

Mining activities within the wetland (within the 1:100 floodlines) and subsequent disruption of the artesian aquifer (due to disruption of the subsurface geology) will cause a decline in the PES of the wetland. The effects of disruption of the groundwater aquifer on the floodplain may be more widespread than just the immediate mining footprint area and it is unlikely that these impacts could be mitigated. The risk of unanticipated decant of acid mine water into the Suikerbos and ultimately the Vaal catchment area should also be considered in the event that floods, rainfall or groundwater inflows exceed the capacity of the mining pits.

Water quality remains the major problem at this site, within the catchment and within the Upper Vaal Water Management Area generally, so further reductions in Water Quality will only serve to place further stress on the resource. The risk of exacerbating the water quality deterioration as well as the non flow and flow related problems in this system should thus be avoided. Moderate

abstraction of water from the low flow channel is unlikely to have any impact on the floodplain since this is maintained by large floods, but abstractions should be considered relative to the Reserve set for nearby EWR 11 on the Suikerbosrand River as this will provide an indication of the required in-channel river flows. Similarly water quality impacts should be evaluated against the environmental water quality required determined at EWR 11 (DWA, 2010a and b).

7 RECOMMENDATIONS FOR WETLAND MANAGEMENT

It is essential to recognise that rising temperatures and reducing rainfall patterns associated with contemporary climate change (Global Warming) will negatively impact upon marginal and transitional wetland systems, decreasing their extent and modifying their species diversity (Ellery *et al.*, in press). The wetlands of the lower Upper Vaal WMA are likely to be particularly sensitive to the expected reduced rainfall and higher temperatures (with associated increased evapotranspiration losses) because these wetlands are located in a low rainfall region with already very high evaporation rates.

Although many of the wetlands in the Upper Vaal WMA remain in a good to moderate condition, more than 50% of South Africa's wetlands are estimated to have already been destroyed (DEAT: State of the Environment, http://soer.deat.gov.za/themes.aspx?m=149). South Africa is a contracting party to the Ramsar Convention on Wetlands and therefore has an obligation to promote the conservation and responsible use of wetlands. The assessment and monitoring of wetland condition is an important component in managing the use of wetland (Ramsar Convention, 2002).

The National Water Act requires the DWA to ensure the conservation, protection and sustainable utilisation of wetlands. A key aspect of regulating the use and enabling sustainable utilisation and protection of wetlands is through Section 21 Water User Licence Applications (WULAs). The following impacts upon wetlands requires authorisation from DWA through the approval of a relevant WULA:

- Taking water directly from the wetland or from groundwater.
- Impeding or diverting the flow of water in a wetland or upstream watercourse.
- Afforestation in the catchment.
- Discharging waste or water containing waste into a wetland through a pipe, canal, sewer, sea outfall or other conduit.
- Altering the bed, banks, course or characteristics of a wetland; or even.
- Using water for recreational purposes.

Additional legislation regulates the use of wetlands. The DEA's National Environmental Management Act (NEMA, Government Gazette of 21 April 2006, no. 386 & 387) lists the following impacting activities as requiring authorisation from DEA:

- Mining of peat.
- Any purpose within the 1:10 year flood line, or within 32 m of the bank; including canals; channels; bridges; dams and weirs (excludes existing residential use); and
- The dredging, excavation, infilling, removal or moving of soil, sand or rock exceeding 5 cubic metres from a river, tidal lagoon, tidal river, lake, in-stream dam, floodplain or wetland.

The first step in the protection of wetlands and the regulation of their use is to determine if wetlands exist at proposed development sites, and if so, what the potential impact upon the wetland/s would be. Wetlands should be identified and mapped according to the DWA (DWAF 2005 and 2008a) guidelines on wetland delineation. If a wetland is located at the site, and the development footprint is within the wetland or 500m from a wetland, or the nature of the impact is such that a Water User Licence is required, then the developer should be advised to proceed with the WULA application in conjunction with the standard EIA study (e.g. Figure 7.1).

In general, due to the critical loss of wetlands across the country, the DWA has proposed, in a draft position paper on wetland management, which future losses of wetlands are to be discouraged. Using the DWA guidelines, the edges of wetlands should be identified and these should not be encroached upon by future developments. In addition, suitable buffer zones should also be provided for to limit the impacts of developments upon nearby wetlands.

Any developments near the wetlands should therefore undertake a Wetland Delineation Study (according to the guidelines provided in DWA, 2005) to determine the edge of the wetland resource. DWA is the custodian of wetlands in South Africa and no development may take place inside the wetland boundary without the necessary authorization (generally a Section 21 Water User Licence is required).

The following section of the report provides recommendations for the management of the wetlands in relation to specific impacts identified across the WMA. These recommendations should be considered in addition to the general management recommendations that are based on the functioning of wetlands per wetland type (explained in further detail in section 7 below).

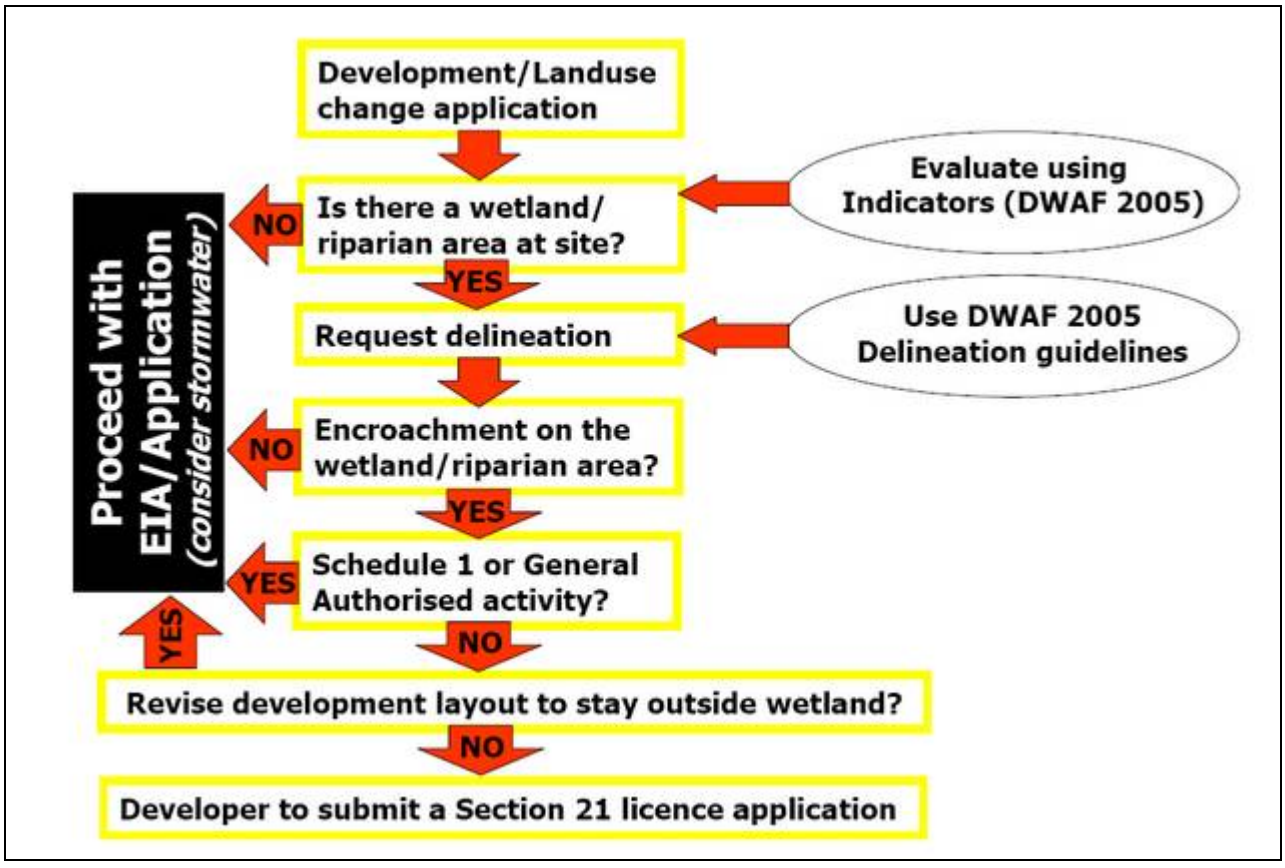

Figure 7.1 Generalised procedures for aligning EIA and DWA Water User Licence Applications in the case of residential developments

7.1 ROAD CROSSINGS

Road crossings through wetlands can cause erosion and drainage of wetlands. Where diffuse flows are concentrated into one or two culverts, an incised channel develops downstream of the road (left, Figure 7.2) and this lowers the local water table, drying out the wetland and enhancing further erosion by the continued concentration of flows. If the headcuts from the erosion pass under the road crossing, the eroding channel can propagate upstream (right, Figure 7.2) and further reduce wetland condition and integrity. Simple drop inlet structures as part of the bridge or

road crossing design can prevent upstream erosion, whilst flow dissipaters; numerous culverts and sensitive sitting of road crossings can reduce downstream erosion.

Figure 7.2 Incised channel (left) and eroding channel upstream (right) caused by crossings

Wetlands which are eroded - where flows are concentrated into channels and floodplains desiccate - have reduced functioning and cannot attenuate floods or ameliorate water quality problems as well as intact wetlands.

To minimise the impacts of road crossings, the following recommendations are provided:

- No road crossings through unchannelled valley bottom wetlands; since these are specifically sensitive to flow concentrations and erosion.
- Any Specifications for Road crossings across seeps.
- Where road crossings need to cross floodplain rivers; crossings should as far as possible be restricted to confined reaches of the river to mitigate impacts.
- Wherever possible, road crossings could coincide with the local key points across the wetland.
- Drop inlets should be built as part of the bridge design where culverts are proposed on small wetlands and streams;
- Numerous culverts and flow dissipators should be constructed where feasible and necessary to prevent risk of erosion on downstream wetlands.
- Crossings should in general avoid the concentration of flows or the formation of hydrological discontinuity across the wetland

7.2 AGRICULTURE

Agriculture impacts directly on wetlands through encroachment of fields into wetlands, canalisation/drainage of wetlands to increase useable land and through grazing and trampling effects of livestock. Runoff from fields can also create secondary water quality impacts on the receiving wetlands.

To mitigate these impacts:

- Appropriate buffers should be placed around wetlands (Figure 7.3), and the buffer vegetation managed correctly. Buffers of natural vegetation should also be left in place along the major rivers of the WMA.

- SusFarms, Farming for the Future and other lower input approaches to farming can create win-win situations for the farmer and water resources, since the former reduces costs through reduced inputs, and the receiving waters have lower doses of nutrients to process.

Figure 7.3 Buffers around wetlands within afforested areas in Mpumalanga allow much of the wetland functionality to persist

7.3 MINING

Mining is a widespread activity within the Upper Vaal WMA and is likely to continue to expand. Although each mine must be evaluated on its individual merits, it is highly recommended that a strategic approach to wetland management be adopted if the footprint of mining is to expand within the catchment. This would enable trade-off and reasonable, effective mitigation options to be identified upfront according catchment objectives and avoid the application of an ad hoc piecemeal approach.

In general, some of the objectives which could be considered for mining might be:

- No net loss of wetlands, or possibly more appropriately no net loss of the functions of wetlands, since this would incorporate aspects of off-site mitigation, wetland engineering and recognition of the ecosystem goods and services that need to be replaced or reinstated if wetlands are impacted.
- Maintenance or restoration of as much of the pre-mining hydrological (diffuse surface, channelled and soil interflow) flows as possible on the post-mined landscape.
- Where river diversions are required, the same HGM wetland must be created – i.e. diffuse lows across unchannelled valley bottoms should not be replaced with a canal.
- Clean water should be diverted and reinstated in the landscape in a similar way so that similar landscape hydrological processes can be achieved.

8 APPLICATION OF THE DATA

There are thousands of wetlands in South Africa, and it would be difficult, if not impossible, to manage each wetland individually as many are small (i.e. beyond a reasonable mapping scale), some are cryptic (i.e. not be easily identified) and others have been extensively modified, thus making their identification and delineation difficult. Even if all the wetlands within a region could be identified and mapped, their sheer number would preclude a site-specific approach to wetland management.

Grouping individual wetlands by similar characteristics into larger units - Wetland Resource Units – provides working at a scale that identifies fewer assemblages of wetlands rather than the many individual wetland systems. Through the use of WRUs, DWA and other natural resource managers can more easily manage wetlands on the basis of similar characteristics, driving processes, and sensitivities to developments and other impacts.

Provided they are correctly classified and fairly well understood, the classification and delineation of Wetland Resource Units and description of dominant wetland types within these can be used for strategic planning, reporting, assessment and monitoring purposes, as well as to provide some insight and understanding of wetland processes and predictions of likely impacts when WULAs are being evaluated. WRUs can thus facilitate the implementation of the National Water Act by allowing for the management, conservation, protection and sustainable utilisation of wetlands, at a scale appropriate to available knowledge and resources. For instance, the information about wetland processes and sensitivities for a WRU can be used in low confidence (desktop) Reserve studies, which may be sufficient for many Water User Licence Applications (WULAs).

Whilst the WRU classification and descriptions provide some insight into the underlying processes of the different types of wetlands across the study area, the quaternary scale PES and EIS for wetlands provides a first step for managing wetlands (The WRUs could be further divided according to quaternary catchment areas if appropriate). Although these data were derived from largely desktop information and are therefore very low confidence, the data could aid in low confidence Wetland Reserve studies associated with the WULAs of small-scale, low impact developments. When assessing the risk of activities on wetlands it is critical to identify underlying processes at the Wetland Resource Unit scale. Desktop PES and EIS assessments provided for wetlands at the quaternary catchment scale could be used in conjunction with WRU characteristics to evaluate the potential risks of WULAs. Very low risk WULAs may be able to be evaluated at the desktop level; low to moderate risk WULAs may require at least a brief field-based assessment of the site; whilst moderate to high risk WULAs may necessitate a full wetland Reserve determination study to be initiated.

The PES and EIS of a catchment can additionally be used to inform how wetlands within that area should be managed. For example, high EIS scores in areas where the wetland PES scores are low or moderate would suggest that interventions (such as Working for Wetlands) could be considered to stabilise and/or improve the condition of the wetland. In such areas, developments that result in a net decline in wetland extent or condition would not enable the DWA to achieve the aims of the National Water Act. Thus developments which result in an overall decline in wetland condition should be discouraged from areas where the REC is to maintain or improve the PES. These considerations should be used, not only as inputs in future, more in-depth Reserve Studies and WULA evaluations but also as inputs into first level wetland management planning (e.g. as part of the development of Catchment Management Strategies).

The use of WRUs does not, however, obviate the need for detailed Reserve studies for large, unique or highly-sensitive individual wetlands, particularly where potential developments are likely to have a significant impact upon their water supply. In such situations, DWA and other managers could evaluate the anticipated impacts of the development against the general characteristics and sensitivities of wetlands within the relevant WRU to assess whether or not the impact is likely to be significant, and thus require a detailed Reserve assessment. Where site-specific information for a wetland does exist, some extrapolation of that information may be possible. For the purposes of extrapolation, it should be noted that the extrapolation of information should only be made between wetlands of the same or very similar HGM wetland types. Additionally, there is a greater potential for effective extrapolation of wetland information between catchments but within the same WRU type, than within the same catchment area but across WRU boundaries.

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APPENDIX A: DESCRIPTION OF HGM WETLAND TYPES

A1 DESCRIPTION OF HGM WETLAND TYPES

The following describe the level III HGM wetland types recognised by the classification system applied in this study.

A1.1 RIVERS

Linear fluvial, eroded landforms that carry channelised flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorges) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone. For the purposes of this wetland report, no further focus has been placed upon the rivers of the study area.

A1.2 MEANDERING FLOODPLAIN

Linear fluvial, net depositional valley bottom surfaces that have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea). The meandering channel flows within an unconfined depositional valley, and ox-bows or cut-off meanders - evidence of meandering – are usually visible at the 1:10 000 scale (i.e. observable from 1:10 000 orthomaps). The floodplain surface usually slopes away from the channel margins due to preferential sediment deposition along the channel edges and areas closest to the channel. This can result in the formation of backwater swamps at the edges of the floodplain margins.

A1.3 CHANNELED VALLEY BOTTOMS

Linear fluvial, net depositional valley bottom surfaces that have a straight channel with flow on a permanent, seasonal or ephemeral/episodic basis. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no ox-bows or cut-off meanders are present in these wetland systems. The valley floor is, however, a depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas.

A1.4 UNCHANNELED VALLEY BOTTOMS

Linear fluvial, net depositional valley bottom surfaces that do not have a channel. The valley floor is a depositional environment composed of fluvial but may also have some colluvial sediment. These systems tend to be found in the upper catchment areas.

A1.5 LAKES

These are depressions in the valley bottoms that may be temporarily, seasonally or permanently inundated. Unlike pans, they are not deflationary erosional features, but instead they have, or would have had, an outlet at the downstream end of the valley (a low point); which has been variously blocked or otherwise restricted by dune deposits (e.g. Kosi Bay), terminal moraines (e.g. Lake District; United Kingdom.) or landslides (Lake Fundudzi) or other depositional features across the valley bottom. Within this study area, sand dunes had blocked previously eroded river valleys and when sea levels rose, these interdune depressions have become drowned as the regional water table rose (Allanson *et al.*, 1990). The shape of lakes is therefore determined by the surrounding slopes/higher ground rather than deflational processes creating the typical circular or oval pan shape.

A1.6 SEEPAGE WETLANDS (ISOLATED OR CONNECTED)

Hillslope seepage wetlands are the most common type of wetland (in extent and number), but also probably the most overlooked. Hillslope seepage wetlands are located on the mid- and footslopes of hillsides, and are connected to valley bottom wetlands or riparian zones. Hillslope seepage wetlands occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where throughflow in the soil profile is forced up to/near the surface due to impervious layers (such as Plinthite or other impervious layers; or where large outcrops of impervious rock force subsurface water to the surface). Seepage wetlands can also occur connected to (fringing, or surrounding) pan wetlands.

Isolated hillslope seepage wetlands can occur in the hillslope or crest positions of the landscape. As with the other hillslope seepage wetlands, these occur where springs are decanting into the soil profile near the surface, or where throughflow in the soil profile is forced up to/near the surface due to impervious layers.

A1.7 PANS

Small (deflationary) depressions that are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are “leaky” in the sense that they are hydrologically connected to adjacent valley bottoms through subsurface diffuse flow paths.

A1.8 FLATS

Wetland flats could be expected to occur in specific geologies that have a significant groundwater component (i.e. very pervious rock) where the permanently or seasonally high water table intersects with low-lying portions of the landscape. These troughs in the topography become permanently or seasonally saturated due to the proximity of the water table and wetland conditions are able to develop at these points. Such conditions exist in areas like the Cape Flats; in low-lying sections of the northern KwaZulu-Natal coastal belt and in some low-lying areas of Dolomitic regions.

APPENDIX B: DETAILED QUATERNARY CATCHMENT WETLAND PES SCORING

Name	Description	Comments	Score (0 - 5)
C11A	**Catchment Scale:**		
C11A	Afforestation/Invasive plants	limited	1
C11A	Dams, irrigation, other flow reduction activities	some irrigation, farm dams	2
C11A	Extent of Urbanisation/catchment hardening	none	0
C11A	Mining/urban/cropping - water quality factors	extensive agriculture	2
C11A	**Within the wetlands:**		
C11A	Invasive plants	very little invasive areas	1
C11A	Land use activities (mining-cropping-grazing)	primarily agriculture	2
C11A	Altered hydrology (drains/dams)	few dams, abstraction	2
C11A	Erosion of wetlands	limited channelisation	2
C11B	**Catchment Scale:**		
C11B	Afforestation/Invasive plants	limited	1
C11B	Dams, irrigation, other flow reduction activities	irrigation, dams	2
C11B	Extent of Urbanisation/catchment hardening	some	2
C11B	Mining/urban/cropping - water quality factors	agriculture	2
C11B	**Within the wetlands:**		
C11B	Invasive plants	very little invasive areas	1
C11B	Land use activities (mining-cropping-grazing)	some infilling/encroachment by infrastructure	2.5
C11B	Altered hydrology (drains/dams)	few small dams	2
C11B	Erosion of wetlands	some erosion evident	2
C11C	**Catchment Scale:**		
C11C	Afforestation/Invasive plants	very limited	1
C11C	Dams, irrigation, other flow reduction activities	irrigation, dams	2.5
C11C	Extent of Urbanisation/catchment hardening	none	0
C11C	Mining/urban/cropping - water quality factors	agriculture	1.5
C11C	**Within the wetlands:**		
C11C	Invasive plants	very little invasive areas	1
C11C	Land use activities (mining-cropping-grazing)	agricultural encroachment	1.5
C11C	Altered hydrology (drains/dams)	farm dams, abstraction	2
C11C	Erosion of wetlands	limited channelisation	2
C11D	**Catchment Scale:**		
C11D	Afforestation/Invasive plants	very limited	1
C11D	Dams, irrigation, other flow reduction activities	irrigation, dams	2.5
C11D	Extent of Urbanisation/catchment hardening	none	0
C11D	Mining/urban/cropping - water quality factors	agriculture	1.5
C11D	**Within the wetlands:**		
C11D	Invasive plants	very little invasive areas	1
C11D	Land use activities (mining-cropping-grazing)	agricultural encroachment	1.5
C11D	Altered hydrology (drains/dams)	farm dams, abstraction	2
C11D	Erosion of wetlands	limited channelisation	2
C11E	**Catchment Scale:**		
C11E	Afforestation/Invasive plants	very limited	0.5
C11E	Dams, irrigation, other flow reduction activities	many farm dams	2
C11E	Extent of Urbanisation/catchment hardening	small urban areas	2
C11E	Mining/urban/cropping - water quality factors	cropping, urban areas	2.5
C11E	**Within the wetlands:**		
C11E	Invasive plants	limited	0.5
C11E	Land use activities (mining-cropping-grazing)	cropping and grazing	1

Name	Description	Comments	Score (0 - 5)
C11E	Altered hydrology (drains/dams)	some dams	1.5
C11E	Erosion of wetlands	incision in lower catchment	1.5
C11F	**Catchment Scale:**		
C11F	Afforestation/Invasive plants	limited but present	1
C11F	Dams, irrigation, other flow reduction activities	farm dams, abstraction, urban areas	2
C11F	Extent of Urbanisation/catchment hardening	some urban areas	1.5
C11F	Mining/urban/cropping - water quality factors	urban, extensive agriculture, mining	2.5
C11F	**Within the wetlands:**		
C11F	Invasive plants	low	1
C11F	Land use activities (mining-cropping-grazing)	agric encroachment	2
C11F	Altered hydrology (drains/dams)	farm dams	1
C11F	Erosion of wetlands	some erosion evident	1
C11G	**Catchment Scale:**		
C11G	Afforestation/Invasive plants	limited	0.5
C11G	Dams, irrigation, other flow reduction activities	some dams	1.5
C11G	Extent of Urbanisation/catchment hardening	none	0
C11G	Mining/urban/cropping - water quality factors	agriculture	1
C11G	**Within the wetlands:**		
C11G	Invasive plants	limited	0.5
C11G	Land use activities (mining-cropping-grazing)	agriculture	1
C11G	Altered hydrology (drains/dams)	farm dams	1.5
C11G	Erosion of wetlands	some erosion evident	1.5
C11H	**Catchment Scale:**		
C11H	Afforestation/Invasive plants	none	0
C11H	Dams, irrigation, other flow reduction activities	small farm dams	1
C11H	Extent of Urbanisation/catchment hardening	Bethal at top of catchment	2
C11H	Mining/urban/cropping - water quality factors	low but extensive agriculture	1.5
C11H	**Within the wetlands:**		
C11H	Invasive plants	limited	1
C11H	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C11H	Altered hydrology (drains/dams)	some dams	1.5
C11H	Erosion of wetlands	limited	1
C11J	**Catchment Scale:**		
C11J	Afforestation/Invasive plants	none	0
C11J	Dams, irrigation, other flow reduction activities	small farm dams	1
C11J	Extent of Urbanisation/catchment hardening	limited	0.5
C11J	Mining/urban/cropping - water quality factors	low but extensive agriculture, power station	2
C11J	**Within the wetlands:**		
C11J	Invasive plants	limited	1
C11J	Land use activities (mining-cropping-grazing)	extensive agriculture	1.5
C11J	Altered hydrology (drains/dams)	some dams	1.5
C11J	Erosion of wetlands	appears extensive	1.5
C11K	**Catchment Scale:**		
C11K	Afforestation/Invasive plants	none	0
C11K	Dams, irrigation, other flow reduction activities	small farm dams	1
C11K	Extent of Urbanisation/catchment hardening	limited	0.5
C11K	Mining/urban/cropping - water quality factors	low but extensive agriculture, power station	2
C11K	**Within the wetlands:**		
C11K	Invasive plants	limited	1

Name	Description	Comments	Score (0 - 5)
C11K	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C11K	Altered hydrology (drains/dams)	some dams	1.5
C11K	Erosion of wetlands	appears extensive	2
C11L	**Catchment Scale:**		
C11L	Afforestation/Invasive plants	none	0
C11L	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C11L	Extent of Urbanisation/catchment hardening	small	1
C11L	Mining/urban/cropping - water quality factors	low but extensive agriculture, small urban areas	1.5
C11L	**Within the wetlands:**		
C11L	Invasive plants	limited	1
C11L	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C11L	Altered hydrology (drains/dams)	Very large dam, and small farm dams.	2.5
C11L	Erosion of wetlands	some apparent	1.5
C11M	**Catchment Scale:**		
C11M	Afforestation/Invasive plants	none	0
C11M	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C11M	Extent of Urbanisation/catchment hardening	small	1
C11M	Mining/urban/cropping - water quality factors	low but extensive agriculture, large urban areas	3
C11M	**Within the wetlands:**		
C11M	Invasive plants	limited	1
C11M	Land use activities (mining-cropping-grazing)	extensive agriculture, urban	1.5
C11M	Altered hydrology (drains/dams)	Few small farm dams.	1
C11M	Erosion of wetlands	some apparent	1.5
C12A	**Catchment Scale:**		
C12A	Afforestation/Invasive plants	none	0
C12A	Dams, irrigation, other flow reduction activities	few small dams	0.5
C12A	Extent of Urbanisation/catchment hardening	none	0
C12A	Mining/urban/cropping - water quality factors	low impact, extensive agriculture	1
C12A	**Within the wetlands:**		
C12A	Invasive plants	limited	1
C12A	Land use activities (mining-cropping-grazing)	extensive agriculture, but limited encroachment	0.5
C12A	Altered hydrology (drains/dams)	Few small farm dams.	1
C12A	Erosion of wetlands	limited	1
C12B	**Catchment Scale:**		
C12B	Afforestation/Invasive plants	none	0
C12B	Dams, irrigation, other flow reduction activities	few small dams	0.5
C12B	Extent of Urbanisation/catchment hardening	none	0
C12B	Mining/urban/cropping - water quality factors	extensive agriculture	2
C12B	**Within the wetlands:**		
C12B	Invasive plants	limited	1
C12B	Land use activities (mining-cropping-grazing)	extensive agriculture	2.5
C12B	Altered hydrology (drains/dams)	Few small farm dams; irrigation	1.5
C12B	Erosion of wetlands	limited	1
C12C	**Catchment Scale:**		
C12C	Afforestation/Invasive plants	none	0
C12C	Dams, irrigation, other flow reduction activities	few small dams	0.5
C12C	Extent of Urbanisation/catchment hardening	limited	0.5
C12C	Mining/urban/cropping - water quality factors	extensive agriculture, small urban area	2
C12C	**Within the wetlands:**		

Name	Description	Comments	Score (0 - 5)
C12C	Invasive plants	limited	1
C12C	Land use activities (mining-cropping-grazing)	extensive agriculture	1.5
C12C	Altered hydrology (drains/dams)	Few small farm dams.	1
C12C	Erosion of wetlands	limited	1
C12D	**Catchment Scale:**		
C12D	Afforestation/Invasive plants	limited	1
C12D	Dams, irrigation, other flow reduction activities	numerous dams	2.5
C12D	Extent of Urbanisation/catchment hardening	extensive urban areas	2.5
C12D	Mining/urban/cropping - water quality factors	mining/tailings dams, urban areas	3
C12D	**Within the wetlands:**		
C12D	Invasive plants	limited	1
C12D	Land use activities (mining-cropping-grazing)	agriculture, urban/industrial areas	2.5
C12D	Altered hydrology (drains/dams)	urban areas, dams	2
C12D	Erosion of wetlands	some apparent	1
C12E	**Catchment Scale:**		
C12E	Afforestation/Invasive plants	none	0
C12E	Dams, irrigation, other flow reduction activities	small farm dams	1
C12E	Extent of Urbanisation/catchment hardening	limited	0.5
C12E	Mining/urban/cropping - water quality factors	extensive agriculture	1.5
C12E	**Within the wetlands:**		
C12E	Invasive plants	limited	1
C12E	Land use activities (mining-cropping-grazing)	extensive agriculture	1.5
C12E	Altered hydrology (drains/dams)	some dams	1.5
C12E	Erosion of wetlands	appears extensive	2
C12F	**Catchment Scale:**		
C12F	Afforestation/Invasive plants	none	0
C12F	Dams, irrigation, other flow reduction activities	small farm dams	1
C12F	Extent of Urbanisation/catchment hardening	limited	0.5
C12F	Mining/urban/cropping - water quality factors	extensive agriculture, upstream urbanisation	2.5
C12F	**Within the wetlands:**		
C12F	Invasive plants	limited	1
C12F	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C12F	Altered hydrology (drains/dams)	some dams	1.5
C12F	Erosion of wetlands	appears extensive	2
C12G	**Catchment Scale:**		
C12G	Afforestation/Invasive plants	none	0
C12G	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C12G	Extent of Urbanisation/catchment hardening	limited	0.5
C12G	Mining/urban/cropping - water quality factors	extensive agriculture, especially in southern half	2
C12G	**Within the wetlands:**		
C12G	Invasive plants	limited	1
C12G	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C12G	Altered hydrology (drains/dams)	few small dams	0.5
C12G	Erosion of wetlands	limited	0.5
C12H	**Catchment Scale:**		
C12H	Afforestation/Invasive plants	none	0
C12H	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C12H	Extent of Urbanisation/catchment hardening	limited - small area	1
C12H	Mining/urban/cropping - water quality factors	extensive agriculture	2

Name	Description	Comments	Score (0 - 5)
C12H	**Within the wetlands:**		
C12H	Invasive plants	limited	1
C12H	Land use activities (mining-cropping-grazing)	extensive agriculture	2
C12H	Altered hydrology (drains/dams)	few small dams	0.5
C12H	Erosion of wetlands	some apparent	1
C12J	**Catchment Scale:**		
C12J	Afforestation/Invasive plants	none	0
C12J	Dams, irrigation, other flow reduction activities	few small dams	0.5
C12J	Extent of Urbanisation/catchment hardening	limited	0.5
C12J	Mining/urban/cropping - water quality factors	extensive agriculture	2.5
C12J	**Within the wetlands:**		
C12J	Invasive plants	limited	1
C12J	Land use activities (mining-cropping-grazing)	extensive agriculture	2
C12J	Altered hydrology (drains/dams)	Few small farm dams.	1
C12J	Erosion of wetlands	appears extensive	1.5
C12K	**Catchment Scale:**		
C12K	Afforestation/Invasive plants	none	0
C12K	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C12K	Extent of Urbanisation/catchment hardening	small urban area, industry.	2
C12K	Mining/urban/cropping - water quality factors	extensive agriculture, tailings dams	3
C12K	**Within the wetlands:**		
C12K	Invasive plants	limited	1
C12K	Land use activities (mining-cropping-grazing)	extensive agriculture	1
C12K	Altered hydrology (drains/dams)	few small dams	0.5
C12K	Erosion of wetlands	some	1
C12L	**Catchment Scale:**		
C12L	Afforestation/Invasive plants	none	0
C12L	Dams, irrigation, other flow reduction activities	small farm dams	0.5
C12L	Extent of Urbanisation/catchment hardening	very limited	0.5
C12L	Mining/urban/cropping - water quality factors	extensive agriculture,	1.5
C12L	**Within the wetlands:**		
C12L	Invasive plants	limited	1
C12L	Land use activities (mining-cropping-grazing)	extensive agriculture, but often good buffers.	1
C12L	Altered hydrology (drains/dams)	few small dams, very large Vaal Dam	3
C12L	Erosion of wetlands	some	1.5
C13A	**Catchment Scale:**		
C13A	Afforestation/Invasive plants	none	0
C13A	Dams, irrigation, other flow reduction activities	few farm dams	0.5
C13A	Extent of Urbanisation/catchment hardening	none	0
C13A	Mining/urban/cropping - water quality factors	some agriculture	1
C13A	**Within the wetlands:**		
C13A	Invasive plants	limited	1
C13A	Land use activities (mining-cropping-grazing)	limited impacts	1
C13A	Altered hydrology (drains/dams)	few small dams	3
C13A	Erosion of wetlands	fairly common	2
C13B	**Catchment Scale:**		
C13B	Afforestation/Invasive plants	none	0
C13B	Dams, irrigation, other flow reduction activities	few farm dams	0.5
C13B	Extent of Urbanisation/catchment hardening	none	0

Name	Description	Comments	Score (0 - 5)
C13B	Mining/urban/cropping - water quality factors	some agriculture	1
C13B	**Within the wetlands:**		
C13B	Invasive plants	limited	1
C13B	Land use activities (mining-cropping-grazing)	extensive agriculture	2
C13B	Altered hydrology (drains/dams)	few small dams	2
C13B	Erosion of wetlands	fairly common	1.5
C13C	**Catchment Scale:**		
C13C	Afforestation/Invasive plants	very low	0.5
C13C	Dams, irrigation, other flow reduction activities	limited in this upper catchment area	0.5
C13C	Extent of Urbanisation/catchment hardening	limited to small town (Memel)	0.5
C13C	Mining/urban/cropping - water quality factors	urban areas, agriculture	1
C13C	**Within the wetlands:**		
C13C	Invasive plants	limited - Willows and other small patches of exotics	0.5
C13C	Land use activities (mining-cropping-grazing)	agricultural impacts are low	0.5
C13C	Altered hydrology (drains/dams)	limited - only a few small farm dams	0.5
C13C	Erosion of wetlands	no extensive erosion is apparent	0
C13D	**Catchment Scale:**		
C13D	Afforestation/Invasive plants	very low	0.5
C13D	Dams, irrigation, other flow reduction activities	limited in this upper catchment area	0.5
C13D	Extent of Urbanisation/catchment hardening	none	0
C13D	Mining/urban/cropping - water quality factors	urban areas, agriculture	1
C13D	**Within the wetlands:**		
C13D	Invasive plants	limited - Willows and other small patches of exotics	0.5
C13D	Land use activities (mining-cropping-grazing)	agricultural impacts are low	0.5
C13D	Altered hydrology (drains/dams)	limited - only a few small farm dams, Memel impacts	1
C13D	Erosion of wetlands	limited	1
C13E	**Catchment Scale:**		
C13E	Afforestation/Invasive plants	very low	0.5
C13E	Dams, irrigation, other flow reduction activities	small farm dams	1
C13E	Extent of Urbanisation/catchment hardening	none	0
C13E	Mining/urban/cropping - water quality factors	agricultural impacts are low	1
C13E	**Within the wetlands:**		
C13E	Invasive plants	limited	0.5
C13E	Land use activities (mining-cropping-grazing)	agricultural impacts are low	0.5
C13E	Altered hydrology (drains/dams)	irrigation/abstraction	1
C13E	Erosion of wetlands	limited	1
C13F	**Catchment Scale:**		
C13F	Afforestation/Invasive plants	very low	0.5
C13F	Dams, irrigation, other flow reduction activities	small farm dams	1
C13F	Extent of Urbanisation/catchment hardening	none	0
C13F	Mining/urban/cropping - water quality factors	agricultural impacts are very low	0.5
C13F	**Within the wetlands:**		
C13F	Invasive plants	limited	0.5
C13F	Land use activities (mining-cropping-grazing)	agricultural impacts are low	0.5
C13F	Altered hydrology (drains/dams)	irrigation/abstraction	1
C13F	Erosion of wetlands	some large eroded areas	2
C13G	**Catchment Scale:**		
C13G	Afforestation/Invasive plants	very low	0.5

Name	Description	Comments	Score (0 - 5)
C13G	Dams, irrigation, other flow reduction activities	several small and medium dams	2
C13G	Extent of Urbanisation/catchment hardening	limited	1
C13G	Mining/urban/cropping - water quality factors	agricultural impacts are very low	0.5
C13G	**Within the wetlands:**		
C13G	Invasive plants	limited	0.5
C13G	Land use activities (mining-cropping-grazing)	agricultural impacts are low	1
C13G	Altered hydrology (drains/dams)	limited impacts	1.5
C13G	Erosion of wetlands	limited	0.5
C13H	**Catchment Scale:**		
C13H	Afforestation/Invasive plants	very low	0.5
C13H	Dams, irrigation, other flow reduction activities	small farm dams	1
C13H	Extent of Urbanisation/catchment hardening	none	0
C13H	Mining/urban/cropping - water quality factors	agricultural impacts are low	1
C13H	**Within the wetlands:**		
C13H	Invasive plants	limited	0.5
C13H	Land use activities (mining-cropping-grazing)	agricultural impacts are low	0.5
C13H	Altered hydrology (drains/dams)	irrigation/abstraction	1
C13H	Erosion of wetlands	some small eroded areas	1.5
C21A	**Catchment Scale:**		
C21A	Afforestation/Invasive plants	very low	0.5
C21A	Dams, irrigation, other flow reduction activities	some dams	1.5
C21A	Extent of Urbanisation/catchment hardening	some urban areas	2
C21A	Mining/urban/cropping - water quality factors	urban areas, agriculture	1.5
C21A	**Within the wetlands:**		
C21A	Invasive plants	limited	1
C21A	Land use activities (mining-cropping-grazing)	agriculture, urban/industrial areas	2.5
C21A	Altered hydrology (drains/dams)	urban areas, dams	2
C21A	Erosion of wetlands	some apparent	1
C21B	**Catchment Scale:**		
C21B	Afforestation/Invasive plants	very low	0.5
C21B	Dams, irrigation, other flow reduction activities	some dams	1.5
C21B	Extent of Urbanisation/catchment hardening	some urban areas	2
C21B	Mining/urban/cropping - water quality factors	urban areas, agriculture	1.5
C21B	**Within the wetlands:**		
C21B	Invasive plants	limited	1
C21B	Land use activities (mining-cropping-grazing)	agriculture, small urban areas	1.5
C21B	Altered hydrology (drains/dams)	urban area, small dams	1.5
C21B	Erosion of wetlands	some apparent	1
C21C	**Catchment Scale:**		
C21C	Afforestation/Invasive plants	very low	0.5
C21C	Dams, irrigation, other flow reduction activities	some dams, abstraction	2.5
C21C	Extent of Urbanisation/catchment hardening	none	0
C21C	Mining/urban/cropping - water quality factors	upstream, agriculture, feedlots	3
C21C	**Within the wetlands:**		
C21C	Invasive plants	limited	0.5
C21C	Land use activities (mining-cropping-grazing)	agriculture	0.5
C21C	Altered hydrology (drains/dams)	abstractions, dams	2
C21C	Erosion of wetlands	some apparent	1
C21D	**Catchment Scale:**		

Name	Description	Comments	Score (0 - 5)
C21D	Afforestation/Invasive plants	moderate/low	1.5
C21D	Dams, irrigation, other flow reduction activities	flow reductions and increases have occurred	3
C21D	Extent of Urbanisation/catchment hardening	very high in upper catchment	3
C21D	Mining/urban/cropping - water quality factors	urban and industrial runoff, tailings, mine water	4
C21D	**Within the wetlands:**		
C21D	Invasive plants	extensive encroachment (loss of wetland grasslands)	2
C21D	Land use activities (mining-cropping-grazing)	mining encroached in areas; roads confine flows	2
C21D	Altered hydrology (drains/dams)	enormous changes to natural hydrology	5
C21D	Erosion of wetlands	some areas are affected	1.5
C21E	**Catchment Scale:**		
C21E	Afforestation/Invasive plants	moderate/low	1.5
C21E	Dams, irrigation, other flow reduction activities	dams and mine water inflows	3
C21E	Extent of Urbanisation/catchment hardening	moderated and attenuated	2,5
C21E	Mining/urban/cropping - water quality factors	urban and industrial runoff, tailings, mine water	4.5
C21E	**Within the wetlands:**		
C21E	Invasive plants	extensive encroachment (loss of wetland grasslands)	2
C21E	Land use activities (mining-cropping-grazing)	mining encroached in areas; roads confine flows	2
C21E	Altered hydrology (drains/dams)	elevated baseflows in mainstem, dams	3.5
C21E	Erosion of wetlands	limited	0.5
C21F	**Catchment Scale:**		
C21F	Afforestation/Invasive plants	low	0.5
C21F	Dams, irrigation, other flow reduction activities	dams and mine water inflows	1
C21F	Extent of Urbanisation/catchment hardening	increased baseflows	2.5
C21F	Mining/urban/cropping - water quality factors	urban and industrial runoff, tailings, mine water	3
C21F	**Within the wetlands:**		
C21F	Invasive plants	limited	0.5
C21F	Land use activities (mining-cropping-grazing)	agriculture, roads	1
C21F	Altered hydrology (drains/dams)	elevated baseflows in mainstem	2.5
C21F	Erosion of wetlands	limited	0.5
C21G	**Catchment Scale:**		
C21G	Afforestation/Invasive plants	low	0.5
C21G	Dams, irrigation, other flow reduction activities	dams and mine water inflows	1
C21G	Extent of Urbanisation/catchment hardening	increased baseflows	2
C21G	Mining/urban/cropping - water quality factors	urban and industrial runoff, tailings, mine water	2
C21G	**Within the wetlands:**		
C21G	Invasive plants	limited	0.5
C21G	Land use activities (mining-cropping-grazing)	agriculture	1
C21G	Altered hydrology (drains/dams)	elevated baseflows in mainstem	1.5
C21G	Erosion of wetlands	some impact	0.5
C22A	**Catchment Scale:**		
C22A	Afforestation/Invasive plants	low	0.5
C22A	Dams, irrigation, other flow reduction activities	dams, waste water inflows	3
C22A	Extent of Urbanisation/catchment hardening	increased baseflows and floods	3.5
C22A	Mining/urban/cropping - water quality factors	waste water inflows, tailings dams	3
C22A	**Within the wetlands:**		
C22A	Invasive plants	limited	0.5
C22A	Land use activities (mining-cropping-grazing)	urban areas - encroachment	1

Name	Description	Comments	Score (0 - 5)
C22A	Altered hydrology (drains/dams)	drains in some sections	2
C22A	Erosion of wetlands	some seriously eroded reaches	2.5
C22B	**Catchment Scale:**		
C22B	Afforestation/Invasive plants	low	0.5
C22B	Dams, irrigation, other flow reduction activities	dams, waste water inflows	3
C22B	Extent of Urbanisation/catchment hardening	increased baseflows and floods	4
C22B	Mining/urban/cropping - water quality factors	waste water inflows, tailings dams	3.5
C22B	**Within the wetlands:**		
C22B	Invasive plants	limited	0.5
C22B	Land use activities (mining-cropping-grazing)	urban areas - encroachment	1
C22B	Altered hydrology (drains/dams)	drains in some sections	2
C22B	Erosion of wetlands	some seriously eroded reaches	2.5
C22C	**Catchment Scale:**		
C22C	Afforestation/Invasive plants	low	0.5
C22C	Dams, irrigation, other flow reduction activities	dams, waste water inflows	3
C22C	Extent of Urbanisation/catchment hardening	increased baseflows and floods	3
C22C	Mining/urban/cropping - water quality factors	waste water inflows, tailings dams	3
C22C	**Within the wetlands:**		
C22C	Invasive plants	limited	0.5
C22C	Land use activities (mining-cropping-grazing)	urban areas - encroachment	1
C22C	Altered hydrology (drains/dams)	drains in some sections	2
C22C	Erosion of wetlands	some seriously eroded reaches	2.5
C22D	**Catchment Scale:**		
C22D	Afforestation/Invasive plants	low	0.5
C22D	Dams, irrigation, other flow reduction activities	dams, waste water inflows	4
C22D	Extent of Urbanisation/catchment hardening	increased baseflows and floods	5
C22D	Mining/urban/cropping - water quality factors	waste water inflows decrease water quality	4
C22D	**Within the wetlands:**		
C22D	Invasive plants	limited	0.5
C22D	Land use activities (mining-cropping-grazing)	urban areas - encroachment	0.5
C22D	Altered hydrology (drains/dams)	drains in some sections	3
C22D	Erosion of wetlands	some seriously eroded reaches	4.5
C22E	**Catchment Scale:**		
C22E	Afforestation/Invasive plants	low	0.5
C22E	Dams, irrigation, other flow reduction activities	irrigation	1
C22E	Extent of Urbanisation/catchment hardening	increased baseflows and floods	3
C22E	Mining/urban/cropping - water quality factors	encroachment	1
C22E	**Within the wetlands:**		
C22E	Invasive plants	limited	0.5
C22E	Land use activities (mining-cropping-grazing)	agriculture and urban - encroachment	0.5
C22E	Altered hydrology (drains/dams)	limited	0.5
C22E	Erosion of wetlands	urban areas expected to cause erosion	2
C22F	**Catchment Scale:**		
C22F	Afforestation/Invasive plants	low	0.5
C22F	Dams, irrigation, other flow reduction activities	irrigation	1
C22F	Extent of Urbanisation/catchment hardening	increased baseflows and floods	3
C22F	Mining/urban/cropping - water quality factors	encroachment	1
C22F	**Within the wetlands:**		
C22F	Invasive plants	limited	0.5

Name	Description	Comments	Score (0 - 5)
C22F	Land use activities (mining-cropping-grazing)	urban areas - encroachment	0.5
C22F	Altered hydrology (drains/dams)	limited	0.5
C22F	Erosion of wetlands	urban areas expected to cause erosion	2
C22G	**Catchment Scale:**		
C22G	Afforestation/Invasive plants	low	0.5
C22G	Dams, irrigation, other flow reduction activities	irrigation	1
C22G	Extent of Urbanisation/catchment hardening	limited	0.5
C22G	Mining/urban/cropping - water quality factors	agriculture	1
C22G	**Within the wetlands:**		
C22G	Invasive plants	limited	0.5
C22G	Land use activities (mining-cropping-grazing)	agricultural encroachment	2
C22G	Altered hydrology (drains/dams)	small dams	1
C22G	Erosion of wetlands	some extensive eroded areas	2.5
C22H	**Catchment Scale:**		
C22H	Afforestation/Invasive plants	low	0.5
C22H	Dams, irrigation, other flow reduction activities	abstractions, dams	1.5
C22H	Extent of Urbanisation/catchment hardening	extensive urban area	2.5
C22H	Mining/urban/cropping - water quality factors	mine tailings, urban areas	2.5
C22H	**Within the wetlands:**		
C22H	Invasive plants	limited	0.5
C22H	Land use activities (mining-cropping-grazing)	agricultural (limited encroachment); urban area	2
C22H	Altered hydrology (drains/dams)	few small dams	1
C22H	Erosion of wetlands	none evident	0.5
C22J	**Catchment Scale:**		
C22J	Afforestation/Invasive plants	low	0.5
C22J	Dams, irrigation, other flow reduction activities	abstractions, dams	1.5
C22J	Extent of Urbanisation/catchment hardening	urban areas	1.5
C22J	Mining/urban/cropping - water quality factors	mine tailings, urban areas	2
C22J	**Within the wetlands:**		
C22J	Invasive plants	limited	0.5
C22J	Land use activities (mining-cropping-grazing)	agricultural (limited encroachment); urban area	1.5
C22J	Altered hydrology (drains/dams)	few small dams	1
C22J	Erosion of wetlands	none evident	0.5
C22K	**Catchment Scale:**		
C22K	Afforestation/Invasive plants	low	0.5
C22K	Dams, irrigation, other flow reduction activities	limited reductions	1
C22K	Extent of Urbanisation/catchment hardening	urban areas	4
C22K	Mining/urban/cropping - water quality factors	urban runoff	3
C22K	**Within the wetlands:**		
C22K	Invasive plants	limited	0.5
C22K	Land use activities (mining-cropping-grazing)	encroachment	3
C22K	Altered hydrology (drains/dams)	few small dams - wetlands get narrowed,	2
C22K	Erosion of wetlands	urban areas expected to cause erosion	2
C23A	**Catchment Scale:**		
C23A	Afforestation/Invasive plants	none evident	0
C23A	Dams, irrigation, other flow reduction activities	very limited	0.5
C23A	Extent of Urbanisation/catchment hardening	none	0
C23A	Mining/urban/cropping - water quality factors	agriculture only	1
C23A	**Within the wetlands:**		

Name	Description	Comments	Score (0 - 5)
C23A	Invasive plants	limited	0.5
C23A	Land use activities (mining-cropping-grazing)	encroachment from agriculture	1.5
C23A	Altered hydrology (drains/dams)	very little alteration	1
C23A	Erosion of wetlands	limited	1
C23B	**Catchment Scale:**		
C23B	Afforestation/Invasive plants	none evident	0
C23B	Dams, irrigation, other flow reduction activities	very limited	0.5
C23B	Extent of Urbanisation/catchment hardening	none	0
C23B	Mining/urban/cropping - water quality factors	agriculture only	1.5
C23B	**Within the wetlands:**		
C23B	Invasive plants	limited	0.5
C23B	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C23B	Altered hydrology (drains/dams)	very little alteration	1
C23B	Erosion of wetlands	limited	1
C23C	**Catchment Scale:**		
C23C	Afforestation/Invasive plants	none evident	0
C23C	Dams, irrigation, other flow reduction activities	very limited	0.5
C23C	Extent of Urbanisation/catchment hardening	very limited	1
C23C	Mining/urban/cropping - water quality factors	agriculture only	1.5
C23C	**Within the wetlands:**		
C23C	Invasive plants	limited	0.5
C23C	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C23C	Altered hydrology (drains/dams)	very little alteration	1.5
C23C	Erosion of wetlands	limited extent	2
C23D	**Catchment Scale:**		
C23D	Afforestation/Invasive plants	low	0.5
C23D	Dams, irrigation, other flow reduction activities	dams, waste water inflows	3
C23D	Extent of Urbanisation/catchment hardening	increased baseflows	2
C23D	Mining/urban/cropping - water quality factors	tailings dams, Acid mine drainage, wastewater	5
C23D	**Within the wetlands:**		
C23D	Invasive plants	limited	0.5
C23D	Land use activities (mining-cropping-grazing)	infrastructure, agriculture	1.5
C23D	Altered hydrology (drains/dams)	canalisation of some sections.	2
C23D	Erosion of wetlands	limited	1
C23E	**Catchment Scale:**		
C23E	Afforestation/Invasive plants	low	0.5
C23E	Dams, irrigation, other flow reduction activities	dams, waste water inflows, abstraction	3
C23E	Extent of Urbanisation/catchment hardening	increased baseflows	2
C23E	Mining/urban/cropping - water quality factors	Acid mine drainage, wastewater	4
C23E	**Within the wetlands:**		
C23E	Invasive plants	limited	0.5
C23E	Land use activities (mining-cropping-grazing)	infrastructure, agriculture	1.5
C23E	Altered hydrology (drains/dams)	canalisation of some sections, peat mining	4
C23E	Erosion of wetlands	limited	1
C23F	**Catchment Scale:**		
C23F	Afforestation/Invasive plants	low	0.5
C23F	Dams, irrigation, other flow reduction activities	abstraction, small dams	1.5
C23F	Extent of Urbanisation/catchment hardening	limited	1
C23F	Mining/urban/cropping - water quality factors	agriculture	1

Name	Description	Comments	Score (0 - 5)
C23F	**Within the wetlands:**		
C23F	Invasive plants	limited	0.5
C23F	Land use activities (mining-cropping-grazing)	limited encroachment	1
C23F	Altered hydrology (drains/dams)	canalisation in sections	2
C23F	Erosion of wetlands	limited	1
C23G	**Catchment Scale:**		
C23G	Afforestation/Invasive plants	low	0.5
C23G	Dams, irrigation, other flow reduction activities	dams, waste water inflows, abstraction	3
C23G	Extent of Urbanisation/catchment hardening	limited	1
C23G	Mining/urban/cropping - water quality factors	Acid mine drainage, wastewater (diluted)	3
C23G	**Within the wetlands:**		
C23G	Invasive plants	limited	0.5
C23G	Land use activities (mining-cropping-grazing)	peat mining, encroachment	3
C23G	Altered hydrology (drains/dams)	canalisation of some sections, peat mining	4
C23G	Erosion of wetlands	limited	1
C23H	**Catchment Scale:**		
C23H	Afforestation/Invasive plants	low	0.5
C23H	Dams, irrigation, other flow reduction activities	dams, abstraction	3
C23H	Extent of Urbanisation/catchment hardening	some	1.5
C23H	Mining/urban/cropping - water quality factors	upstream catchment issues somewhat diluted	2
C23H	**Within the wetlands:**		
C23H	Invasive plants	limited	0.5
C23H	Land use activities (mining-cropping-grazing)	agric encroachment	2
C23H	Altered hydrology (drains/dams)	canalisation of some sections	3
C23H	Erosion of wetlands	some incised reaches	2.5
C23J	**Catchment Scale:**		
C23J	Afforestation/Invasive plants	low	0.5
C23J	Dams, irrigation, other flow reduction activities	abstractions, dams	1.5
C23J	Extent of Urbanisation/catchment hardening	urban areas	1
C23J	Mining/urban/cropping - water quality factors	mine tailings, urban areas, agric	2
C23J	**Within the wetlands:**		
C23J	Invasive plants	limited	0.5
C23J	Land use activities (mining-cropping-grazing)	agricultural (limited encroachment)	1
C23J	Altered hydrology (drains/dams)	few small dams	1
C23J	Erosion of wetlands	limited	1
C23K	**Catchment Scale:**		
C23K	Afforestation/Invasive plants	low	0.5
C23K	Dams, irrigation, other flow reduction activities	abstractions, dams	1.5
C23K	Extent of Urbanisation/catchment hardening	none	0
C23K	Mining/urban/cropping - water quality factors	agric	1
C23K	**Within the wetlands:**		
C23K	Invasive plants	limited	0.5
C23K	Land use activities (mining-cropping-grazing)	agricultural (widespread encroachment)	3
C23K	Altered hydrology (drains/dams)	few small dams	1
C23K	Erosion of wetlands	some erosion evident	2
C23L	**Catchment Scale:**		
C23L	Afforestation/Invasive plants	low	0.5
C23L	Dams, irrigation, other flow reduction activities	abstractions, dams	2
C23L	Extent of Urbanisation/catchment hardening	none	0

Name	Description	Comments	Score (0 - 5)
C23L	Mining/urban/cropping - water quality factors	agric	2
C23L	**Within the wetlands:**		
C23L	Invasive plants	limited	0.5
C23L	Land use activities (mining-cropping-grazing)	agricultural (widespread encroachment)	3
C23L	Altered hydrology (drains/dams)	some dams	1.5
C23L	Erosion of wetlands	some erosion evident	2
C81A	**Catchment Scale:**		
C81A	Afforestation/Invasive plants	low	0.5
C81A	Dams, irrigation, other flow reduction activities	very limited	0.5
C81A	Extent of Urbanisation/catchment hardening	none	0
C81A	Mining/urban/cropping - water quality factors	none - very limited agric	0.5
C81A	**Within the wetlands:**		
C81A	Invasive plants	limited	0.5
C81A	Land use activities (mining-cropping-grazing)	grazing	0.5
C81A	Altered hydrology (drains/dams)	none	0
C81A	Erosion of wetlands	none	0
C81B	**Catchment Scale:**		
C81B	Afforestation/Invasive plants	low	0.5
C81B	Dams, irrigation, other flow reduction activities	limited	1
C81B	Extent of Urbanisation/catchment hardening	none	0
C81B	Mining/urban/cropping - water quality factors	agriculture	1.5
C81B	**Within the wetlands:**		
C81B	Invasive plants	limited	0.5
C81B	Land use activities (mining-cropping-grazing)	agriculture	1
C81B	Altered hydrology (drains/dams)	small dams	1
C81B	Erosion of wetlands	limited	0.5
C81C	**Catchment Scale:**		
C81C	Afforestation/Invasive plants	low	0.5
C81C	Dams, irrigation, other flow reduction activities	limited	1
C81C	Extent of Urbanisation/catchment hardening	none	0
C81C	Mining/urban/cropping - water quality factors	agriculture	1.5
C81C	**Within the wetlands:**		
C81C	Invasive plants	limited	0.5
C81C	Land use activities (mining-cropping-grazing)	agriculture	1
C81C	Altered hydrology (drains/dams)	small dams	1
C81C	Erosion of wetlands	limited	0.5
C81D	**Catchment Scale:**		
C81D	Afforestation/Invasive plants	none	0
C81D	Dams, irrigation, other flow reduction activities	Sterkfontein Dam covers large area of catchment	5
C81D	Extent of Urbanisation/catchment hardening	none	0
C81D	Mining/urban/cropping - water quality factors	none	0
C81D	**Within the wetlands:**		
C81D	Invasive plants	(most vegetation drowned by dam)	5
C81D	Land use activities (mining-cropping-grazing)	none	0
C81D	Altered hydrology (drains/dams)	Sterkfontein Dam covers large area of catchment	5
C81D	Erosion of wetlands	limited	1
C81E	**Catchment Scale:**		
C81E	Afforestation/Invasive plants	low	0.5
C81E	Dams, irrigation, other flow reduction activities	dams, abstraction	1.5

Name	Description	Comments	Score (0 - 5)
C81E	Extent of Urbanisation/catchment hardening	limited	1
C81E	Mining/urban/cropping - water quality factors	agriculture, urban	1.5
C81E	**Within the wetlands:**		
C81E	Invasive plants	limited	0.5
C81E	Land use activities (mining-cropping-grazing)	agriculture	1.5
C81E	Altered hydrology (drains/dams)	small dams	2
C81E	Erosion of wetlands	limited	1
C81F	**Catchment Scale:**		
C81F	Afforestation/Invasive plants	low	0.5
C81F	Dams, irrigation, other flow reduction activities	dams, abstraction	1
C81F	Extent of Urbanisation/catchment hardening	much of the catchment is peri-urban	3.5
C81F	Mining/urban/cropping - water quality factors	urban	2.5
C81F	**Within the wetlands:**		
C81F	Invasive plants	limited	0.5
C81F	Land use activities (mining-cropping-grazing)	cleared for housing	3
C81F	Altered hydrology (drains/dams)	rapid runoff, high sediment	3.5
C81F	Erosion of wetlands	extensive urban area	3
C81G	**Catchment Scale:**		
C81G	Afforestation/Invasive plants	low	0.5
C81G	Dams, irrigation, other flow reduction activities	dams, abstraction	1.5
C81G	Extent of Urbanisation/catchment hardening	limited	1
C81G	Mining/urban/cropping - water quality factors	agriculture, urban	1.5
C81G	**Within the wetlands:**		
C81G	Invasive plants	limited	0.5
C81G	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2.5
C81G	Altered hydrology (drains/dams)	small dams	2
C81G	Erosion of wetlands	some apparent	2
C81H	**Catchment Scale:**		
C81H	Afforestation/Invasive plants	low	0.5
C81H	Dams, irrigation, other flow reduction activities	dams, abstraction	1.5
C81H	Extent of Urbanisation/catchment hardening	none	0
C81H	Mining/urban/cropping - water quality factors	agriculture	1.5
C81H	**Within the wetlands:**		
C81H	Invasive plants	limited	0.5
C81H	Land use activities (mining-cropping-grazing)	extensive encroachment from agriculture	3
C81H	Altered hydrology (drains/dams)	small dams	2
C81H	Erosion of wetlands	some apparent	2
C81J	**Catchment Scale:**		
C81J	Afforestation/Invasive plants	low	0.5
C81J	Dams, irrigation, other flow reduction activities	dams, abstraction	1.5
C81J	Extent of Urbanisation/catchment hardening	none	0
C81J	Mining/urban/cropping - water quality factors	agriculture	1.5
C81J	**Within the wetlands:**		
C81J	Invasive plants	limited	0.5
C81J	Land use activities (mining-cropping-grazing)	some encroachment from agriculture	2
C81J	Altered hydrology (drains/dams)	small dams	2
C81J	Erosion of wetlands	some apparent	2
C81K	**Catchment Scale:**		
C81K	Afforestation/Invasive plants	low	0.5

Name	Description	Comments	Score (0 - 5)
C81K	Dams, irrigation, other flow reduction activities	dams, abstraction	1.5
C81K	Extent of Urbanisation/catchment hardening	none	0
C81K	Mining/urban/cropping - water quality factors	agriculture	1.5
C81K	**Within the wetlands:**		
C81K	Invasive plants	limited	0.5
C81K	Land use activities (mining-cropping-grazing)	some encroachment from agriculture	2
C81K	Altered hydrology (drains/dams)	small dams	2
C81K	Erosion of wetlands	some apparent	2
C81L	**Catchment Scale:**		
C81L	Afforestation/Invasive plants	low	0.5
C81L	Dams, irrigation, other flow reduction activities	limited	1
C81L	Extent of Urbanisation/catchment hardening	none	0
C81L	Mining/urban/cropping - water quality factors	agriculture	1.5
C81L	**Within the wetlands:**		
C81L	Invasive plants	limited	0.5
C81L	Land use activities (mining-cropping-grazing)	agriculture	1
C81L	Altered hydrology (drains/dams)	small dams	1
C81L	Erosion of wetlands	limited	0.5
C81M	**Catchment Scale:**		
C81M	Afforestation/Invasive plants	low	0.5
C81M	Dams, irrigation, other flow reduction activities	small farm dams	2
C81M	Extent of Urbanisation/catchment hardening	none	0
C81M	Mining/urban/cropping - water quality factors	agriculture	2
C81M	**Within the wetlands:**		
C81M	Invasive plants	limited	0.5
C81M	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C81M	Altered hydrology (drains/dams)	small dams	1
C81M	Erosion of wetlands	some evident	1
C82A	**Catchment Scale:**		
C82A	Afforestation/Invasive plants	low	0.5
C82A	Dams, irrigation, other flow reduction activities	limited	1
C82A	Extent of Urbanisation/catchment hardening	none	0
C82A	Mining/urban/cropping - water quality factors	agriculture	1.5
C82A	**Within the wetlands:**		
C82A	Invasive plants	limited	0.5
C82A	Land use activities (mining-cropping-grazing)	agriculture	1
C82A	Altered hydrology (drains/dams)	small dams	1
C82A	Erosion of wetlands	limited	0.5
C82B	**Catchment Scale:**		
C82B	Afforestation/Invasive plants	low	0.5
C82B	Dams, irrigation, other flow reduction activities	small farm dams, abstraction	2
C82B	Extent of Urbanisation/catchment hardening	limited	1
C82B	Mining/urban/cropping - water quality factors	agriculture, urban	2
C82B	**Within the wetlands:**		
C82B	Invasive plants	limited	0.5
C82B	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C82B	Altered hydrology (drains/dams)	small dams	1
C82B	Erosion of wetlands	some evident	1
C82C	**Catchment Scale:**		

Name	Description	Comments	Score (0 - 5)
C82C	Afforestation/Invasive plants	low	0.5
C82C	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C82C	Extent of Urbanisation/catchment hardening	none	0
C82C	Mining/urban/cropping - water quality factors	agriculture	3
C82C	**Within the wetlands:**		
C82C	Invasive plants	limited	0.5
C82C	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C82C	Altered hydrology (drains/dams)	farm dams	2
C82C	Erosion of wetlands	limited	1
C82D	**Catchment Scale:**		
C82D	Afforestation/Invasive plants	low	0.5
C82D	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C82D	Extent of Urbanisation/catchment hardening	none	0
C82D	Mining/urban/cropping - water quality factors	agriculture	3
C82D	**Within the wetlands:**		
C82D	Invasive plants	limited	0.5
C82D	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C82D	Altered hydrology (drains/dams)	farm dams	2
C82D	Erosion of wetlands	limited	1
C82E	**Catchment Scale:**		
C82E	Afforestation/Invasive plants	low	0.5
C82E	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C82E	Extent of Urbanisation/catchment hardening	none	0
C82E	Mining/urban/cropping - water quality factors	agriculture	3
C82E	**Within the wetlands:**		
C82E	Invasive plants	limited	0.5
C82E	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C82E	Altered hydrology (drains/dams)	farm dams	2
C82E	Erosion of wetlands	erosion evident	1.5
C82F	**Catchment Scale:**		
C82F	Afforestation/Invasive plants	low	0.5
C82F	Dams, irrigation, other flow reduction activities	dams	1
C82F	Extent of Urbanisation/catchment hardening	none	0
C82F	Mining/urban/cropping - water quality factors	agriculture	1.5
C82F	**Within the wetlands:**		
C82F	Invasive plants	limited	0.5
C82F	Land use activities (mining-cropping-grazing)	encroachment from agriculture	1
C82F	Altered hydrology (drains/dams)	farm dams	1
C82F	Erosion of wetlands	limited	1
C82G	**Catchment Scale:**		
C82G	Afforestation/Invasive plants	low	0.5
C82G	Dams, irrigation, other flow reduction activities	dams	1
C82G	Extent of Urbanisation/catchment hardening	none	0
C82G	Mining/urban/cropping - water quality factors	agriculture	1
C82G	**Within the wetlands:**		
C82G	Invasive plants	limited	0.5
C82G	Land use activities (mining-cropping-grazing)	encroachment from agriculture	0.5
C82G	Altered hydrology (drains/dams)	farm dams	1
C82G	Erosion of wetlands	limited	1

Name	Description	Comments	Score (0 - 5)
C82H	**Catchment Scale:**		
C82H	Afforestation/Invasive plants	low	0.5
C82H	Dams, irrigation, other flow reduction activities	dams	1
C82H	Extent of Urbanisation/catchment hardening	none	0
C82H	Mining/urban/cropping - water quality factors	agriculture	1.5
C82H	**Within the wetlands:**		
C82H	Invasive plants	limited	0.5
C82H	Land use activities (mining-cropping-grazing)	encroachment from agriculture	1.5
C82H	Altered hydrology (drains/dams)	farm dams	1
C82H	Erosion of wetlands	limited	1.5
C83A	**Catchment Scale:**		
C83A	Afforestation/Invasive plants	low	1
C83A	Dams, irrigation, other flow reduction activities	dams, abstraction	1
C83A	Extent of Urbanisation/catchment hardening	none, but interbasin transfer incremental flows	3
C83A	Mining/urban/cropping - water quality factors	agriculture	1.5
C83A	**Within the wetlands:**		
C83A	Invasive plants	limited	0.5
C83A	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2.5
C83A	Altered hydrology (drains/dams)	small dams, erosion	2.5
C83A	Erosion of wetlands	extensive	3.5
C83B	**Catchment Scale:**		
C83B	Afforestation/Invasive plants	low	1
C83B	Dams, irrigation, other flow reduction activities	dams, abstraction	1
C83B	Extent of Urbanisation/catchment hardening	none	0
C83B	Mining/urban/cropping - water quality factors	agriculture	1
C83B	**Within the wetlands:**		
C83B	Invasive plants	limited	0.5
C83B	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83B	Altered hydrology (drains/dams)	small dams	2
C83B	Erosion of wetlands	some apparent	2
C83C	**Catchment Scale:**		
C83C	Afforestation/Invasive plants	low	1
C83C	Dams, irrigation, other flow reduction activities	dams, abstraction	1
C83C	Extent of Urbanisation/catchment hardening	some at top of catchment	1.5
C83C	Mining/urban/cropping - water quality factors	agriculture, urban	2.5
C83C	**Within the wetlands:**		
C83C	Invasive plants	limited	0.5
C83C	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83C	Altered hydrology (drains/dams)	small dams	2
C83C	Erosion of wetlands	limited	1
C83D	**Catchment Scale:**		
C83D	Afforestation/Invasive plants	low	1
C83D	Dams, irrigation, other flow reduction activities	dams, abstraction	1
C83D	Extent of Urbanisation/catchment hardening	none	0
C83D	Mining/urban/cropping - water quality factors	agriculture,	2
C83D	**Within the wetlands:**		
C83D	Invasive plants	limited	0.5
C83D	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83D	Altered hydrology (drains/dams)	small dams	2

Name	Description	Comments	Score (0 - 5)
C83D	Erosion of wetlands	limited	1
C83E	**Catchment Scale:**		
C83E	Afforestation/Invasive plants	low	0.5
C83E	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83E	Extent of Urbanisation/catchment hardening	none	0
C83E	Mining/urban/cropping - water quality factors	agriculture	3
C83E	**Within the wetlands:**		
C83E	Invasive plants	limited	0.5
C83E	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83E	Altered hydrology (drains/dams)	farm dams	2
C83E	Erosion of wetlands	limited	1
C83F	**Catchment Scale:**		
C83F	Afforestation/Invasive plants	low	0.5
C83F	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83F	Extent of Urbanisation/catchment hardening	some	1.5
C83F	Mining/urban/cropping - water quality factors	agriculture	3
C83F	**Within the wetlands:**		
C83F	Invasive plants	limited	0.5
C83F	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83F	Altered hydrology (drains/dams)	farm dams	2
C83F	Erosion of wetlands	erosion evident	2
C83G	**Catchment Scale:**		
C83G	Afforestation/Invasive plants	low	0.5
C83G	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83G	Extent of Urbanisation/catchment hardening	none	0
C83G	Mining/urban/cropping - water quality factors	agriculture	3
C83G	**Within the wetlands:**		
C83G	Invasive plants	limited	0.5
C83G	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83G	Altered hydrology (drains/dams)	farm dams	2
C83G	Erosion of wetlands	erosion evident	2
C83H	**Catchment Scale:**		
C83H	Afforestation/Invasive plants	low	0.5
C83H	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83H	Extent of Urbanisation/catchment hardening	limited	0.5
C83H	Mining/urban/cropping - water quality factors	agriculture	2
C83H	**Within the wetlands:**		
C83H	Invasive plants	limited	0.5
C83H	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2
C83H	Altered hydrology (drains/dams)	farm dams	2
C83H	Erosion of wetlands	erosion evident	1
C83J	**Catchment Scale:**		
C83J	Afforestation/Invasive plants	low	0.5
C83J	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83J	Extent of Urbanisation/catchment hardening	limited	0.5
C83J	Mining/urban/cropping - water quality factors	agriculture	2
C83J	**Within the wetlands:**		
C83J	Invasive plants	limited	0.5
C83J	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2

Name	Description	Comments	Score (0 - 5)
C83J	Altered hydrology (drains/dams)	farm dams	2
C83J	Erosion of wetlands	erosion evident	1
C83K	**Catchment Scale:**		
C83K	Afforestation/Invasive plants	low	0.5
C83K	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83K	Extent of Urbanisation/catchment hardening	limited	0.5
C83K	Mining/urban/cropping - water quality factors	agriculture	2.5
C83K	**Within the wetlands:**		
C83K	Invasive plants	limited	0.5
C83K	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2.5
C83K	Altered hydrology (drains/dams)	farm dams	2
C83K	Erosion of wetlands	erosion evident	1
C83L	**Catchment Scale:**		
C83L	Afforestation/Invasive plants	low	0.5
C83L	Dams, irrigation, other flow reduction activities	dams, abstraction	2
C83L	Extent of Urbanisation/catchment hardening	limited	0.5
C83L	Mining/urban/cropping - water quality factors	agriculture	2
C83L	**Within the wetlands:**		
C83L	Invasive plants	limited	0.5
C83L	Land use activities (mining-cropping-grazing)	encroachment from agriculture	1.5
C83L	Altered hydrology (drains/dams)	farm dams	2
C83L	Erosion of wetlands	erosion evident	1
C83M	**Catchment Scale:**		
C83M	Afforestation/Invasive plants	low	0.5
C83M	Dams, irrigation, other flow reduction activities	large Vaal Dam	4
C83M	Extent of Urbanisation/catchment hardening	limited	0.5
C83M	Mining/urban/cropping - water quality factors	agriculture	3
C83M	**Within the wetlands:**		
C83M	Invasive plants	limited	0.5
C83M	Land use activities (mining-cropping-grazing)	encroachment from agriculture	2.5
C83M	Altered hydrology (drains/dams)	large Vaal Dam has drowned many wetland areas	4
C83M	Erosion of wetlands	limited	0.5

APPENDIX C: DETAILED QUATERNARY CATCHMENT WETLAND EIS SCORING

The EIS scores are provided below. EIS descriptors are scored as follows:

- Diversity of wetland types: 4 = Very high – 1 = Low)
- Density of wetlands: 4 = Very high - 0 = Low/none)
- Unique wetlands (size; type etc.): 4 = Very high - 0 = None
- Importance of conservation and natural areas: 4 = Very high – 0 = Very low
- Migration route/corridor (links to other systems): 4 = Very high - 0 = None
- Rare/endangered/unique populations: 4 = Very high - 0 = None
- Sensitivity to water quality changes: 4 = Very high – 1 = Marginal/low
- Sensitivity to upstream flow changes: 4 = Very high – 1 = Low
- Dependence on Groundwater: 4 = Very high – 1 = Marginal/low

Name	Descriptor	Comments	Score (1 – 4)
C11A	Diversity of wetland types	pans, seeps, unchannelled and channeled valley bottoms	3.5
C11A	Density of wetlands	High	4
C11A	Unique wetlands (size; type etc.)	large pans	3.5
C11A	Species Richness	high – grassland	3
C11A	Importance of conservation & natural areas	limited formal protection/status	1.5
C11A	Migration route/corridor (links to other systems)	wider distribution of pans is important	2
C11A	Rare/endangered/unique populations	Endangered vegetation type	4
C11A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11A	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11A	Dependence on Groundwater	pans depend on surface and interflow; seeps on interflow	2
C11B	Diversity of wetland types	pans, seeps, unchannelled and channeled valley bottoms	3
C11B	Density of wetlands	High	4
C11B	Unique wetlands (size; type etc.)	large pans	3
C11B	Species Richness	high – grassland	3
C11B	Importance of conservation & natural areas	adjacent to Chrissiesmeer	3
C11B	Migration route/corridor (links to other systems)	link to Chrissiesmeer system	3
C11B	Rare/endangered/unique populations	Endangered vegetation type	4
C11B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11B	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11B	Dependence on Groundwater	pans depend on surface and interflow; seeps on interflow	2
C11C	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms	2
C11C	Density of wetlands	Moderate	3
C11C	Unique wetlands (size; type etc.)	extensive VB wetlands	2
C11C	Species Richness	high – grassland	2.5
C11C	Importance of conservation & natural areas	none known	1
C11C	Migration route/corridor (links to other systems)	Low	1
C11C	Rare/endangered/unique populations	least threatened vegetation type, but avifauna may be important	2
C11C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11C	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11C	Dependence on Groundwater	seeps and some VBs may rely on interflow	1
C11D	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms	2
C11D	Density of wetlands	moderate/low	2
C11D	Unique wetlands (size; type etc.)	some extensive VB wetlands	2
C11D	Species Richness	high - grassland	2

Name	Descriptor	Comments	Score (1 – 4)
C11D	Importance of conservation & natural areas	none known	1
C11D	Migration route/corridor (links to other systems)	low	1
C11D	Rare/endangered/unique populations	least threatened and vulnerable vegetation types, but avifauna may be important	2.5
C11D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11D	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11D	Dependence on Groundwater	seeps and some VBs may rely on interflow	1
C11E	Diversity of wetland types	pans, seeps, unchannelled and channelled valley bottoms, floodplains	3
C11E	Density of wetlands	moderate/low	2.5
C11E	Unique wetlands (size; type etc.)	few pans, meandering floodplain reaches	2.5
C11E	Species Richness	high - grassland	3
C11E	Importance of conservation & natural areas	none known	1
C11E	Migration route/corridor (links to other systems)	wider distribution of pans is important	1
C11E	Rare/endangered/unique populations	Small section of Endangered vegetation type	1.5
C11E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11E	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11E	Dependence on Groundwater	pans depend on surface and interflow; seeps on interflow	2
C11F	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms, isolated pans	2
C11F	Density of wetlands	moderate/low	1.5
C11F	Unique wetlands (size; type etc.)	none evident	1
C11F	Species Richness	high - grassland	2
C11F	Importance of conservation & natural areas	none known,	0.5
C11F	Migration route/corridor (links to other systems)	none known	0.5
C11F	Rare/endangered/unique populations	none known	1
C11F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11F	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11F	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	1
C11G	Diversity of wetland types	pans, seeps, unchannelled and channelled valley bottoms	2.5
C11G	Density of wetlands	moderate/low	2
C11G	Unique wetlands (size; type etc.)	some pans	1.5
C11G	Species Richness	high - grassland	2
C11G	Importance of conservation & natural areas	none known	1
C11G	Migration route/corridor (links to other systems)	none known	0.5
C11G	Rare/endangered/unique populations	vulnerable vegetation type	1.5
C11G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11G	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11G	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C11H	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms	2
C11H	Density of wetlands	moderate/low	2
C11H	Unique wetlands (size; type etc.)	none evident	1
C11H	Species Richness	high - grassland	2
C11H	Importance of conservation & natural areas	none known	1
C11H	Migration route/corridor (links to other systems)	none known	0.5
C11H	Rare/endangered/unique populations	vegetation type endangered	3
C11H	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11H	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2

Name	Descriptor	Comments	Score (1 – 4)
C11H	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C11J	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms	2
C11J	Density of wetlands	moderate/low	2
C11J	Unique wetlands (size; type etc.)	none evident	1
C11J	Species Richness	high - grassland	2
C11J	Importance of conservation & natural areas	none known	1
C11J	Migration route/corridor (links to other systems)	none known	0.5
C11J	Rare/endangered/unique populations	vegetation type endangered	3
C11J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11J	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11J	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C11K	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms, floodplains	3
C11K	Density of wetlands	moderate	2.5
C11K	Unique wetlands (size; type etc.)	some large VB's	2
C11K	Species Richness	high - grassland	2
C11K	Importance of conservation & natural areas	none known	1
C11K	Migration route/corridor (links to other systems)	VB's could be important	1.5
C11K	Rare/endangered/unique populations	Veg type endangered	3
C11K	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11K	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11K	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C11L	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms	2
C11L	Density of wetlands	moderate	2
C11L	Unique wetlands (size; type etc.)	some large VB's	2
C11L	Species Richness	high - grassland	2
C11L	Importance of conservation & natural areas	none known	1
C11L	Migration route/corridor (links to other systems)	VB's could be important	1.5
C11L	Rare/endangered/unique populations	Veg type endangered	3
C11L	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11L	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11L	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C11M	Diversity of wetland types	seeps, unchannelled and channelled valley bottoms, floodplains	3
C11M	Density of wetlands	moderate/low	1.5
C11M	Unique wetlands (size; type etc.)	some large VB's	1.5
C11M	Species Richness	high - grassland	2
C11M	Importance of conservation & natural areas	none known	1
C11M	Migration route/corridor (links to other systems)	none known	1
C11M	Rare/endangered/unique populations	Some Veg is endangered	2
C11M	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C11M	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C11M	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12A	Diversity of wetland types	seeps, valley bottoms	2
C12A	Density of wetlands	moderate	2
C12A	Unique wetlands (size; type etc.)	some large VB's	2
C12A	Species Richness	high - grassland	2

Name	Descriptor	Comments	Score (1 – 4)
C12A	Importance of conservation & natural areas	none known	1
C12A	Migration route/corridor (links to other systems)	none known	1
C12A	Rare/endangered/unique populations	Veg is Vulnerable	1
C12A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C12A	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12A	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12B	Diversity of wetland types	seeps, VBs, floodplain, pans	3
C12B	Density of wetlands	moderate	2
C12B	Unique wetlands (size; type etc.)	some large VB's	2.5
C12B	Species Richness	high - grassland	2
C12B	Importance of conservation & natural areas	none known	1
C12B	Migration route/corridor (links to other systems)	none known	1
C12B	Rare/endangered/unique populations	Veg is Vulnerable	1
C12B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C12B	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12B	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12C	Diversity of wetland types	seeps, VBs, floodplain, pans	3
C12C	Density of wetlands	moderate	2
C12C	Unique wetlands (size; type etc.)	some large pans	3
C12C	Species Richness	high - grassland	2
C12C	Importance of conservation & natural areas	none known	1
C12C	Migration route/corridor (links to other systems)	none known. Pans likely important for avifauna	2
C12C	Rare/endangered/unique populations	Veg is Vulnerable	1
C12C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C12C	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12C	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12D	Diversity of wetland types	seeps, VBs, floodplains	2.5
C12D	Density of wetlands	moderate/low	2
C12D	Unique wetlands (size; type etc.)	none evident	1
C12D	Species Richness	high - grassland	2
C12D	Importance of conservation & natural areas	none known	1
C12D	Migration route/corridor (links to other systems)	none known	0.5
C12D	Rare/endangered/unique populations	Veg type endangered	3
C12D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C12D	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12D	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12E	Diversity of wetland types	seeps, valley bottoms, floodplains	2.5
C12E	Density of wetlands	moderate	2
C12E	Unique wetlands (size; type etc.)	some large VB's	2
C12E	Species Richness	high - grassland	2
C12E	Importance of conservation & natural areas	none known	1
C12E	Migration route/corridor (links to other systems)	VB's could be important	1.5
C12E	Rare/endangered/unique populations	Veg type endangered	3
C12E	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C12E	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12E	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12F	Diversity of wetland types	seeps, pans, valley bottoms, floodplains	3

Name	Descriptor	Comments	Score (1 – 4)
C12F	Density of wetlands	moderate	2
C12F	Unique wetlands (size; type etc.)	some large VB's, large pan	2.5
C12F	Species Richness	high - grassland	2
C12F	Importance of conservation & natural areas	none known	1
C12F	Migration route/corridor (links to other systems)	VB's could be important	1.5
C12F	Rare/endangered/unique populations	Veg type endangered	3
C12F	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C12F	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12F	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12G	Diversity of wetland types	seeps, valley bottoms	2
C12G	Density of wetlands	moderate	3
C12G	Unique wetlands (size; type etc.)	some large VB's on Andesites	3
C12G	Species Richness	high - grassland	2
C12G	Importance of conservation & natural areas	none known	1
C12G	Migration route/corridor (links to other systems)	VB's could be important	1.5
C12G	Rare/endangered/unique populations	Some veg types endangered	2.5
C12G	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C12G	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12G	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12H	Diversity of wetland types	seeps, valley bottoms	2
C12H	Density of wetlands	moderate/low	2
C12H	Unique wetlands (size; type etc.)	none evident	1
C12H	Species Richness	high - grassland	2
C12H	Importance of conservation & natural areas	none known	1
C12H	Migration route/corridor (links to other systems)	VB's could be important	1
C12H	Rare/endangered/unique populations	Some veg types endangered	2
C12H	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C12H	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12H	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12J	Diversity of wetland types	seeps, VBs, floodplain	2
C12J	Density of wetlands	moderate/low	1.5
C12J	Unique wetlands (size; type etc.)	some large VBs	1.5
C12J	Species Richness	high - grassland	2
C12J	Importance of conservation & natural areas	none known	1
C12J	Migration route/corridor (links to other systems)	none known	1
C12J	Rare/endangered/unique populations	Veg is Vulnerable	1
C12J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C12J	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12J	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12K	Diversity of wetland types	seeps, valley bottoms, pan	2.5
C12K	Density of wetlands	moderate	2.5
C12K	Unique wetlands (size; type etc.)	none apparent	1
C12K	Species Richness	high - grassland	2
C12K	Importance of conservation & natural areas	none known	1
C12K	Migration route/corridor (links to other systems)	VB's could be important	1.5
C12K	Rare/endangered/unique populations	Some veg types endangered	2.5
C12K	Sensitivity to water quality changes	grassland wetlands may be sensitive	2

Name	Descriptor	Comments	Score (1 – 4)
C12K	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12K	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C12L	Diversity of wetland types	seeps, valley bottoms, pans	3
C12L	Density of wetlands	moderate/low	2.5
C12L	Unique wetlands (size; type etc.)	none apparent	1
C12L	Species Richness	high - grassland	2
C12L	Importance of conservation & natural areas	none known	1
C12L	Migration route/corridor (links to other systems)	pans likely important for avifauna	2
C12L	Rare/endangered/unique populations	Some veg types endangered	2.5
C12L	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C12L	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C12L	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13A	Diversity of wetland types	seeps, valley bottoms, floodplains	2.5
C13A	Density of wetlands	high/moderate	3.5
C13A	Unique wetlands (size; type etc.)	large vb's	2.5
C13A	Species Richness	high - grassland	2
C13A	Importance of conservation & natural areas	none known	1
C13A	Migration route/corridor (links to other systems)	none known	1
C13A	Rare/endangered/unique populations	Low threat veg types	1.5
C13A	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13A	Sensitivity to upstream flow changes	extensive unchannelled VBs especially sensitive	3
C13A	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13B	Diversity of wetland types	seeps, valley bottoms, floodplains	2.5
C13B	Density of wetlands	high/moderate	3.5
C13B	Unique wetlands (size; type etc.)	large vb's	2.5
C13B	Species Richness	high - grassland	2
C13B	Importance of conservation & natural areas	none known	1
C13B	Migration route/corridor (links to other systems)	none known	1
C13B	Rare/endangered/unique populations	Low threat veg types	1.5
C13B	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13B	Sensitivity to upstream flow changes	extensive unchannelled VBs especially sensitive	3
C13B	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13C	Diversity of wetland types	seeps, valley bottoms, floodplains	3
C13C	Density of wetlands	high	4
C13C	Unique wetlands (size; type etc.)	very large floodplain - Seekoevlei	4
C13C	Species Richness	high - grassland	2
C13C	Importance of conservation & natural areas	high - RAMSAR wetland system	4
C13C	Migration route/corridor (links to other systems)	important for avifauna	3
C13C	Rare/endangered/unique populations	some Endangered veg types	2.5
C13C	Sensitivity to water quality changes	grassland wetlands may be sensitive	3
C13C	Sensitivity to upstream flow changes	floodplain sensitive to flow changes	4
C13C	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13D	Diversity of wetland types	seeps, valley bottoms, floodplains	3
C13D	Density of wetlands	high	4
C13D	Unique wetlands (size; type etc.)	very large floodplain - Seekoevlei	4
C13D	Species Richness	high - grassland	2
C13D	Importance of conservation & natural areas	high - RAMSAR wetland system	4

Name	Descriptor	Comments	Score (1 – 4)
C13D	Migration route/corridor (links to other systems)	important for avifauna	3
C13D	Rare/endangered/unique populations	some Endangered veg types	2.5
C13D	Sensitivity to water quality changes	grassland wetlands may be sensitive	3
C13D	Sensitivity to upstream flow changes	floodplain sensitive to flow changes	4
C13D	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13E	Diversity of wetland types	seeps, valley bottoms, floodplains, pans	3
C13E	Density of wetlands	moderate/low	2.5
C13E	Unique wetlands (size; type etc.)	none known	1
C13E	Species Richness	high - grassland	2
C13E	Importance of conservation & natural areas	none known	1
C13E	Migration route/corridor (links to other systems)	none known	1
C13E	Rare/endangered/unique populations	no endangered veg types	1
C13E	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13E	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C13E	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13F	Diversity of wetland types	seeps, valley bottoms, floodplains	3
C13F	Density of wetlands	moderate	3
C13F	Unique wetlands (size; type etc.)	meandering floodplain	3
C13F	Species Richness	high - grassland	2
C13F	Importance of conservation & natural areas	likely important floodplains for avifauna	2.5
C13F	Migration route/corridor (links to other systems)	none known	1
C13F	Rare/endangered/unique populations	some Endangered veg types	2
C13F	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13F	Sensitivity to upstream flow changes	unchannelled VBs, floodplains are sensitive	2
C13F	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13G	Diversity of wetland types	seeps, valley bottoms, floodplains	3
C13G	Density of wetlands	moderate/low	2.5
C13G	Unique wetlands (size; type etc.)	none known	1
C13G	Species Richness	high - grassland	2
C13G	Importance of conservation & natural areas	none known	1
C13G	Migration route/corridor (links to other systems)	none known	1
C13G	Rare/endangered/unique populations	no endangered veg types	1
C13G	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13G	Sensitivity to upstream flow changes	unchannelled VBs, floodplains are sensitive	2
C13G	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C13H	Diversity of wetland types	seeps, valley bottoms	2.5
C13H	Density of wetlands	moderate	3
C13H	Unique wetlands (size; type etc.)	none known	1
C13H	Species Richness	high - grassland	2
C13H	Importance of conservation & natural areas	none known	1
C13H	Migration route/corridor (links to other systems)	none known	1
C13H	Rare/endangered/unique populations	some Endangered veg types	2
C13H	Sensitivity to water quality changes	grassland wetlands may be sensitive	2
C13H	Sensitivity to upstream flow changes	unchannelled VBs are sensitive	2
C13H	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C21A	Diversity of wetland types	seeps, VBs, floodplains, pans	3
C21A	Density of wetlands	moderate/low	2

Name	Descriptor	Comments	Score (1 – 4)
C21A	Unique wetlands (size; type etc.)	large floodplain reaches	2.5
C21A	Species Richness	high - grassland	2
C21A	Importance of conservation & natural areas	none known	1
C21A	Migration route/corridor (links to other systems)	likely important floodplains for avifauna	2
C21A	Rare/endangered/unique populations	Veg type endangered	3
C21A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21A	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C21A	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C21B	Diversity of wetland types	seeps, VBs, floodplains, pans	3
C21B	Density of wetlands	moderate/low	2
C21B	Unique wetlands (size; type etc.)	large floodplain reaches	2.5
C21B	Species Richness	high - grassland	2
C21B	Importance of conservation & natural areas	none known	1
C21B	Migration route/corridor (links to other systems)	likely important floodplains for avifauna	2
C21B	Rare/endangered/unique populations	Veg type endangered	3
C21B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21B	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C21B	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C21C	Diversity of wetland types	seeps, VBs, floodplains	2.5
C21C	Density of wetlands	moderate/low	2
C21C	Unique wetlands (size; type etc.)	large floodplain reaches	2.5
C21C	Species Richness	high - grassland	2
C21C	Importance of conservation & natural areas	none known	1
C21C	Migration route/corridor (links to other systems)	known importance for birds	2.5
C21C	Rare/endangered/unique populations	Veg type endangered	3
C21C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21C	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C21C	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C21D	Diversity of wetland types	seeps, VBs, pans	3
C21D	Density of wetlands	high/moderate	3
C21D	Unique wetlands (size; type etc.)	large unchannelled VB	3.5
C21D	Species Richness	high - grassland	2
C21D	Importance of conservation & natural areas	Some conservation areas along wetland	2
C21D	Migration route/corridor (links to other systems)	known importance for birds	3
C21D	Rare/endangered/unique populations	Veg types Endangered	3
C21D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21D	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2.5
C21D	Dependence on Groundwater	Very high (Dolomites)	4
C21E	Diversity of wetland types	seeps, VBs, floodplains	3
C21E	Density of wetlands	high/moderate	3
C21E	Unique wetlands (size; type etc.)	large unchannelled VB	3.5
C21E	Species Richness	high - grassland	2
C21E	Importance of conservation & natural areas	Some conservation areas along wetland	2
C21E	Migration route/corridor (links to other systems)	known importance for birds	3
C21E	Rare/endangered/unique populations	Veg types Endangered	3
C21E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21E	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2.5
C21E	Dependence on Groundwater	Very high (Dolomites)	4

Name	Descriptor	Comments	Score (1 – 4)
C21F	Diversity of wetland types	seeps, VBs, floodplains	2.5
C21F	Density of wetlands	low	1.5
C21F	Unique wetlands (size; type etc.)	none known	1
C21F	Species Richness	high - grassland	2
C21F	Importance of conservation & natural areas	none known	1
C21F	Migration route/corridor (links to other systems)	known importance for birds	2
C21F	Rare/endangered/unique populations	Veg types Endangered	3
C21F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21F	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C21F	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C21G	Diversity of wetland types	seeps, VBs, floodplains, pans	3
C21G	Density of wetlands	moderate/low	2
C21G	Unique wetlands (size; type etc.)	none known	1
C21G	Species Richness	high - grassland	2
C21G	Importance of conservation & natural areas	none known	1
C21G	Migration route/corridor (links to other systems)	likely important floodplains for avifauna	1.5
C21G	Rare/endangered/unique populations	Some veg types endangered	2
C21G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C21G	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C21G	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C22A	Diversity of wetland types	VBs, peats,	3
C22A	Density of wetlands	moderate	2.5
C22A	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C22A	Species Richness	high - grassland	2
C22A	Importance of conservation & natural areas	high funcitonal values	3
C22A	Migration route/corridor (links to other systems)	none known	1
C22A	Rare/endangered/unique populations	Some veg types endangered	2
C22A	Sensitivity to water quality changes	high sensitivity	3
C22A	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C22A	Dependence on Groundwater	Very high (Dolomites)	4
C22B	Diversity of wetland types	VBs, peats,	3
C22B	Density of wetlands	moderate	2.5
C22B	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C22B	Species Richness	high - grassland	2
C22B	Importance of conservation & natural areas	high funcitonal values	3
C22B	Migration route/corridor (links to other systems)	none known	1
C22B	Rare/endangered/unique populations	Some veg types endangered	2
C22B	Sensitivity to water quality changes	high sensitivity	3
C22B	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C22B	Dependence on Groundwater	Very high (Dolomites)	4
C22C	Diversity of wetland types	VBs, peats,	3
C22C	Density of wetlands	moderate	2.5
C22C	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C22C	Species Richness	high - grassland	2
C22C	Importance of conservation & natural areas	high funcitonal values	3
C22C	Migration route/corridor (links to other systems)	none known	1
C22C	Rare/endangered/unique populations	Some veg types endangered	2
C22C	Sensitivity to water quality changes	high sensitivity	3

Name	Descriptor	Comments	Score (1 – 4)
C22C	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C22C	Dependence on Groundwater	Very high (Dolomites)	4
C22D	Diversity of wetland types	VBs, peats,	3
C22D	Density of wetlands	moderate	2.5
C22D	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C22D	Species Richness	high - grassland	2
C22D	Importance of conservation & natural areas	high funcitonal values	3
C22D	Migration route/corridor (links to other systems)	none known	1
C22D	Rare/endangered/unique populations	Some veg types endangered	2
C22D	Sensitivity to water quality changes	high sensitivity	3
C22D	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C22D	Dependence on Groundwater	Very high (Dolomites)	4
C22E	Diversity of wetland types	low	1
C22E	Density of wetlands	very low	0.5
C22E	Unique wetlands (size; type etc.)	none known	1
C22E	Species Richness	high - grassland	2
C22E	Importance of conservation & natural areas	none known	1
C22E	Migration route/corridor (links to other systems)	links between Vaal and Klip wetlands	2
C22E	Rare/endangered/unique populations	Veg types Endangered	2
C22E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22E	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22E	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C22F	Diversity of wetland types	pans, VBs, seeps	2.5
C22F	Density of wetlands	very low	0.5
C22F	Unique wetlands (size; type etc.)	none known	1
C22F	Species Richness	high - grassland	2
C22F	Importance of conservation & natural areas	none known	1
C22F	Migration route/corridor (links to other systems)	none known	1
C22F	Rare/endangered/unique populations	Veg types Endangered	2
C22F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22F	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22F	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2
C22G	Diversity of wetland types	vb's, seeps	1.5
C22G	Density of wetlands	moderate/low	2
C22G	Unique wetlands (size; type etc.)	some large vb's	2
C22G	Species Richness	high - grassland	2
C22G	Importance of conservation & natural areas	none known	1
C22G	Migration route/corridor (links to other systems)	none known	1
C22G	Rare/endangered/unique populations	Some Veg types Endangered	2
C22G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22G	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22G	Dependence on Groundwater	possible that groundwater plays a role in some wetlands	2.5
C22H	Diversity of wetland types	VBs, floodplain	2
C22H	Density of wetlands	low	1
C22H	Unique wetlands (size; type etc.)	large VB's	2
C22H	Species Richness	high - grassland	2
C22H	Importance of conservation & natural areas	none known	1
C22H	Migration route/corridor (links to other systems)	none known	1

Name	Descriptor	Comments	Score (1 – 4)
C22H	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C22H	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22H	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22H	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C22J	Diversity of wetland types	VBs, floodplain	2
C22J	Density of wetlands	low	1
C22J	Unique wetlands (size; type etc.)	large VB's	2
C22J	Species Richness	high - grassland	2
C22J	Importance of conservation & natural areas	none known	1
C22J	Migration route/corridor (links to other systems)	none known	1
C22J	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C22J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22J	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22J	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C22K	Diversity of wetland types	VBs, seeps	2
C22K	Density of wetlands	low	1.5
C22K	Unique wetlands (size; type etc.)	none known	0.5
C22K	Species Richness	high - grassland	2
C22K	Importance of conservation & natural areas	none known	1
C22K	Migration route/corridor (links to other systems)	none known	1
C22K	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C22K	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C22K	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C22K	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C23A	Diversity of wetland types	VBs, seeps	2
C23A	Density of wetlands	moderate/low	2
C23A	Unique wetlands (size; type etc.)	none known	0.5
C23A	Species Richness	high - grassland	2
C23A	Importance of conservation & natural areas	none known	1
C23A	Migration route/corridor (links to other systems)	none known	1
C23A	Rare/endangered/unique populations	none known	1
C23A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23A	Sensitivity to upstream flow changes	Valley bottoms - especially unchannelled - would be sensitive	2
C23A	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C23B	Diversity of wetland types	VBs, seeps	2
C23B	Density of wetlands	moderate	2.5
C23B	Unique wetlands (size; type etc.)	none known	0.5
C23B	Species Richness	high - grassland	2
C23B	Importance of conservation & natural areas	none known	1
C23B	Migration route/corridor (links to other systems)	none known	1
C23B	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C23B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23B	Sensitivity to upstream flow changes	Valley bottoms - especially unchannelled - would be sensitive	2
C23B	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C23C	Diversity of wetland types	VBs, seeps, pan	3
C23C	Density of wetlands	moderate	3

Name	Descriptor	Comments	Score (1 – 4)
C23C	Unique wetlands (size; type etc.)	none known	0.5
C23C	Species Richness	high - grassland	2
C23C	Importance of conservation & natural areas	Vredefort Dome area	2.5
C23C	Migration route/corridor (links to other systems)	none known	1
C23C	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C23C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23C	Sensitivity to upstream flow changes	Valley bottoms - especially unchannelled - would be sensitive	2
C23C	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C23D	Diversity of wetland types	VBs, peats,	3
C23D	Density of wetlands	moderate	2.5
C23D	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C23D	Species Richness	high - grassland	2
C23D	Importance of conservation & natural areas	high functional values	2.5
C23D	Migration route/corridor (links to other systems)	none known	1
C23D	Rare/endangered/unique populations	Some veg types endangered	2
C23D	Sensitivity to water quality changes	high sensitivity	3
C23D	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C23D	Dependence on Groundwater	Very high (Dolomites)	4
C23E	Diversity of wetland types	VBs, peats,	3
C23E	Density of wetlands	moderate	2.5
C23E	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C23E	Species Richness	high - grassland	2
C23E	Importance of conservation & natural areas	high functional values	2.5
C23E	Migration route/corridor (links to other systems)	none known	1
C23E	Rare/endangered/unique populations	Some veg types endangered	2
C23E	Sensitivity to water quality changes	high sensitivity	3
C23E	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C23E	Dependence on Groundwater	Very high (Dolomites)	4
C23F	Diversity of wetland types	VBs, peats,	3
C23F	Density of wetlands	high/moderate	3
C23F	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C23F	Species Richness	high - grassland	2
C23F	Importance of conservation & natural areas	high functional values	2.5
C23F	Migration route/corridor (links to other systems)	none known	1
C23F	Rare/endangered/unique populations	Some veg types endangered	2
C23F	Sensitivity to water quality changes	high sensitivity	3
C23F	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C23F	Dependence on Groundwater	Very high (Dolomites)	4
C23G	Diversity of wetland types	VBs, peats,	3
C23G	Density of wetlands	high/moderate	3
C23G	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C23G	Species Richness	high - grassland	2
C23G	Importance of conservation & natural areas	high functional values	2.5
C23G	Migration route/corridor (links to other systems)	none known	1
C23G	Rare/endangered/unique populations	Some veg types endangered	2
C23G	Sensitivity to water quality changes	high sensitivity	3
C23G	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C23G	Dependence on Groundwater	Very high (Dolomites)	4

Name	Descriptor	Comments	Score (1 – 4)
C23H	Diversity of wetland types	VBs, peats,	3
C23H	Density of wetlands	high/moderate	3
C23H	Unique wetlands (size; type etc.)	very large peat wetlands	3.5
C23H	Species Richness	high - grassland	2
C23H	Importance of conservation & natural areas	high functional values	2.5
C23H	Migration route/corridor (links to other systems)	none known	1
C23H	Rare/endangered/unique populations	Some veg types endangered	2
C23H	Sensitivity to water quality changes	high sensitivity	3
C23H	Sensitivity to upstream flow changes	unchannelled VBs especially sensitive	2
C23H	Dependence on Groundwater	Very high (Dolomites)	4
C23J	Diversity of wetland types	un/channelled VBs, seeps	2.5
C23J	Density of wetlands	moderate	2.5
C23J	Unique wetlands (size; type etc.)	large unchannelled VB	2.5
C23J	Species Richness	high - grassland	2
C23J	Importance of conservation & natural areas	none known	1
C23J	Migration route/corridor (links to other systems)	none known	1
C23J	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C23J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23J	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C23J	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C23K	Diversity of wetland types	channelled VBs, seeps	1
C23K	Density of wetlands	low	1
C23K	Unique wetlands (size; type etc.)	none known	1
C23K	Species Richness	high - grassland	2
C23K	Importance of conservation & natural areas	none known	1
C23K	Migration route/corridor (links to other systems)	none known	1
C23K	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C23K	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23K	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C23K	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C23L	Diversity of wetland types	un/channelled VBs, seeps	2.5
C23L	Density of wetlands	moderate	2.5
C23L	Unique wetlands (size; type etc.)	none known	1
C23L	Species Richness	high - grassland	2
C23L	Importance of conservation & natural areas	none known	1
C23L	Migration route/corridor (links to other systems)	none known	1
C23L	Rare/endangered/unique populations	Some Veg types Endangered	2
C23L	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C23L	Sensitivity to upstream flow changes	not likely to be very sensitive	1
C23L	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C81A	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3.5
C81A	Density of wetlands	high	4
C81A	Unique wetlands (size; type etc.)	large floodplain reaches	3
C81A	Species Richness	high - grassland	2
C81A	Importance of conservation & natural areas	NB birding areas	2
C81A	Migration route/corridor (links to other systems)	none known	1
C81A	Rare/endangered/unique populations	Veg type Endangered, endangered avifauna	4
C81A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2

Name	Descriptor	Comments	Score (1 – 4)
C81A	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81A	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C81B	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3.5
C81B	Density of wetlands	moderate	3
C81B	Unique wetlands (size; type etc.)	none known	1
C81B	Species Richness	high - grassland	2
C81B	Importance of conservation & natural areas	NB birding areas	2
C81B	Migration route/corridor (links to other systems)	none known	1
C81B	Rare/endangered/unique populations	Veg type Endangered, endangered avifauna	3.5
C81B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81B	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81B	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C81C	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3
C81C	Density of wetlands	moderate	3
C81C	Unique wetlands (size; type etc.)	none known	1
C81C	Species Richness	high - grassland	2
C81C	Importance of conservation & natural areas	none known	1
C81C	Migration route/corridor (links to other systems)	none known	1
C81C	Rare/endangered/unique populations	Veg type Endangered	2
C81C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81C	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81C	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C81D	Diversity of wetland types	un/channelled VBs, seeps,	2
C81D	Density of wetlands	moderate	3
C81D	Unique wetlands (size; type etc.)	none known	1
C81D	Species Richness	high - grassland	2
C81D	Importance of conservation & natural areas	protected area (Nature Reserve)	2
C81D	Migration route/corridor (links to other systems)	none known	1
C81D	Rare/endangered/unique populations	Veg type Endangered	2
C81D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81D	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81D	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	3
C81E	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3
C81E	Density of wetlands	moderate/low	2
C81E	Unique wetlands (size; type etc.)	none known	1
C81E	Species Richness	high - grassland	2
C81E	Importance of conservation & natural areas	none known	1
C81E	Migration route/corridor (links to other systems)	none known	1
C81E	Rare/endangered/unique populations	Veg type Endangered	2
C81E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81E	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81E	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C81F	Diversity of wetland types	un/channelled VBs, seeps	2
C81F	Density of wetlands	moderate/low	2
C81F	Unique wetlands (size; type etc.)	none known	1
C81F	Species Richness	high - grassland	2
C81F	Importance of conservation & natural areas	none known	1

Name	Descriptor	Comments	Score (1 – 4)
C81F	Migration route/corridor (links to other systems)	none known	1
C81F	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81F	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81F	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81G	Diversity of wetland types	un/channelled VBs, seeps	2
C81G	Density of wetlands	moderate/low	2
C81G	Unique wetlands (size; type etc.)	none known	1
C81G	Species Richness	high - grassland	2
C81G	Importance of conservation & natural areas	none known	1
C81G	Migration route/corridor (links to other systems)	none known	1
C81G	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81G	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81G	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81H	Diversity of wetland types	un/channelled VBs, seeps, pans, floodplains	3.5
C81H	Density of wetlands	moderate/low	2
C81H	Unique wetlands (size; type etc.)	none known	1
C81H	Species Richness	high - grassland	2
C81H	Importance of conservation & natural areas	none known	1
C81H	Migration route/corridor (links to other systems)	none known	1
C81H	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81H	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81H	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81H	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81J	Diversity of wetland types	un/channelled VBs, seeps, pans, floodplains	3.5
C81J	Density of wetlands	moderate/low	2
C81J	Unique wetlands (size; type etc.)	none known	1
C81J	Species Richness	high - grassland	2
C81J	Importance of conservation & natural areas	none known	1
C81J	Migration route/corridor (links to other systems)	none known	1
C81J	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81J	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81J	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81K	Diversity of wetland types	un/channelled VBs, seeps, pans, floodplains	3.5
C81K	Density of wetlands	moderate/low	2
C81K	Unique wetlands (size; type etc.)	some large pans	2
C81K	Species Richness	high - grassland	2
C81K	Importance of conservation & natural areas	none known	1
C81K	Migration route/corridor (links to other systems)	none known	1
C81K	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81K	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81K	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81K	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81L	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3
C81L	Density of wetlands	moderate/low	2

Name	Descriptor	Comments	Score (1 – 4)
C81L	Unique wetlands (size; type etc.)	none known	1
C81L	Species Richness	high - grassland	2
C81L	Importance of conservation & natural areas	none known	1
C81L	Migration route/corridor (links to other systems)	none known	1
C81L	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81L	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81L	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81L	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C81M	Diversity of wetland types	un/channelled VBs, seeps,	2.5
C81M	Density of wetlands	moderate/low	1.5
C81M	Unique wetlands (size; type etc.)	none known	1
C81M	Species Richness	high - grassland	2
C81M	Importance of conservation & natural areas	none known	1
C81M	Migration route/corridor (links to other systems)	none known	1
C81M	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C81M	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C81M	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C81M	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C82A	Diversity of wetland types	un/channelled VBs, seeps, floodplains	3
C82A	Density of wetlands	moderate/low	2
C82A	Unique wetlands (size; type etc.)	none known	1
C82A	Species Richness	high - grassland	2
C82A	Importance of conservation & natural areas	none known	1
C82A	Migration route/corridor (links to other systems)	none known	1
C82A	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C82A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82A	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82A	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C82B	Diversity of wetland types	un/channelled VBs, seeps,	2.5
C82B	Density of wetlands	moderate/low	1.5
C82B	Unique wetlands (size; type etc.)	none known	1
C82B	Species Richness	high - grassland	2
C82B	Importance of conservation & natural areas	none known	1
C82B	Migration route/corridor (links to other systems)	none known	1
C82B	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C82B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82B	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82B	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C82C	Diversity of wetland types	un/channelled VBs, seeps,	2
C82C	Density of wetlands	moderate/low	2
C82C	Unique wetlands (size; type etc.)	none known	1
C82C	Species Richness	high - grassland	2
C82C	Importance of conservation & natural areas	none known	1
C82C	Migration route/corridor (links to other systems)	none known	1
C82C	Rare/endangered/unique populations	Veg type Endangered	2.5
C82C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82C	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2

Name	Descriptor	Comments	Score (1 – 4)
C82C	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C82D	Diversity of wetland types	un/channelled VBs, seeps, pans	3
C82D	Density of wetlands	moderate/low	2
C82D	Unique wetlands (size; type etc.)	some pans	1.5
C82D	Species Richness	high - grassland	2
C82D	Importance of conservation & natural areas	none known	1
C82D	Migration route/corridor (links to other systems)	none known	1
C82D	Rare/endangered/unique populations	Veg type Endangered, pans likely important for avifauna	3
C82D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82D	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82D	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C82E	Diversity of wetland types	un/channelled VBs, seeps, small pans	2.5
C82E	Density of wetlands	moderate/low	2
C82E	Unique wetlands (size; type etc.)	none known	1
C82E	Species Richness	high - grassland	2
C82E	Importance of conservation & natural areas	none known	1
C82E	Migration route/corridor (links to other systems)	none known	1
C82E	Rare/endangered/unique populations	Veg types Endangered	2
C82E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82E	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82E	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C82F	Diversity of wetland types	un/channelled VBs, seeps	2
C82F	Density of wetlands	moderate	3
C82F	Unique wetlands (size; type etc.)	some large vb's	2
C82F	Species Richness	high - grassland	2
C82F	Importance of conservation & natural areas	none known	1
C82F	Migration route/corridor (links to other systems)	none known	1
C82F	Rare/endangered/unique populations	Some Veg types Endangered	1.5
C82F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82F	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82F	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C82G	Diversity of wetland types	un/channelled VBs, seeps	2
C82G	Density of wetlands	moderate	3
C82G	Unique wetlands (size; type etc.)	some large vb's	2
C82G	Species Richness	high - grassland	2
C82G	Importance of conservation & natural areas	none known	1
C82G	Migration route/corridor (links to other systems)	none known	1
C82G	Rare/endangered/unique populations	Some Veg types Endangered	1
C82G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C82G	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C82G	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C82H	Diversity of wetland types	un/channelled VBs, seeps	1.5
C82H	Density of wetlands	moderate/low	1.5
C82H	Unique wetlands (size; type etc.)	none known	1
C82H	Species Richness	high - grassland	2
C82H	Importance of conservation & natural areas	none known	1

Name	Descriptor	Comments	Score (1 – 4)
C82H	Migration route/corridor (links to other systems)	none known	1
C82H	Rare/endangered/unique populations	No Veg type Endangered	0.5
C82H	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	1
C82H	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	1.5
C82H	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C83A	Diversity of wetland types	un/channelled VBs, seeps	1.5
C83A	Density of wetlands	moderate/low	1.5
C83A	Unique wetlands (size; type etc.)	none known	1
C83A	Species Richness	high - grassland	2
C83A	Importance of conservation & natural areas	none known	1
C83A	Migration route/corridor (links to other systems)	none known	1
C83A	Rare/endangered/unique populations	Veg type Endangered	2
C83A	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	1
C83A	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83A	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C83B	Diversity of wetland types	un/channelled VBs, seeps	1.5
C83B	Density of wetlands	moderate/low	1.5
C83B	Unique wetlands (size; type etc.)	none known	1
C83B	Species Richness	high - grassland	2
C83B	Importance of conservation & natural areas	none known	1
C83B	Migration route/corridor (links to other systems)	none known	1
C83B	Rare/endangered/unique populations	Veg type Endangered	2
C83B	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	1
C83B	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83B	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C83C	Diversity of wetland types	un/channelled VBs, seeps, pans	3
C83C	Density of wetlands	moderate/low	1.5
C83C	Unique wetlands (size; type etc.)	none known	1
C83C	Species Richness	high - grassland	2
C83C	Importance of conservation & natural areas	none known	1
C83C	Migration route/corridor (links to other systems)	none known	1
C83C	Rare/endangered/unique populations	Veg type Endangered	2
C83C	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	1
C83C	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83C	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C83D	Diversity of wetland types	un/channelled VBs, seeps	2
C83D	Density of wetlands	moderate/low	1.5
C83D	Unique wetlands (size; type etc.)	none known	1
C83D	Species Richness	high - grassland	2
C83D	Importance of conservation & natural areas	none known	1
C83D	Migration route/corridor (links to other systems)	none known	1
C83D	Rare/endangered/unique populations	Veg type Endangered	2
C83D	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	1
C83D	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83D	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	2
C83E	Diversity of wetland types	un/channelled VBs, seeps, pans	3
C83E	Density of wetlands	moderate/low	2

Name	Descriptor	Comments	Score (1 – 4)
C83E	Unique wetlands (size; type etc.)	some pans	1.5
C83E	Species Richness	high - grassland	2
C83E	Importance of conservation & natural areas	none known	1
C83E	Migration route/corridor (links to other systems)	none known	1
C83E	Rare/endangered/unique populations	Veg type Endangered	2.5
C83E	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83E	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83E	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1
C83F	Diversity of wetland types	un/channelled VBs, seeps, small pans	3
C83F	Density of wetlands	moderate/low	2
C83F	Unique wetlands (size; type etc.)	numerous pans	2
C83F	Species Richness	high - grassland	2
C83F	Importance of conservation & natural areas	none known	1
C83F	Migration route/corridor (links to other systems)	none known	1
C83F	Rare/endangered/unique populations	Some Veg types Endangered, pans likely important for avifauna	3
C83F	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83F	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83F	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83G	Diversity of wetland types	un/channelled VBs, seeps, small pans	2.5
C83G	Density of wetlands	moderate/low	2
C83G	Unique wetlands (size; type etc.)	some pans	1.5
C83G	Species Richness	high - grassland	2
C83G	Importance of conservation & natural areas	none known	1
C83G	Migration route/corridor (links to other systems)	none known	1
C83G	Rare/endangered/unique populations	Some Veg types Endangered, pans likely important for avifauna	3
C83G	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83G	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83G	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83H	Diversity of wetland types	un/channelled VBs, seeps,	2
C83H	Density of wetlands	moderate/low	2
C83H	Unique wetlands (size; type etc.)	none known	1
C83H	Species Richness	high - grassland	2
C83H	Importance of conservation & natural areas	none known	1
C83H	Migration route/corridor (links to other systems)	none known	1
C83H	Rare/endangered/unique populations	No Veg types Endangered	1
C83H	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83H	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83H	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83J	Diversity of wetland types	un/channelled VBs, seeps,	2
C83J	Density of wetlands	moderate/low	2
C83J	Unique wetlands (size; type etc.)	none known	1
C83J	Species Richness	high - grassland	2
C83J	Importance of conservation & natural areas	none known	1
C83J	Migration route/corridor (links to other systems)	none known	1
C83J	Rare/endangered/unique populations	No Veg types Endangered	1
C83J	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2

Name	Descriptor	Comments	Score (1 – 4)
C83J	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83J	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83K	Diversity of wetland types	un/channelled VBs, seeps, pans	3
C83K	Density of wetlands	moderate/low	2
C83K	Unique wetlands (size; type etc.)	some pans	2
C83K	Species Richness	high - grassland	2
C83K	Importance of conservation & natural areas	none known	1
C83K	Migration route/corridor (links to other systems)	none known	1
C83K	Rare/endangered/unique populations	No Veg types Endangered	1
C83K	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83K	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83K	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83L	Diversity of wetland types	un/channelled VBs, seeps, pans	2.5
C83L	Density of wetlands	moderate/low	2
C83L	Unique wetlands (size; type etc.)	some large VB's	2
C83L	Species Richness	high - grassland	2
C83L	Importance of conservation & natural areas	none known	1
C83L	Migration route/corridor (links to other systems)	none known	1
C83L	Rare/endangered/unique populations	No Veg types Endangered	1
C83L	Sensitivity to water quality changes	grassland wetlands may be moderately sensitive	2
C83L	Sensitivity to upstream flow changes	unchannelled VB's very sensitive	2
C83L	Dependence on Groundwater	likely that groundwater plays a role in some wetlands	1.5
C83M	Diversity of wetland types	dam, VBs, seeps	1
C83M	Density of wetlands	low - most drowned out by dam	1
C83M	Unique wetlands (size; type etc.)	none known	1
C83M	Species Richness	high - grassland	2
C83M	Importance of conservation & natural areas	wetlands important to trap sediments from tribs before entering dam	2
C83M	Migration route/corridor (links to other systems)	none known	1
C83M	Rare/endangered/unique populations	Could be important for birds	2
C83M	Sensitivity to water quality changes	not likely to be very sensitive	1
C83M	Sensitivity to upstream flow changes	adjusted	1
C83M	Dependence on Groundwater	not likely	0

APPENDIX D: MINUTES OF THE WETLANDS PRIORITISATION WORKSHOP

DWAF

Vaal Wetlands Prioritisation Workshop

14 November 2007: Project No : 8820

MINUTED BY GOLDER AND ASSOCIATES

ACTION

1. Welcome

Barbara Weston welcomed all attendees present and invited all to introduce themselves. The Agenda was tabled without any changes.

2. Attendance and Apologies

Attendance register attached.

Apologies:

Anet Muir	Valerie du Plessis
David Lindley	Dawie Koekemoer
Delana Louw	Delia Marius
Gerda Venter	Hermien Roux
Johan Engelbrecht	John Dini
Magda Ligthelm	Naomi Fourie
Neels Kleynhans	Ralph Heath
Rianna Munnik	Shael Koekemoer
Willem Grobler	

3. Background to the Vaal Comprehensive Reserve Project – Retha Stassen

Questions/comments

R Stassen confirmed that Reserve determination in Inkomati Rivers do not include wetlands.

4. Wetland Reserve determination background – Jackie Jay

Questions/comments

Criteria list must be added to if needed.

5. Wetlands of the Upper Vaal – Mark Rountree

M Rountree outlined the desktop prioritisation process:

1. Aims and objectives
2. Scale of study
3. Collate data
4. Identify wetlands and if possible types of wetlands
5. Develop prioritisation criteria – prioritisation for management and RDM planning

6a. Develop candidate list, e.g.
Gerhard Minnebron and Boovenste Oog - Peat wetlands
Blesbokspruit – Ramsar site, important birding area
Blaauw Pan system – area surrounding the pans is rapidly urbanising, IWULA
Conservation/rehabilitation
Klip River Wetland, Gauteng – functional importance

ACTION

Seekoeivlei – Ramsar site, rare in terms of size and type and bird diversity
Chrissiesmeer Lake, Mpumalanga – unique density and sizes of pans (320)

6b. Prioritize wetland areas

Questions/Comments

In terms of ranking and most important in terms of rarity – catchment list per province/region – suggest to use Vaal as a pilot with a high level weighting system.

Include Suikerbosrand system / river floodplain complex in Upper Vaal.

N Collins requested that environmental drivers such as evaporation/effect of rainfall and altitude be included in eco-regions, especially in the Free State area.

Eco-regions will be categorised at Level 2.

EIS tables are currently based on Gary Marneweck's tables, however these will be verified and updated.

6. Wetlands of the Middle and Lower Vaal – Danie Otto

Questions/comments

It was proposed to consult an Ornithologist regarding a list of important bird populations. D Otto to contact Mark Anderson in this regard. — D Otto

A Lintström noted that the different approach being adopted in the Middle and Lower Vaal to that in the Upper Vaal (excluding wetlands intercepting with rivers) could mean that important wetlands are missed. He proposed continued consultation with river guys.

Fauna and Flora biodiversity – A Lintström said that in addition to red data species, it was necessary to also focus on unique population species that may indicate an area of refuse for species.

A Lintström questioned the reason for Gerrard Minnebron being listed as a priority even though the wetland has already been mined out. B Weston pointed out that a directive has been issued and that further mining is not allowed in the wetland. The aim is to try to preserve and rehabilitate the wetland. J.Jay said that this wetland still provides an opportunity to give input on how to manage the wetland even though the peat has been taken out.

P Muller - Connectivity of a wetland must be considered.

N Collins proposed the use of Ramsar criteria and then scale down.

Overlay maps – be aware of shift / distortion

7. Prioritisation method for Wetlands in the Vaal Catchment – Mark Rowntree/Danie Otto

The current criteria list used for prioritising for Lower, Middle and Upper Vaal is based on three categories, i.e. Reserved determination, rehabilitation and conservation.

Identify prioritisation criteria
Develop a candidate list of priority wetlands
Prioritising wetlands

7.1 Questions to ask for RDM methods:

Connectivity – separate downstream users, other wetlands (groundwater and surface water)

Groundwater linkages

Desktop PES – high EIS/PES, high priority

ACTION

Socio economic

Function of wetland
- Social
- Cultural
- Ecological
- Hydrological

Conservation status/biodiversity value (habitat refuse)

Size

Type of wetland

Vulnerable
Sensitive habitat, biota
Resilience to impact
Current/proposed resource use/threats

Research value

RAMSAR status

Rehabilitation – current or future

Explicit migratory corridors (connectivity)
- Hydro and ecological

EMP

Surrounding/adjacent land use practises

Notes

In glossary explain regarding terms such as resilient and sensitivity.

More sensitive wetlands score higher, however the score must be linked to impact.

N Collins suggested to separate wetlands per natural wetlands vs degraded wetlands.

Agreed that a first step should be a high level decision support system which is then further unpacked.

The group used the scoring system proposed to compare the Blaauw Pan System and Gerhard Minnebron.
The following comments/suggestions were noted:

It is important to substantiate reasoning behind scorings (comments for every decision)
How information is analysed is important – some subjective assessment is needed.
PES/EIS must be weighted highest and scored with functionality and threats.
Score each section separately.

7.2 List of Wetlands

Upper Vaal

Blesbokspruit – RAMSAR status

Klip River wetland – low ecological status, high functionality, flood retention, water quality.

Suikerbos floodplain complex – peat wetlands

Blaaupan and Gerhard Minnebron – WULA applications pending

Add the following wetlands to the list for the Upper Vaal:
Vanger peat wetland - white winged fluff tails, currently good PES (near pristine).
Murphy's Rust – white winged fluff tail, currently good PES
Braamhoek – breeding wattled crane, fluff tail, peat wetland. Question around environmental flows from the dam.

Middle Vaal

Remove Wonderfonteinspruit and add to Upper Vaal.

Lower Vaal

Kuruman – check, may have World Heritage status.

		ACTION
	D Otto will send a list of additional sites to be added to M Rowntree.	D Otto

8. Closure

A draft report will be sent to everyone for their review and comment. A Linstrom and N Collins undertook to forward relevant information on wetlands to J Jay for consideration in preparation of the document.

B Weston thanked everyone for their input to the workshop.

There being no further matters to discuss, the meeting adjourned at 16h00.

DATE:
SIGNATURE:

_____

B. WESTON
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
RESOURCE DIRECTED MEASURES

VAAL WETLANDS PRIORITISATION WORKSHOP
14 November 2007
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