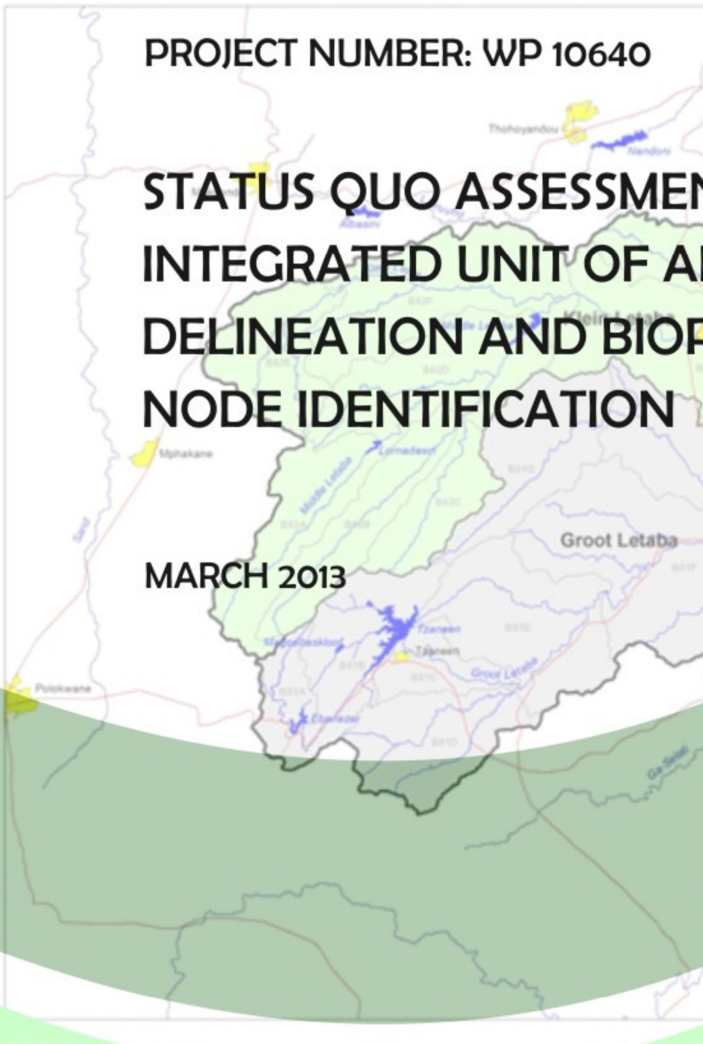
IMPLEMENTATION OF THE WATER RESOURCES CLASSIFICATION SYSTEM AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES FOR SIGNIFICANT WATER RESOURCES IN THE LETABA CATCHMENT



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STATUS QUO ASSESSMENT, INTEGRATED UNIT OF ANALYSIS DELINEATION AND BIOPHYSICAL NODE IDENTIFICATION

MARCH 2013

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DEPARTMENT OF WATER AFFAIRS AND FORESTRY

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES IN THE LETABA CATCHMENT

STATUS QUO ASSESSMENT, IUA AND BIOPHYSICAL NODE DELINEATION AND IDENTIFICATION

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DEPARTMENT OF WATER AFFAIRS AND FORESTRY
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES IN THE LETABA CATCHMENT

STATUS QUO ASSESSMENT, IUA AND BIOPHYSICAL NODE DELINEATION AND IDENTIFICATION: DRAFT

Report Number: RDM/WMA02/00/CON/CLA/0113

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EXECUTIVE SUMMARY

INTRODUCTION

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba River catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study with support from various specialist consultancies as outlined in DWA (2013 – Section 8).

The purpose of this report is to describe and document the status quo task which includes various components such as water use, economy, river and wetland ecology, identifying water quality problems and Ecosystem Goods, Services and Attributes (EGSA). This information was used to define the IUAs and provide background information to assist with the catchment visioning process. Once the IUAs are delineated, Resource Units (RUs) and biophysical nodes must be identified for different levels of EWR assessment and setting of RQOs.

WATER RESOURCES STATUS QUO ASSESSMENT

The Letaba River Catchment was divided into water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. Each of the water resources zones was assessed.

In the last quarter of 2011 the DWA commissioned the Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System where both the WRYM hydrological database and the system configuration will be updated based in the latest available information. As part of the updating process, the WRYM model will be disaggregated to the resolution required by this study.

The Groot Letaba sub-system is a major contribution to the hydrology of the whole Letaba catchment and it is where the main economic activity takes place. The Letaba River runs from the mountainous Haenertsburg area stretching down to its confluence with the Klein Letaba River. Major dams include the Dap Naude, Ebenezer, Magoebaskloof, Tzaneen and Thabina Dams. Dense forestation have been established in the upper parts of the catchment and the intensive irrigated agriculture on the banks of the Groot Letaba River upstream of the Kruger National Park (KNP) are the major water users in the area.

The Middle and Klein Letaba River sub-systems can be classified as predominantly rural with a strong bias towards agriculture and retail. The Middle Letaba River valley as well as the middle reaches of the Klein Letaba River and its tributary, the Nsama River, has been extensively developed in terms of irrigation. Forestry is also present in the upper high rainfall areas of both the Middle Letaba and Klein Letaba river catchments. The major dams in this sub-system include the Middle Letaba Dam and Nsami Dam.

The Lower Letaba sub-system stretches from the confluence of the Klein and Groot Letaba Rivers to the confluence to the Olifants River just upstream of the border with Mozambique. The KNP covers almost the entire sub-system.

The overarching water supply situation in the Letaba River system is that the water requirements exceed the available water resources to the extent that further developments are being planned for implementation over the next five to ten years (These developments include construction of the transfer pipeline from Nandoni Dam in the Luvhvhu River to augment Giyani, the raising of Tzaneen Dam, construction of the Nwamitwa Dam, groundwater resource developments and implementing associated distribution infrastructure). Relevant scenarios relating to the current and future operation of these new developments will be considered in the formulation of scenarios for analysis in further tasks of this study.

WATER QUALITY ISSUES

Undesirable levels of water quality not only impact negatively on irrigation crop yields and quality and have an adverse impact on industrial water use, but also impact negatively on aquatic ecosystems, thereby degrading the very resource that so many services are dependent on. Bringing the quality of the water to acceptable levels for specific users can also be a costly process. The first step in the Classification process is evaluating the Status Quo of water quality across the catchment, for which an evaluation of land use is necessary.

Land use in the Letaba catchment consists largely of nature conservation in the form of national, provincial and private nature reserves and forest reserves. The primary land use along the rivers is citrus and sub-tropical fruit production, with grazing in the less fertile sandy loam soils. Removal of the vegetative cover by overgrazing has led to erosion in some places, resulting in an increased sediment load in the rivers. The main industrial development points are at Tzaneen (along the Groot Letaba River downstream of Tzaneen Dam), Nkowankowa and Giyani, with a number of sewage works spread throughout the catchment. Approximately 80 to 90% of the population can be considered as rural, scattered throughout the WMA. A large proportion of the population depends on subsistence farming. Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment, upstream and downstream of the Middel Letaba Dam, and particularly along the Groot Letaba and Letsitele rivers. Land use in the catchment upstream of the Middel Letaba Dam is characterized by irrigated crop farming where tomato is the major crop.

There is little industrial or mining development in the catchment. Northern Canners at Politisi and the industrial complex at Nkowankowa near Tzaneen are the prominent major industries.

An extensive literature survey and review of Reserve data available to the study, has identified the following water quality hotspots, i.e. areas where water quality impacts range from large to serious. No critical water quality hotspot areas were identified. These are listed below:

- Poorly functioning WWTWs with concomitant impacts on elevated nutrients, salts and algal growth. These are in particular the Ga-Kgapene WWTW (Molototsi River; SQ B81G-00164); Modjadjiskloof-Duiwelskloof WWTW (Brandboontjies River; SQ B82C-00175); Lenyenye WWTW (Thabina River; SQ B81D-00277) and Giyani WWTW (Klein Letaba River; SQ B82G-00135) (Refer to Chapter 7 for an explanation of the Sub Quaternary or SQ reaches).
- The extensive agricultural area of the Middel Letaba River, particularly upstream of Middel Letaba Dam, resulting in elevated nutrients, salts, algal growth and herbicides/fertilizers. Commercial fruit farms are fed by the Middel Letaba Canal Irrigation Scheme. Note that the tomato-growing area is on the upper section of the SQ due to high rainfall conditions. Location of the biophysical nodes will account for the spatial variability in water quality along the SQ.

- Citrus plantations, particularly on the Groot Letaba downstream from Die Eiland and the Letsitele River (at Letsitele Tank), with increases in nutrients, salts, algal growth and herbicides/fertilizers.

STATUS QUO OF THE ECONOMY

The economic significance of water uses in the Letaba Catchment is dominated by irrigated agriculture and commercial forestry.
The following are the major economic sectors in the Letaba Basin:

- Irrigated agriculture.
- Commercial forestry.
- Industry – fruit processing and timber saw mills; and
- Eco-tourism.

The Letaba Catchment has four distinct socio-economic characteristics:

- The high commercial forestry and irrigated agriculture with high value crops such as citrus, avocados and bananas situated in the headwaters of the Greater Letaba Catchment including its tributaries like the Letsitele River. The catchment also has agro-industries such as canning and juice plants.
- The irrigated agriculture upstream of the Middle Letaba Dam, where nearly 50% of the country's tomatoes are produced.
- The residential areas in the Klein Letaba catchment which are mainly rural and the urban areas in the Groot Letaba; and
- The eco-tourism sector which is situated above the Tzaneen Dam and in the lower reaches of the Groot Letaba River and below the confluence with the Klein Letaba River into the Kruger National Park.

ECOLOGICAL GOODS, SERVICES AND ATTRIBUTES (EGSA) STATUS QUO

EGSA are the goods and services provided by the river (and associated ecological systems) that result in a value being produced for consumers. Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, medicine, etc., that are in many cases directly consumed. Other services include cultural services (ritual use of rivers, aesthetic or historical importance), regulating services (e.g. water quality inputs), and supporting services (e.g. nutrient formation).

The study area is located in a region that is largely rural in nature with a number of regionally important urban nodes and smaller satellite towns, as well as rural settlements. Based on the status quo analysis the catchment has been divided into zones that reflect the EGSA as a direct dependent of land use. For the purposes of this catchment five different land use forms that reflect types of goods and services that might be associated with the usage have been identified. The land use based zones are:

- Commercial Agriculture and Plantation: This is largely given over to zones dominated by commercial farming entities. Utilisation of ecological goods and services tends to be low and restricted often to farm workers or incidental recreational aspects.
- Subsistence agriculture: These areas are dominated by subsistence agriculture but in areas where population densities are relatively low. Utilisation of ecological goods and services tends to be higher here and the populations that make use are often poor and marginal.
- Rural Closer Settlement – Subsistence: These are the former homeland areas that have generally higher population densities than the purely subsistence areas. In some instance

densities are high enough to be categorised as closer settlement/informal urban. Utilisation of ecological goods and services tends to be higher here and the populations that make use are often poor and marginal. However, the population densities are such that resources tend to be under pressure.

- High Density Formal Urban: These are the SQs heavily influenced by the town of Tzaneen. The utilisation of ecological goods and services tends to be low as the populations tend to be urbanised and alienated from direct use of the resources.
- Recreational/Dams/Game Farms. These are areas given over to game farms (notably the Kruger Park) as well as SQs dominated by dams. Recreational usage tends to dominate ecological goods and services attributes.

ECOLOGICAL STATUS QUO: RIVERS

A desktop analysis was undertaken to determine the ecological status quo (otherwise referred to as the Present Ecological State (PES)) of 75 river reaches covering the Letaba catchment. The PES is described in terms of Ecological Categories (EC) of A to F with A being almost natural and F meaning critically modified. Reasons for the change from natural are provided and what is especially important, is whether these are flow (eg abstraction) or non-flow (e.g. riparian vegetation removal or land use practices) related.

The Letaba catchment is characterised by large dams, of which the majority are concentrated in the upper reaches of the Letaba, irrigation of mainly orchards, rural settlements and subsistence agriculture (with the often associated overgrazing, trampling and erosion) and the conservation areas at the lower end (Kruger National Parks and Letaba Ranch). Flow modification in terms of decreased flows is one of the most severe impacts (Letaba, Klein and Middel Letaba Rivers)

The main impacts upstream of Tzaneen Dam are related to forestry, abstraction, dams and their barrier effect, alien vegetation and irrigation.

The Letsitele River's PES varies from a B (near natural) Ecological Category (EC) (at the source) to a D (Largely modified) EC for most of the rest of the river. This is mainly due to the presence of many tributary dams, irrigation, settlements and abstraction. The Thabina tributary is also in a D PES, but it must be noted that the source zone and some other small sections are in a much better state than a D PES.

Two of the north east flowing tributaries are in a B PES as they both flow through private conservation areas.

The Middel and Klein Letaba Rivers are, outside of conservation areas, mostly in a D and C PES. The PES is mostly due to many dams (main river and mostly tributaries), irrigation and the presence of large settlements. Two of the rivers are in an E PES and the reasons for this are:

- Intensive irrigation and many dams present throughout the whole reach.
- Presence of a large dam in the reach which impacts on instream continuity and contributes to flow modification. There are also extensive canal systems present in this reach.

The lower section of the river in the conservation areas are a mix of mostly A PES for those rivers with their source and whole length of river in the conservation area, and a C PES for the main Letaba River. In these reaches the main Letaba River bears the brunt of all the severe utilisation of the water resources outside of the conservation areas, as well as sedimentation which impacts on the channel. In effect, the river is physically much smaller than natural within a very large macro channel which is maintained by the low frequency large floods that still come through.

ECOLOGICAL STATUS QUO: WETLANDS

All SQs that achieved a score of 3 (potential wetland importance due to frequency of occurrence) or contained a FEPA wetland were assessed for PES using a combination of Google Earth © (used mainly for verification of NFEPA data and impacts) and the Wetland IHI (DWAF, 2007) where wetlands were floodplain or channelled valley-bottom wetlands.

The PES score represents an average score for wetlands associated with the SQ and is generally a C or D PES. The most common problem that has caused the PES is vegetation removal.Wetlands in the Tsende River (B83B-00161) have an A/B PES and are well conserved within the KNP. Many of these wetlands (predominantly channelled valley-bottom wetlands) are associated with tributaries in B83C.

IUAs

An IUA is a broad scale unit (or catchment area) that contains several biophysical nodes. These nodes define at a detail scale specific attributes which together describe the catchment configuration of the IUA. Scenarios are assessed within the IUA and relevant implications in terms of the Management Classes are provided for each IUA.

The identification and selection of the Integrated Units of Analysis (IUAs) were based on the following considerations:

- The resolution of the hydrological analysis and available water resource network configurations currently being modelled.
- Location of significant water resource infrastructure.
- Distinctive functions of the catchments in context of the larger system.
- Available budget for refinement of the existing network and undertaking scenario analysis of each IUA. The Present Ecological State (PES) of each biophysical node was considered as well the type of impacts and the homogeneity of the state and impacts.

The following IUAs were delineated in the Letaba Catchment:

IUA 1: Letaba upstream of Tzaneen Dam.
IUA 2: Letsitele and Thabina.
IUA 3: Letaba downstream of Tzaneen Dam to the proposed Nwamitwa Dam.
IUA 4: Letaba from proposed Nwamitwa Dam to Klein Letaba confluence.
IUA 5: Southern tributaries of Letaba IUA 4.
IUA 6: Northern tributaries of Letaba IUA 4.
IUA 7: Upper Middel Letaba and tributaries upstream of Middel Letaba Dam.
IUA 8: Klein Letaba upstream of Middel Letaba Dam.
IUA 9: Klein Letaba downstream of Middel Letaba Dam.
IUA 10: Lower Klein Letaba tributaries.
IUA 11: Letaba main stem in the Kruger National Park.
IUA 12: Letaba tributaries in the Kruger National Park.

HOTSPOTS

The hotspot represents a river reach with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future (Louw and Huggins, 2007; Louw *et al.,* 2010).

Hotspots are areas with high Integrated Environmental Importance (IEI) and high Water Resource Use Importance (WRUI). IEI considers PES, Ecological Importance and Sensitivity, Freshwater EcoSystem Priority Areas and Socio-Cultural Importance.

Of the 75 SQ reaches assess, 32 has a VERY HIGH status. These areas are mostly situation in nature reserves and in upper mountainous reaches.

There are 19 hotspots which are situated mostly along the Letaba River and the Klein Letaba River. This is due to a combination of HIGH WRUI and MODERATE to HIGH IEI. The 7 existing EWR sites (key biophysical nodes) are all situated on hotspots. Sixty-seven additional desktop biophysical zones occur which will be assessed at desktop level.

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ACRONYMS

CD:RDM	Chief Directorate: Resource Directed Measures
CD:RQS	Chief Directorate: Resource Quality Services
DSS	Decision Support System
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EGSA	Ecological Goods, Services and Attributes
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
EMF	Environmental Management Framework
ES	Ecological Sensitivity
ER	Economic Region
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Area
FSC	Full Supply Capacity
GDP	Gross Domestic Product
GIS	Geographic Information Systems
IEI	Integrated Environmental Importance
ISP	Internal Strategic Perspective
IUA	Integrated Unit of Analysis
KNP	Kruger National Park
MEA	Millennium Ecosystem Assessment
MC	Management Class
msl	mean sea level
NFEPA	National Freshwater Ecosystem Priority Area
NWRCS	National Water Resource Classification System
PES	Present Ecological State
PESEIS	Present Ecological State and Ecological Importance -Ecological Sensitivity
PSP	Professional Service Provider
REC	Recommended Ecological Category
RQO	Resource Quality Objectives
RU	Resource Unit
SAM	Social Accounting Matrics
SCI	Socio-Cultural importance
SQ	Sub-quaternary
WIM	Water Impact Model
WMA	Water Management Area
WQSU	Water quality sub-unit
WRCS	Water Resource Classification System
WRUI	Water Resource Use Importance
WRYM	Water Resources Yield Model
WTW	Waste Treatment Works
WUA	Water User Association
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 STUDY AREA OVERVIEW

The study area is the catchment of the Letaba River and illustrated in Figure 1.1.

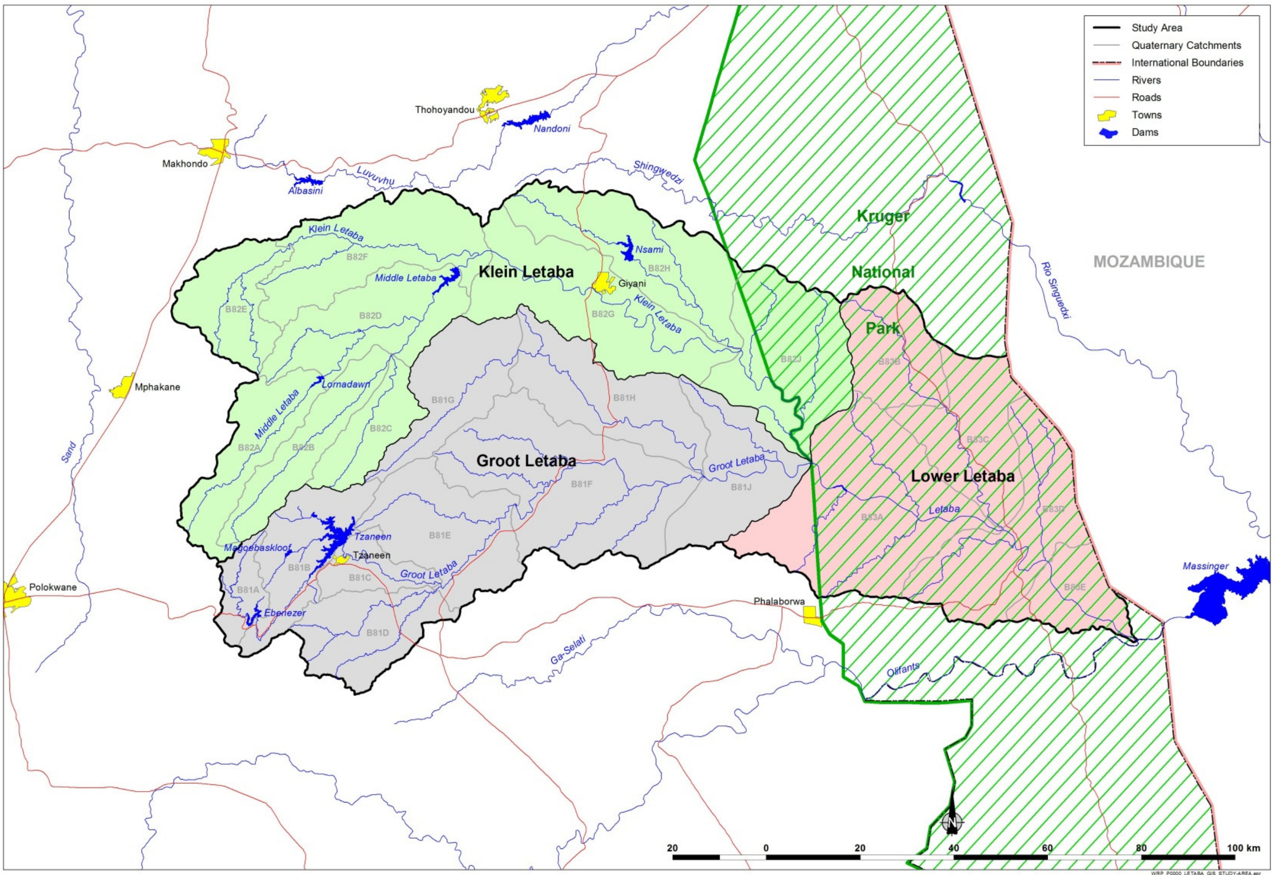


Figure 1.1 Study area: Letaba River Catchment

The Letaba Catchment is located in the north east of South Africa. The two main tributaries of the Letaba River, the Klein and Groot Letaba, have their confluence on the western boundary of the Kruger National Park (KNP), whilst the Letaba River flows into the Olifants River just upstream of the border with Mozambique.

The topography of the Luvuvhu/Letaba Water Management Area (WMA) varies from a zone of high mountains in the west through low mountains and foothills in the central part of the WMA to the low lying plains in the east. The mountainous zone or Great Escarpment includes the northern portion of the Drakensberg mountain range and the eastern Soutpansberg, which both extend to the western parts of the WMA, and the characteristic wide expanse of the Lowveld to the east of the escarpment. The highest peaks have an elevation of more than 2000 m above mean sea level (msl). This zone is deeply incised by the major tributaries draining the WMA. The low lying plains cover most of the WMA and have gentle to flat slopes.

The main urban areas are Tzaneen and Nkowankowa in the Groot Letaba River catchment and Giyani in the Klein Letaba River catchment. Approximately 80 to 90% of the population can be considered as rural, scattered throughout the WMA. A large proportion of the population depends on subsistence farming and this makes availability of water a vital subject for consideration.

Rainfall is strongly seasonal and occurs mainly during the summer months (i.e. October to March) and is strongly influenced by the topography. The peak rainfall months are January and February. The average potential mean annual gross evaporation (as measured by S pan) ranges between 1 300 mm in the extreme western mountainous region and 2 000 mm in the northern and eastern areas. The highest evaporation occurs in the period October to January and the lowest is in June.

The geology is varied and complex and consists mainly of sedimentary rocks in the north and metamorphic and igneous rocks in the south. A wide spectrum of soils occur in the WMA, with sandy soils most common.

Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment, upstream and downstream of the Middle Letaba Dam, and particularly along the Groot Letaba and Letsitele Rivers. Vegetables (including the largest tomato production area in the country), citrus and a variety of fruits such as bananas, mangoes, avocados and nuts are grown. Large areas have been planted with commercial forests in the high rainfall parts of the Drakensberg escarpment.

From a groundwater region and response unit perspective, the catchment can be largely classified as crystalline igneous and metamorphic basement rocks of Swazian to Randian age underlying the Lowveld region. Aquifers are predominantly secondary, with the exception of the alluvial deposits. The land surface has been dissected by erosion beginning in the early Cretaceous along the Escarpment which forms the western watershed to the early Miocene in the east.

The hydrogeology of the Letaba catchment is characterized by secondary or fractured aquifers formed by mainly metamorphic basement rocks of the Goudplaats Gneiss, Giyani and Gravelotte Greenstone belts, Igneous rocks of the Lebombo Granite, Makhutzi Granite, various younger granitoid intrusions of the Vorster Suite and gabbroic intrusions of the Rooiwater Suite Timbavati Gabbro. Intergranual aquifers (unconsolodiated to semi consolidated materials, with primary porosity) occur on the Letaba River, mainly inside the Kruger Park.

1.3 TASK D1: DESCRIBE STATUS QUO, DELINEATE IUAS AND RUs, IDENTIFY BIOPHYSICAL NODES

The objective of this task was to describe and document the status quo which included various components such as water use, economy, river and wetland ecology, identifying water quality problems and Ecosystem Goods, Services and Attributes (EGSA). This information was used to define the Integrated Units of Analysis (IUAs). Once the IUAs were delineated, Resource Units (RUs) and biophysical nodes had to be identified for different levels of Ecological Water Requirement (EWR) assessment and setting of RQOs. This task therefore describes the physical template and information for decision making regarding the different levels of investigation for Reserve, Classification and RQO determination.

1.4 PURPOSE AND OUTLINE OF THIS REPORT

The purpose of the Status Quo Report is to define the current status of the water resources in the study area in terms of the water resource systems, the ecological characteristics, the socio-economic conditions and the community well-being. The report outline is as follows:

- **Section 2 – 8** of the report outlines the various multi-disciplinary methodologies adopted during this task and provides the findings of the various Status Quo assessments.
- **Section 9** provides information on the delineation of integrated IUAs.
- **Section 10** outlines the general approach to identifying Hotspots and the results of this process is provided in **Section 11**.
- **Section 12** outlines the process of selecting final biophysical nodes for which EWRs will be assessed and the level of EWR assessment is also discussed.
- References are listed in **Section 13**.

2 STATUS QUO ASSESSMENT: WATER RESOURCES

2.1 INTRODUCTION

This section deals with the status quo assessment of both the available Decision Support Systems (DSS) for the Letaba River Catchment and the water resources in the study area.

2.2 APPROACH

2.2.1 Decision Support System

The status quo of the available Decision Support Systems (including the hydrological database used by the DSS) from both past and present studies in the study area were assessed, in order to obtain the most appropriate DSS for conducting the water resource analyses required for this study.

2.2.2 Water resources

The Letaba River Catchment was divided into water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. Each of the water resources zones was assessed.

2.3 DESCRIPTION OF WATER RESOURCES

The Letaba Catchment is drained by the Groot Letaba River together with its major tributaries including the Klein Letaba, Middle Letaba, Letsitele and Molototsi rivers. From the confluence of the Klein and Groot Letaba Rivers, the Letaba River flows through the KNP until it joins the Olifants River near the border of Mozambique.

More than 20 major Instream dams have been constructed in the Groot Letaba catchment which has resulted in the catchment being highly regulated. The major dams occurring in the Letaba Catchment are summarised in Table 2.1. The existing limited water resources in the Letaba Catchment have been overexploited to meet the commercial (irrigation, afforestation and industry) and rapidly increasing domestic water demands.

Table 2.1 Major dams in the Letaba catchment

Dam	Quaternary Catchment	Full Supply Capacity (FSC) (million m^3)	Use
Dap Naude	B81A	1.94	Domestic
Ebenezer	B81A	70.00	Domestic
Magoebaskloof	B81B	4.91	Irrigation
Tzaneen Dam	B81B	157.30	Irrigation
Hans Merensky	B81B	1.26	Irrigation
Thabina	B81D	0.28	Irrigation
Lorna Dawn	B82A	11.75	Irrigation
Middle Letaba	B82D	184.20	Irrigation
Nsami	B82H	29.46	Irrigation

The dense forestation that takes place in the upper catchment and the intensive irrigated agriculture on the banks of the Groot Letaba River outside of the KNP are the major water users in the study area.

The Letaba water system can be grouped into three major subsystems, namely:

- **The Groot Letaba River sub-system** stretching down to its confluence with the Klein Letaba River (includes Dap Naude, Ebenezer, Magoebaskloof, Tzaneen and Thabina Dams)
- **The Middle Klein Letaba River sub-system** stretching down to its confluence with the Groot Letaba River (includes Middle Letaba and Nsami Dams)
- **Lower Letaba River sub-system** which stretches from the confluence of the Klein and Groot Letaba Rivers to the confluence to the Olifants River just upstream of the border with Mozambique.

The first water system is in the Groot Letaba River sub-system mainly along the Groot Letaba River, which is where the main economic activity takes place. The Groot Letaba River sub-system is a major contribution to the hydrology of the whole Letaba catchment. The Letaba River runs from the mountainous Haenertsburg area through Ebenezer Dam into Tzaneen Dam over a distance of about 30 kilometres. There are two small weirs (George's Valley and Pusela) that divert water released from Ebenezer dam, from the river to irrigation farms in the stretch of river between Ebenezer and Tzaneen Dams.

Downstream for about 120 kilometres there are five weirs, namely:

- Yamorna Weir.
- Junction Weir.
- Jasi Weir.
- Prieska Weir.
- Nondweni Weir.

The Groot Letaba Water User Association (WUA) operates these weirs. The weirs have limited capacity and are subjected to silting up (been in operation for over 20 years). The weirs are opened and closed in order to relieve demands for water at any given time, usually at a point where the flow in the river gets too low to deliver 0.6 m^3/s to the KNP, after primary, industrial and irrigation allocations have been met.

The objective is to obtain water from the nearest weir and then to "refund" the particular weir with water from upstream weirs and eventually Tzaneen Dam. These actions are activated through visual inspections and observations by the Letaba WUA's bailiffs, and through messages from various sources along the river and interpreted in view of their long experience in the behaviour of the river. There are no hard and fast operational rules and the DWA Regional Office have up to now been responsible for implementing operating rules for the Ebenezer and Tzaneen Dams.

2.4 STATUS QUO ASSESSMENT

2.4.1 Decision Support System (DSS)

The first major study undertaken in this study area was the Letaba River Basin Study in 1985 (DWAF, 1990), which included the collection and analysis of all available data on water availability and use and assessments of potential future water resource development options. This study was then followed by a Pre-feasibility Study (DWA, 1994) which was completed in 1994. The focus of this prefeasibility study was the complete updating of the hydrology of the basin and the Water Resources Yield Model (WRYM) was configured the first time (Letaba River Catchment) and used as a DSS.

The next study undertaken was the Feasibility Study of the Development and Management options (DWA, 1998), completed in 1998. A bridging study was then initiated by DWA i.e. The Groot Letaba Water Development Project (DWA, 2010) in order to re-assess the recommendations contained in the Feasibility Study in the light of the developments that have taken place in the intervening 10 years. The WRYM was updated, improved according to the latest development levels and the hydrological database was extended to the end of 2004 (previously only up to 1992).

Both the latest WRYM hydrological database and the WRYM network configuration are not at the resolution or level of detail that will be required in this study and will need to be disaggregated to a lower resolution for conducting analysis at the required level.

In the last quarter of 2011 the DWA commissioned the Development of a Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System where both the WRYM hydrological database and the system configuration will be updated based in the latest available information. As part of the updating process, the WRYM model will be disaggregated to the resolution required by this study. The WRYM will subsequently be used as the DSS for this study.

2.4.2 Water resources zones

The Letaba River Catchment was divided into 12 water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system.

Figure 2.1 shows the Letaba River Catchment and the 12 proposed water resource zones. The significant resources of the proposed water resource zones are summarised in Table 2.2.

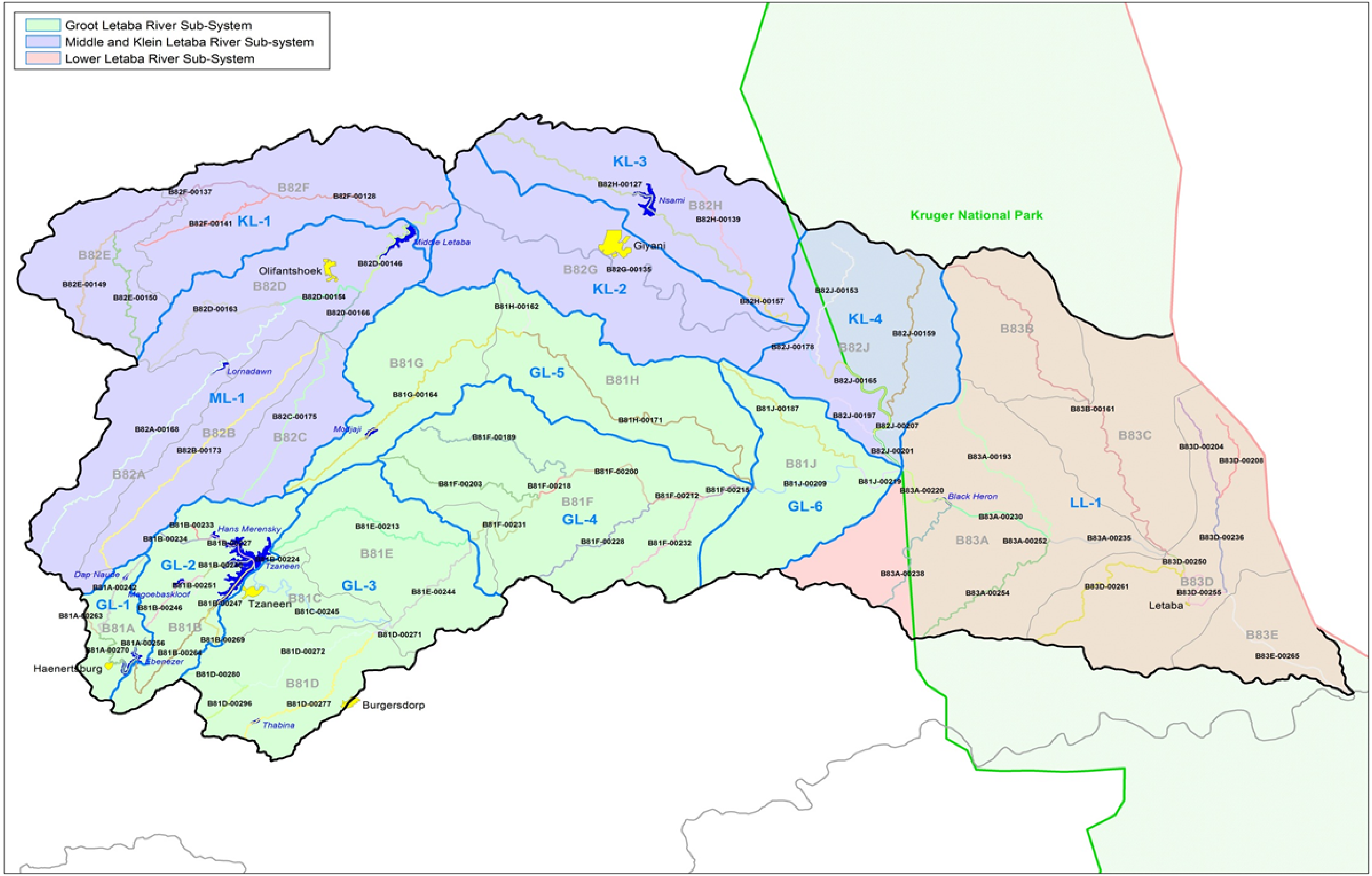


Figure 2.1 Letaba River Catchment sub-systems and water resources zones

Table 2.2 Letaba River Catchment Water Resource Zones

Water Resource Zone	Description	Major Impoundments	Quaternary Catchments
GL-1	Broedestroom upstream Ebenezer Dam.	Dap Naude Ebenezer Dam	B81A
GL-2	Mahitse, Politsi and Groot Letaba flowing into Tzaneen Dam.	Magoebaskloof Dam Hans Merensky Dam Tzaneen Dam	B81B
GL-3	Groot Letaba downstream of Tzaneen Dam up to the Nwanedzi confluence.	Thabina Dam (Proposed Nwamitwa Dam Site)	B81C B81D B81E
GL-4	Groot Letaba from the Nwanedzi confluence up to the Molototsi confluence.	-	B81F
GL-5	Upper Molototsi up to Groot Letaba confluence.	Modjaji Dam	B81G B81H
GL-6	Groot Letaba from Molototsi confluence to Klein Letaba confluence.	-	B81J
ML-1	Upper Middle Letaba up to Middle Letaba Dam.	Lornadawn Dam Middle Letaba Dam	B82A B82B B82C B82D
KL-1	Upper Klein Letaba up to Middle Letaba confluence.	-	B82E B82F
KL-2	Klein Letaba from Middle Letaba confluence to Nsama confluence.	-	B82G
KL-3	Upper Nsama to Klein Letaba confluence.	Nsami Dam	B82H
KL-4	Klein Letaba from Nsama confluence to Groot Letaba confluence.	-	B82J
LL-1	Letaba from Groot Letaba and Klein Letaba confluence to Olifants confluence.	-	B83A B83B B83C B83D B83E

The water resources status quo assessment for each of the water resource zones in the three major sub-systems are described in this section.

The Groot Letaba River Sub-system

The Groot Letaba sub-system is a major contribution to the hydrology of the whole Letaba catchment and it is where the main economic activity takes place. The Letaba River runs from the mountainous Haenertsburg area stretching down to its confluence with the Klein Letaba River. Major dams include the Dap Naude, Ebenezer, Magoebaskloof, Tzaneen and Thabina Dams. Dense forestation that takes place in the upper catchment and the intensive irrigated agriculture on the banks of the Groot Letaba River outside of the KNP are the major water users in the area.

GL-1: Broedestroom upstream Ebenezer Dam (B81A)

The Ebenezer Dam catchment forms part of the Groot Letaba sub-system and includes Ebenezer and Dap Naude Dams. The land use in this sub-catchment includes intense afforestation as well as irrigation on a somewhat smaller scale.

The Dap Naude Water Supply Scheme draws water from the Dap Naude Dam which is then used exclusively to supply the domestic and industrial demands in Polokwane. Compensation water is also released from the dam for irrigation downstream of the dam.

The Ebenezer Dam Water Scheme is used to supply two domestic user groups, namely Polokwane and Tzaneen. Water for irrigators located along the river reach between Ebenezer Dam and Tzaneen Dam is released from Ebenezer Dam directly into the river and diverted further downstream into two canal systems at the Georges Valley and Pusela Weirs. The irrigators have an allocation of 12.92 million m^3/a. Water for Tzaneen town is also abstracted from the Georges Valley weir.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use in the catchment is currently underutilised with further exploitation potential as shown in Table 2.3.

Table 2.3 Groundwater exploitation potential and current use (B81A)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81A	2.71	0.81	0.57	0.39	Irrigation

GL-2: Mahitse, Politsi and Groot Letaba flowing into Tzaneen Dam (B81B)

The Ebenezer Dam catchment together with this water resource zone forms the total Tzaneen Dam catchment. The Magoebaskloof, Hans Merensky and Tzaneen Dam are the major dams located in this zone. The main land use activities are intense afforestation as well as irrigation.

The Magoebaskloof Dam was originally intended to supply irrigation water to the now disbanded Tzaneen Irrigation Board and Sapekoe. However the need for domestic and industrial water use arose in Politsi, Duiwelskloof and Ga-Kgapane. A canal transfers water from the Magoebaskloof Dam to the Vergelegen Dam where these settlements are supplied. Irrigation water users also draw water from the canal as well as the Vergelegen Dam. The Vergelegen Dam is thus mainly a balancing dam for accepting water from Magoebaskloof Dam with some inflow from its own catchment. The water in the dam is used to supply the above villages as well as irrigation water to Sapekoe Tea Estate.

The Hans Merenskey Dam is located on the Ramadiepa River and supplies water to the Westfalia Estates and Sapekoe Tea Estate (in the B81B catchment). These estates also obtain water directly from the Ramadiepa River, as well as from the Selokwe River and its tributaries. In addition Sapekoe Estate also has an allocation form the Debengeni River, which is obtained via pipeline.

The Tzaneen Dam is located on the Groot Letaba River close to Tzaneen and serves mainly the irrigation demand along the Groot Letaba Valley, domestic and industrial water supply to Tzaneen, Nkonkowa, Letsitele, Consolidated Murchison Gold Mine, several other small industrial users and a large number or rural villages. Provision has also been made to maintain a flow of 0.6 m^3/s where the Letaba River enters the KNP for ecological requirements through the release of water from Tzaneen Dam. Irrigation water is released directly into the Groot Letaba River and the released water is then abstracted by pump irrigators and is also diverted from the river into canals at the Letaba North, N&N and Prieska Weirs.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use in the catchment is currently underutilised with further exploitation potential (non potable) as shown in Table 2.4.

Table 2.4 Groundwater exploitation potential and current use (B81B)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81B	7.72	4.63	2.31	2.70	Irrigation

GL-3: Groot Letaba downstream of Tzaneen Dam up to the Nwanedzi confluence (B81C, B81D, B81E)

The only dam located in this zone is the Thabina Dam on the Letsitele River. The proposed Nwamitwa Dam site is located at the lower end of the area at the confluence of the Groot Letaba and Nwanedzi Rivers. There is a vast amount of irrigation occurring especially along the Groot Letaba River, but also along its tributaries. The area is further characterised by forestry in the upper reaches of the catchment, a number scattered urban and rural settlements and there are also a large number of small farm dams, especially in the irrigation area along the Groot Letaba River.

The irrigation along the Groot Letaba River is supplied by water that is released from the upstream Tzaneen Dam. The water is then abstracted either by pump irrigators or is diverted from the river into canals at the Letaba North and N&N Weirs.

The Thabina Dam is located on the Thabina River which is a tributary of the Letsitele River. There are some small holder irrigation schemes that are irrigated from run-of-river with limited supply from the Thabina Dam. There is also a local domestic water requirement supplied from the dam. In the lower reaches of the Thabina River water is diverted for irrigation from a weir to a canal for irrigation purposes.

There are 6 canals that currently supply run-of-river water to irrigators from the Letsitele River and there is also a large area irrigated where water is pumped directly from the river.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the quaternaries B81C and B81E and heavily utilised with no further exploitation potential as shown in Table 2.5.

Table 2.5 Groundwater exploitation potential and current use (B81C, B81D, B81E)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81C	3.33	1.33	1.33	0.05	Domestic
B81D	7.80	4.68	4.47	6.79	Domestic and Irrigation
B81E	8.94	4.47	4.10	0.01	Livestock

GL-4: Groot Letaba from the Nwanedzi confluence up to the Molototsi confluence (B81F)

There is a vast amount of irrigation occurring along the Groot Letaba River. The area is further characterised by natural areas/nature reserves, agricultural lands, a large amount of small farms dams in the irrigation areas and a large number of rural and urban areas. There are no major dams located in this area.

The water for irrigation along the Groot Letaba River is supported with releases made from the upstream Tzaneen Dam. The water is then abstracted either by pump irrigators or is diverted from the river into canals from weirs in the river.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the quaternary B81F as shown in Table 2.6.

Table 2.6 Groundwater exploitation potential and current use (B81F)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81F	14.41	8.65	6.54	0.61	Domestic

GL-5: Upper Molototsi up to Groot Letaba confluence (B81G, B81H)

The area is characterised by a large number of rural and urban areas especially in the upper reaches of the Molototsi River before the confluence with the Metsemola River as well as livestock grazing areas. The only major dam is located in the upper reaches of the Molototsi River which was constructed for domestic use.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently under underutilised with further exploitation both the B81G and B81H quaternaries as shown in Table 2.7.

Table 2.7 Groundwater exploitation potential and current use (B81G, B81H)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81G	6.73	4.04	3.22	1.07	Domestic
B81H	8.02	5.61	2.55	0.60	Domestic

GL-6: Groot Letaba from Molotsi confluence to Klein Letaba Confluence (B81J)

The area is characterised by a livestock grazing areas, natural area/nature reserves, a few rural and urban settlements and a small irrigation area along the Groot Letaba River. There is no major dam located in this area.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the B81J quaternary as shown in Table 2.8.

Table 2.8 Groundwater exploitation potential and current use (B81J)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B81J	6.46	4.52	1.81	0.16	Domestic

The Middle and Klein Letaba River Sub-system

The Middle and Klein Letaba River sub-systems can be classified as predominantly rural with a strong bias towards agriculture and retail. The Middle Letaba River valley as well as the middle reaches of the Klein Letaba River and its tributary, the Nsama River, has been extensively developed in terms of irrigation. Forestry is also present in the upper high rainfall areas of both the

Middle Letaba and Klein Letaba river catchments. The major dams in this sub-system include the Middle Letaba Dam and Nsami Dam.

ML-1: Upper Middle Letaba up to Middle Letaba Dam (B82A, B82B, B82C, B82D)

The middle Letaba Dam is located in this zone. The land use in this sub-catchment includes mainly of irrigation and a number of urban and rural areas. Some livestock grazing areas and agricultural lands are also present. The Lorna Dawn Dam and Middle Letaba Dam are the only major dams in the area.

The Middle Letaba Dam was originally developed in the Middle Letaba River catchment to supply water to the domestic and agricultural sectors. Since then the situation changes significantly with the domestic supply increasing constantly and the irrigation supply has been significantly reduced. The Middle Letaba Dam delivers water to Nsami Dam through a 60 km long canal with a capacity of 4 m^3/s.

Irrigation plots have been developed along the canal and 11 pump stations deliver water to the fields. A short canal from Nsami Dam delivers water to irrigation plots on the banks of the Nsama River. The bulk water supply scheme can be divided in three main sections delivering water to the domestic users as flows:

- 89 villages supplied from the Water Treatment Works (WTW) located at the Middle Letaba Dam.
- 29 villages supplied from the Malamulele WTW located adjacent to the canal between the Middle Letaba Dam and Nsami Dam.
- 58 Villages and Giyani Town supplied form the treatment works at Nsami dam.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently under underutilised with further exploitation in the quaternaries B82A, B82B, B82C and B82D as shown in Table 2.9.

Table 2.9 Groundwater exploitation potential and current use (B82A, B82B, B82C, B82D)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B82A	7.37	3.68	2.04	1.35	Irrigation
B82B	6.50	3.25	1.90	0.00	-
B82C	4.76	2.38	2.38	0.00	-
B82D	10.11	7.08	5.37	4.22	Domestic

KL-1: Upper Klein Letaba up to Middle Letaba confluence (B82E, B82F)

The area is characterised by a large number of urban and rural areas and some natural areas in the upper reaches. Some livestock grazing areas and agricultural lands are also present. There is no major dam present in this area.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently under underutilised with further exploitation in the quaternaries B82E and B82F, as shown in Table 2.10.

Table 2.10 Groundwater exploitation potential and current use (B82E, B82F)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B82E	6.41	4.49	2.69	2.07	Domestic
B82F	12.05	7.23	6.03	1.14	Domestic and Irrigation

KL-2: Klein Letaba from Middle Letaba confluence to Nsama confluence (B82G)

The catchment is characterised by a large number of urban and rural areas. Some livestock grazing areas and agricultural lands are also present. There is no major dam present in this area.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the quaternarie B82Gas shown in Table 2.11.

Table 2.11 Groundwater exploitation potential and current use (B82G)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B82G	11.02	6.61	4.96	0.62	Domestic

KL-3: Upper Nsama to Klein Letaba confluence (B82H)

The catchment is characterised by a large number of urban and rural areas. Some livestock grazing areas and agricultural lands are also present. The Nsami Dam is located in this area on the Nsama River. The Middle Letaba Dam delivers water to Nsami Dam through a 60 km long canal with a capacity of 4 m^3/s and irrigation and villages are supplied with water along the canal. The Nsami Dam itself supplies water to 58 Villages and Giyani Town from the treatment works at the Nsami Dam. A short canal from Nsami Dam delivers water to irrigation plots on the banks of the Nsama River.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the B82H quaternary as shown in Table 2.12.

Table 2.12 Groundwater exploitation potential and current use (B82H)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B82H	8.47	4.24	2.82	0.16	Domestic

KL-4: Klein Letaba from Nsama confluence to Groot Letaba Confluence (B82J)

The majority of the catchment forms part of the KNP and is thus largely natural with no major dams.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the groundwater use is currently underutilised with further exploitation in the B82J quaternary as shown in Table 2.13.

Table 2.13 Groundwater exploitation potential and current use (B82J)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B82J	6.42	3.85	3.85	0.00	-

The Lower Letaba River Sub-system

The Lower Letaba sub-system stretches from the confluence of the Klein and Groot Letaba Rivers to the confluence to the Olifants River just upstream of the border with Mozambique. The KNP covers almost the entire sub-system.

LL-1: Letaba from Groot Letaba and Klein Letaba confluence to Olifants confluence (B83A, B83B, B83C, B83D, B83E)

The majority of this area forms part of the KNP and is thus largely natural with no major dams.

According to the Letaba Catchment Reserve Determination Study (DWA, 2006a), the available groundwater is not utilised in the B83A, B83B, B83C, B83D and B83E quaternaries. This is expected due to the location within the KNP. The exploitation potential for each quaternary is shown in Table 2.14.

Table 2.14 Groundwater exploitation potential and current use (B83A, B83B, B83C, B83D, B83E)

Quat	Harvest Potential (million m^3/a)	Exploitation Potential (million m^3/a)	Utilisable Exploitation Potential (Potable) (million m^3/a)	Current Use (million m^3/a)	Main Water Use Sector
B83A	12.08	7.25	7.25	0.00	-
B83B	3.51	2.11	1.87	0.00	-
B83C	4.74	3.32	3.32	0.00	-
B83D	7.29	4.37	3.70	0.00	-
B83E	2.90	1.45	0.72	0.00	-

3 STATUS QUO ASSESSMENT: ECONOMICS

3.1 INTRODUCTION

The economic analysis details the status quo in Letaba catchment including specifically the large water users such as irrigation agriculture, commercial forestry, saw mills and food processing which all uses water indirectly. Although the eco-tourism industry is not a large water user and an indirect water user, the benefit lies in the attraction value of what the river and the water provides for the sustainability of the industry and is therefore included in the analysis.

The catchment is divided into the regions of economic activities, taking into consideration climatic and topographic characteristics, and evaluated as Economic Regions (ERs). The economic value of water use for each economic sector is determined. This provides a tool to create an appropriate economic baseline, against which to measure the possible impact of changes in water availability by means of scenarios. Macro-economic impact of possible water reduction on the individual producers, the community and the economy in the Letaba Basin can then be determined.

3.2 APPROACH

The delineation process of the economic regions consisted of the criteria of the different irrigation requirements, rainfall patterns and allocation between dams and identified drainage regions used by the rest of the study team. As macro-economic impacts cannot necessarily be identified at a specific geographical point, it includes a number of quaternaries to form an economic region.

3.2.1 Macro-Economic Models

The economic baseline provides the impacts of water usage when the full water allocation is available in the respective ERs for variables such as Gross Domestic Product (GDP), employment, and income received by low income households.

To accomplish this, an econometric model was been constructed with the multipliers synthesised from the Limpopo Social Accounting Matrix (SAM) for the WMA area, as basis. The Water Impact Model (WIM) will be used for the primary sectors such as irrigation agriculture and commercial forestry. The SAM and its multipliers will also be applied to the secondary and tertiary sectors. A production economic modelling approach will be used for the industries.

A broad schematic representation of the different sectors of the economy is shown below in Figure 3.1.

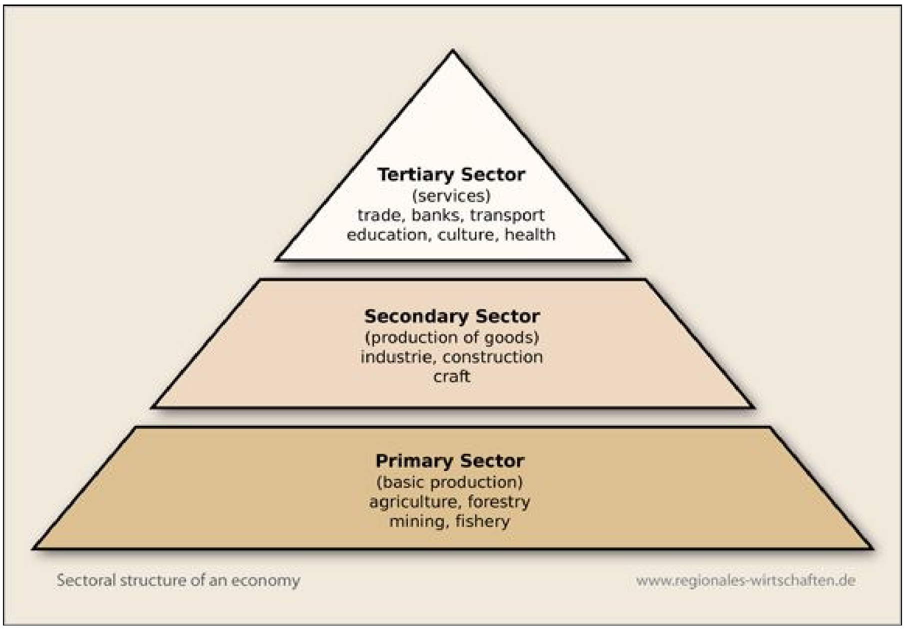


Figure 3.1 Sectorial structure of an economy

The important factor in the economic *status quo is the* dependence of some of the major secondary industries in the WMA on the primary production sector:

- Commercial Forestry
  - Saw mills.
- Tomatoes
  - Tomato processing plant.
- Citrus
  - Fruit processing plant.

3.2.2 Water Impact Model (WIM)

The model, as is currently constructed and were applied to the primary sector, is in the form of a dynamic computerised water entitlement model which can be used to identify and quantify the following indicators:

- Economic benefits.
- Maximum possible water reduction.
- Capitalised impact.

To calculate the macro-economy of each of the ERs in the WMA was to identify and establish the detailed water users in terms of volume used. The main inputs required for the irrigation agriculture and forestry model is the water volumes and number of hectares. Specific crop production budgets were incorporated to the WIM underpinned by the SAM.

A WIM was constructed for the catchment which included the identified ERs. The output of the model provides results of direct, indirect and induced results for the following sectors: irrigation agriculture and commercial forestry. For agriculture the model can accommodate up to twenty different products and for forestry it provides for pine, gum and wattle sub-species.

The direct, indirect and induced effects explained using the agricultural sector as an example are as follows:

- Direct effect: Refers to effects occurring directly in the agriculture sector such as the hectares of cultivated impacts.
- Indirect effects: Refers to those effects occurring in the different economic sectors that link backward to agriculture due to the supply of intermediate inputs, i.e. fertilisers, seeds, etc.
- Induced effects: Refers to the chain reaction triggered by the salaries and profits (less retained earnings) that are ploughed back into the economy in the form of private consumption expenditure.

The following parameters are used to determine the impacts are estimated by the model:

- GDP.
- Low Income Households and Total Households.
- Employment Creation.

Direct employment and payment to low income households are the two macro-economic parameters providing an indication of the socio–economic contribution of the natural resource to the community.

Once the water use per sector is available, a group of economic multipliers will be developed for comparing different water use scenarios in terms of Gross Domestic Product (GDP/m^3), employment creation (number/Mm^3) and the low-income households.

3.3 DESCRIPTION OF ECONOMICS

3.3.1 Economic Regions

For purposes of the study the following production regions have been identified in the relevant quaternary sub-catchments. These regions conform to the ERs and are referred to as ERs in the report:

- ER 1: Above the Tzaneen Dam (Magoebaskloof and Haenertsburg area) – B81A and B81B.
- ER 2: Below the Tzaneen Dam to confluence with the Letsitele River – B81E and comprising a portion of B81F.
- ER 3: Groot Letaba from the confluence with the Letsitele River to the confluence with the Klein Letaba River (Hans Merensky area) – B81F and B81J.
- ER 4: The Letsitele River to the confluence with the Groot Letaba River (Tzaneen and Letsitele area) – portion of B81E together with B81C and B81D.
- ER 5: Molototsi River – B81G and B81H.
- ER 6: Middle Letaba River catchment upstream of the Middle Letaba Dam up to the confluence with the Klein Letaba – B82A to B82D.
- ER 7: The Klein Letaba River catchment up to the confluence of the Klein Letaba River and the Groot Letaba River - B82E to B82J.
- ER 8: Kruger National Park – B83A to B83E.

The figure below presents the different economic regions as used in the analysis.

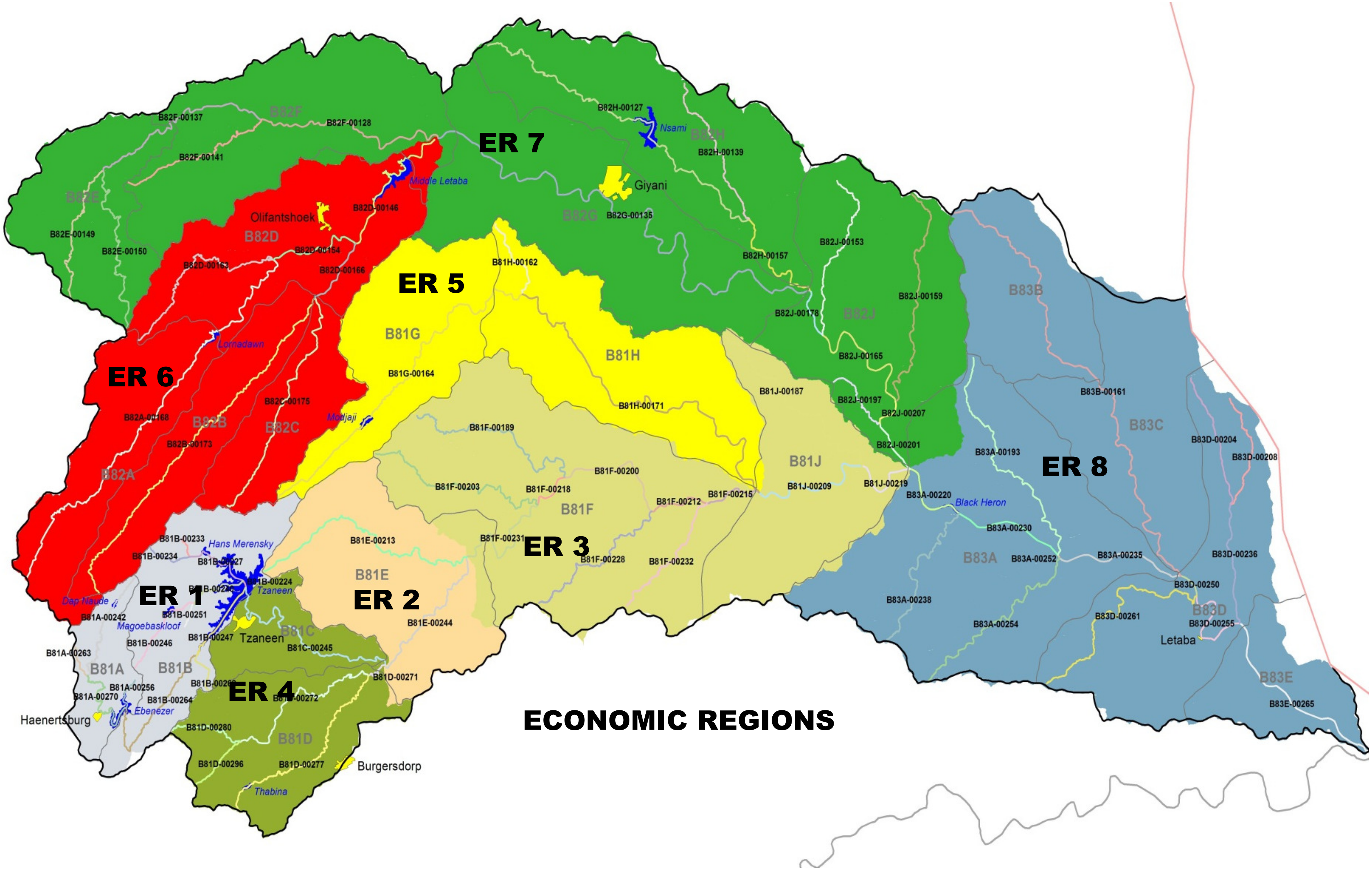


Figure 3.2 Economic Regions of the Letaba Catchment

3.3.2 Land Use

The economic significance of water uses in the Letaba Catchment is dominated by irrigated agriculture and commercial forestry.
The following are the major economic sectors in the Letaba Basin:

- Irrigated agriculture.
- Commercial forestry.
- Industry – fruit processing and timber saw mills; and
- Eco-tourism.

The Letaba Catchment has four distinct socio-economic characteristics:

- The high commercial forestry and irrigated agriculture with high value crops such as citrus, avocados and bananas situated in the headwaters of the Greater Letaba Catchment including its tributaries like the Letsitele River. The catchment also has agro-industries such as canning and juice plants.
- The irrigated agriculture upstream of the Middle Letaba Dam, where nearly 50% of the country's tomatoes are produced.
- The residential areas in the Klein Letaba catchment which are mainly rural and the urban areas in the Groot Letaba; and
- The eco-tourism sector which is situated above the Tzaneen Dam and in the lower reaches of the Groot Letaba River and below the confluence with the Klein Letaba River into the Kruger National Park.

In the Kruger National Park the Letaba camp and to a lesser degree the Olifants camp visitor's experience depends on the environmental health of the Letaba River. The current occupation rate of the Letaba camp was used in calculating the tourism value of the Letaba River.

The Magoebaskloof is a well-known tourist destination in its own right but it also serves as an overnight stop for visitors on their way to the Kruger or leaving the Kruger.

The Eiland Holiday Resort is a large resort on the river in the Hans Merensky nature reserve with over 1 000 beds available and the attractiveness of the resort also depends on the environmental health of the Letaba River.

3.4 STATUS QUO ASSESSMENT

3.4.1 Economic Baseline

The economic baseline for the Letaba Catchment is defined as the economic contribution of the available and "out-of-river use" of surface water and ground water to the total economic activities in the region, without any water restrictions. It will therefore necessitate the identification and quantification of the direct economic contribution of each user and then in turn using this to calculate the indirect and induced impacts.

As an example the production of export fruit is directly dependant on the availability of irrigation water which has a backward linkage to the suppliers of required agricultural commodities, and forward linkages to the fruit transporters and eventually the cold storage facilities or fruit processing. All of these in turn again have backward linkages. The land use of the different sectors to be assessed is discussed below.

3.4.2 Physical Data

Irrigation Area

The irrigation data used was obtained from a number of sources. The total hectares of citrus, banana, avocado and vegetable areas irrigated was obtained from data supplied by Schoeman and Partners and the economic contribution was calculated using the Conningarth internal database and production budgets updated to 2012 prices. The final areas were brought in line with the data received from the Water User Associations.

In Table 3.1 the total irrigation hectares, as used per economic region in the analysis for the Groot Letaba River, is presented.

Table 3.1 Irrigation areas in the Groot Letaba River

ER	Total hectares
1	4 839
2	8 842
3	6 056
4	8 609
5	1 017
Total	**29 363**

In Table 3.2 the total irrigation hectares, as used per economic region in the analysis for the Middle and Klein Letaba Rivers, is presented.

Table 3.2 Irrigation areas in the Middle and Klein Letaba Rivers

ER	Total hectares
6	3 045
7	1 407
8	0
Total	**4 452**

As irrigation agriculture is very dynamic and the crop composition differs from year to year it was necessary to group some of the crops together and reduce the number of crops to 11 crop types. According to the raw data received it appears that as many as 30 different crops types are cultivated. In Table 3.3 the summary of the irrigation data as used in the calculations are presented after the reduction to 11 crops.

Table 3.3 Summarised crop areas under irrigation in the Groot Letaba

Crop Type	ER 1 (ha)	ER 2 (ha)	ER 3 (ha)	ER 4 (ha)	ER 5 (ha)	Total (ha)
Avocado	3 190	210	-	1 476	-	4 876
Bananas	194	88	28	1 204	9	1 523
Citrus - Oranges	22	3 348	2 026	1 633	2	7 031
Citrus - Grapefruit	0	1 576	998	841	0	3 415
Litchi	361	189	28	294	0	873
Macadamia	390	119	0	244	0	753
Maize	186	123	78	5	0	391
Mango	120	1 980	1 113	1 706	29	4 948
Tomatoes	2	19	13	178	383	595
Vegetables (S)	203	574	887	527	263	2 455

Crop Type	ER 1 (ha)	ER 2 (ha)	ER 3 (ha)	ER 4 (ha)	ER 5 (ha)	Total (ha)
Vegetables (W)	171	616	884	502	331	2 504
Total	**4 839**	**8 842**	**6 056**	**8 609**	**1 017**	**29 363**

The three dominant crops are citrus with a total of over 10 000 ha, followed by mangoes with nearly 5 000 ha and avocados also close to 5 000 ha. In Table 3.4 a summary of the crops produced in the Middle and Klein Letaba Rivers is presented.

Table 3.4 Summarised crop areas under irrigation in the Middle and Klein Letaba

Irrigation Crops	ER6 (ha)	ER7 (ha)	Total (ha)
Avocado	641	-	641
Bananas	-	950	950
Citrus - Oranges	48	0	48
Mango	20	0	20
Tomatoes	2 336	120	2 456
Vegetables (S)	-	25	25
Vegetables (W)	-	312	312
Total	**3 045**	**1 407**	**4 452**

The dominant crop is tomato production with over 50% of the irrigated area utilised.

Commercial Forestry

The commercial forestry area data will probably change as more reliable data becomes available. Different sources show different areas being under commercial plantation in the Letaba Catchment area and in the Limpopo province. In the following table the areas as used are presented.

Table 3.5 Commercial Forestry Areas (DWAF, 2009)

ER	Gum (ha)	Pine (ha)	Total (ha)
1	21 060	7326	28 386
2	6 000	2 000	8 000
5	4 300	2 400	6 700
Total	31 360	11 726	43 086

Industry: Saw Mills and Tomato Processing

The industries outside of the municipal areas that were included in the study are the saw mills located in the forestry areas, the two fruit processing factories, one in Letsitele and the other in Tzaneen and the tomato processing factory in the Modjadji Kloof. Although the position of the tomato processing factory in Mooketsi is unclear, it was however included in the calculations and might have to be removed at a later stage. It appears as if it is not operating at present.

During the research it became obvious that the saw mills in the ERs differ in size, but more importantly it was very difficult to isolate the region that acted as the source for a specific sawmill, as saw logs were moved from one mill to the other and across economic region boundaries. A theoretical sawmill model per economic region was therefore developed to accommodate the wood produced per specific region. The average growth per hectare per annum was multiplied with the number of hectares per economic region, which was used as the input for the saw mill model; an average recovery rate was used together with the average mill door price to establish a turnover per region.

The following parameters were used in the calculation of the results:

- Average Annual Mass Increase – Gum – 15.23 tons per hectare.
- Average Annual Mass Increase – Pine – 11.25 tons per hectare.
- Average mill door price – R890 per ton.

The respective turnovers for the three regions and employment, as used in the WIM model are presented in Table 3.6.

Table 3.6 Estimated saw mill turnovers (2012 prices)

ER	Turnover/Annum (R mil)	Employment (Number)[1]
1	R 308.18	1 314
2	R 101.87	434
5	R54.83	219
Total	**R 464.88**	**967**

1: Source: Genisis, Final Report – 29 June 2005

A tomato processing unit is operating quite close to Duiwelskloof and according to information received it employs 146 workers permanently while processing around 26 000 tons of industrial tomatoes per annum.

Tourism

A detailed data base for all agencies advertising was compiled including the number of beds, tariffs and annual occupation rates was constructed. Contact was also made with establishments in Haenertsburg and Tzaneen to estimate average tariffs. So called business tourists were, as far as possible, eliminated from the numbers as they visit the region for business reasons and leisure. The "Eiland" holiday resort is represented in ER 3, the management of the resort provided the team with a complete set of data.

The figures of ER 8 are representative of the numbers in the Letaba and Olifants Rest camps in the Kruger National Park. Table 3.7 reflects the estimated numbers of bed nights sold and are presented as used in the model.

Table 3.7 Estimated Bed Nights per Region

Economic Region	Number of bed nights
1	214 839
2	33 215
3	182 453
4	32 266
5	0
6	5 183
7	2 190
8 (Kruger)	400 113

3.5 ECONOMIC REGIONS RESULTS

The following section will discuss the economic results of the different regions. In certain instances data of prominent sectors were included for background information.

3.5.1 ER 1: Above the Tzaneen Dam

- The area under irrigation is estimated to be 4 839 hectares with the dominant crop Avocado representing about 66% of the total irrigation area.
- The commercial forestry area is 28 386 hectares and the estimated annual turnover of the saw mill is around R308 million. The saw mill figure is calculated assuming that all the annual growth in the specific region is destined for a saw mill within the region.
- The estimated number of bed nights sold to eco-tourists is estimated at 214 000 not taking into consideration the business tourism sector.

Table 3.8 provides an estimation of the economic activities in the region expressed as macro-economic parameters.

Table 3.8 Economic activities in the ER 1 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household income (R mil)	
	Direct	Indirect &induced	Total	Direct	Indirect & induced	Total	Total	Total	Low
Irrigation agriculture	R 180.0	R 154.1	R 334.1	3 690	1 346	5 036	R 696.1	R 336.2	R 89.1
Commercial forestry	R 140.6	R 121.9	R 262.5	1 912	1 168	3 080	R 609.7	R 222.3	R 76.7
Industry	R 183.4	R 242.2	R 425.6	1 460	2 238	3 698	R 944.8	R 440.6	R 160.7
Eco-tourism	R 114.8	R 101.1	R 215.8	786	791	1 577	R 506.4	R 176.9	R 62.4
Total	**R 618.8**	**R 619.2**	**R 1 238.1**	**7 848**	**5 542**	**13 390**	**R 2 757.1**	**R 1 175.9**	**R 388.9**

In total 7 848 direct employment opportunities are provided in the region by the water dependent economic activities, the total employment opportunities are 13 390, all of which are not in the area.

Irrigation is the largest employment provider with 3 690 direct opportunities in the ER with another 1 346 indirect and induced opportunities. The commercial forestry is the second largest direct job creator followed by industry and tourism.

3.5.2 ER 2: Below the Tzaneen Dam to confluence with the Letsitele River

- Included in the region is about 6 000 hectares of commercial forestry, the annual growth is estimated and channelled to a saw mill in the area.
- There is also a juice producing unit employing about 180 people.
- The estimated number of bed nights sold to eco-tourists is estimated at 33 215.

Table 3.9 Economic activities in the ER 2 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & induced	Total	Direct	Indirect& induced	Total	Total	Total	Low
Irrigation agriculture	R 397.6	R 317.5	R 715.1	11 973	2 698	14 672	R 1 785.4	R 706.5	R 21.4
Commercial forestry	R 13.5	R 11.7	R 25.2	189	111	300	R 61.4	R 21.3	R 7.4
Industry	R 116.2	R 117.2	R 233.3	471	935	1 406	R 483.9	R 207.2	R 75.3
Eco-tourism	R 10.35	R 9.11	R 19.46	71	71	142	R 43.66	R 15.9	R 5.63
Total	**R 537.6**	**R 455.5**	**R1 007.0**	**12 704**	**3 816**	**16 520**	**R 2376.4**	**R 950.92**	**R 109.7**

The analysis shows the large overall dependency in the area on the wellbeing of irrigation agriculture. In the case of employment creation at least 11 900 opportunities are created by irrigation and at an average dependency of four people per employment opportunity over 40 000 people depend in the region on irrigation. In total for the water based activities the dependency is over 50 000.

3.5.3 ER 3: Groot Letaba from the confluence with the Letsitele River to the confluence with the Klein Letaba River

- Citrus production comprises nearly 50% of the area followed by mangoes and winter and summer vegetables.
- The estimated number of bed nights sold to eco-tourists is estimated at 182 453.

The following table provides an estimation of the economic activities in the region expressed as macro-economic parameters.

Table 3.10 Economic activities in the ER 3 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation agriculture	R 313.6	R 293.9	R 607.5	10 316	2 594	12 910	R1 093.9	R642.3	R171.8
Commercial forestry	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Industry	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Eco-tourism	R 56.84	R 50.06	R 106.9	389	392	781	R 250.8	R87.6	R 30.9
Total	**R 370.4**	**R 287.7**	**R 714.4**	**10 476**	**2 539**	**13 691**	**R 1 344.7**	**R 729.9**	**R 202.7**

In terms of dependency the 10 316 employment opportunities created by irrigation reflects that about 40 000 individuals are dependent on the continuation of the activity. Citrus farming is the largest of the irrigation activities in the ER employing nearly 50% of the individuals involved in irrigation.

3.5.4 ER 4: Letsitele River to the confluence with the Groot Letaba River

- A wide selection of crops is produced with citrus representing the largest area followed by mangoes, avocados, bananas and vegetables.
- There is a fruit juice processing unit in the region processing about 120 000 tons annually and employing about 130 people.
- The number of bed nights sold to eco-tourists in the region is estimated at about 32 266.

In Table 3.11 the macro-economic parameters of the different activities are presented.

Table 3.11 Economic activities in the ER 4 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation agriculture	R 399.7	R 386.9	R 786.6	10 676	3 079	13 755	R 1 818.8	R 786.3	R 208.8
Commercial forestry	R 58.8	R 50.8	R 109.5	842	480	1 322	R 279.1	R 92.4	R 32.2
Industry	R 164.4	R 184.9	R 349.3	1 213	1 578	2 790	R 758.2	R 331.1	R 120.5
Eco-tourism	R 10.05	R 8.85	R 18.9	69	69	138	R 44.4	R 15.5	R 5.5

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Total	**R 632.9**	**R 631.5**	**R 1 264.4**	**12 799**	**5 206**	**18 005**	**R 2 900.5**	**R 1 225.3**	**R 366.9**

In terms of dependency the 10 676 jobs in irrigation reflects a number of 43 000 individuals depending on the continuation of the activity. Adding the industry and eco-tourism activities the number increases to about 51 000. This is only taking into consideration the direct jobs and immediate dependants and not calculating the indirect and induced numbers.

3.5.5 ER 5: Molototsi River

Although over 1 000 hectares are irrigated the produce is mostly for industrial tomatoes and vegetables. Table 3.12 shows the macro-economic parameters for the irrigation, forestry and saw mill activity.

Table 3.12 Economic activities in the ER 5 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation Agriculture	R 64.23	R 66.78	R 131.01	2 090	531	2 621	R 348.6	R 125.47	R 33.1
Commercial forestry	R 1.62	R 1.42	R 3.04	20	14	34	R 6.0	R 2.6	R 0.9
Industry	R 2.0	R 3.3	R 5.3	25	32	57	R 13.1	R 6.0	R 2.2
Eco-tourism	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Total	**R 67.9**	**R 71.5**	**R 139.3**	**2 135**	**577**	**2 712**	**R 367.7**	**R 134.1**	**R 36.2**

Although the economic base in the region is relatively small with only 2 135 direct employment opportunities supported, it still supports over 10 000 individuals.

3.5.6 ER 6 - Middle Letaba River catchment upstream of the Middle Letaba Dam up to the confluence with the Klein Letaba

Table 3.13 shows that nearly 80% of the irrigation area is under fresh tomato production, it is estimated that at certain times of the year nearly 50% of the country's fresh tomatoes come from the region.

- A tomato processing unit was operating in the area, however, at present it is not clear what the situation is and will be clarified at a later stage.
- A number of very limited accommodation units, aimed at eco-tourists, are operating in the area and the estimated bed nights sold are 5 180.

The following table presents the macro-economic parameters of the economic activities.

Table 3.13 Economic activities in the ER 6 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation agriculture	R 281.6	R 391.0	R 672.6	5 974	3 107	9 082	R 1959.2	R 743.2	R 195.4
Commercial forestry	R 39.5	R 34.1	R 73.6	562	324	885	R 185.2	R 62.2	R 21.6
Industry	R 121.0	R 133.6	R 254.6	795	1 128	1 923	R 548.6	R 238.8	R 86.9

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Eco-tourism	R 2.6	R 2.3	R 4.9	18	18	36	R 11.6	R4.0	R 1.4
Total	**R 444.7**	**R 561.1**	**R 1 005.8**	**7 349**	**4 578**	**11 927**	**R 2 704.6**	**R 1 048.2**	**R 305.3**

Although the water dependent activities are relatively small they still create about 6 000 direct employment opportunities as tomato production is very labour intensive. Irrigation agriculture provides 97% of the employment opportunities and industry and tourism together 3%. In the case of GDP irrigation contributes about 74%, industry 25% and tourism 1%. In case of household income irrigation provides 83%, industry 16.5% and tourism 0.5%. In terms of the local population's dependency on the water based activities, around 28 000 individuals depend on these activities.

3.5.7 ER 7 - The Klein Letaba River catchment up to the confluence of the Klein Letaba River and the Groot Letaba River

- The largest crop is bananas followed by vegetables and tomatoes.
- The eco-tourism activity is very limited and the estimated number of bed nights sold is around 2 190.

The macro-economic parameters representing the water based activities in the region are presented in Table 3.14.

Table 3.14 Economic activities in the ER 7 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation agriculture	R 136.6	R 181.7	R 318.4	2 402	1 426	3 828	R 773.3	R 349.7	R 93.4
Commercial forestry	R 20.6	R 17.8	R 38.4	290	169	459	R 94.7	R 32.5	R 11.3
Industry	R 18.4	R 29.4	R 47.8	329	292	621	R 118.3	R 54.3	R 19.8
Eco-tourism	R 0.62	R 0..54	R 1.16	4	4	8	R 2.7	R 0.95	R0.34
Total	**R 176.3**	**R 229.46**	**R 405.73**	**3 025**	**1 891**	**4 916**	**R 988.95**	**R 437.4**	**R 124.8**

Although the water dependent activities are relatively restricted the area still creates and supports about 2 400 direct employment opportunities as both banana and tomato production is very labour intensive. Annual production capital needs is around R988 million. Irrigation agriculture provides 99.6% of the employment opportunities tourism 0.4%. In the case of GDP irrigation contributes about 94.4% and tourism 1.6%. In case of household income irrigation provides 99% and tourism 1%. In terms of the local population's dependency on the water based activities around 12 000 individuals depend on the activities.

3.5.8 ER 8 - Kruger National Park

- As basis for the calculations a percentage of foreign tourists to Magoebaskloof was used on the assumption that they were either on their way to the KNP or were returning from the park. According to this calculations the annual number of overnight visitors to Magoebaskloof and Tzaneen excluding the business tourism sector is estimated at 214 839, of which about 41% are foreign visitors, namely 89 360. The average amount spent by the foreign tourists is then set at R91.9 million which is added to the tourist value of the KNP as it is assumed that the Kruger is the reason why they overnight in the Magoebaskloof.

- The total value of the tourist activities in the ER is then estimated at R244.7 million.
- The macro-economic parameter results of the tourist activities are presented in the following table.

Table 3.15 Economic activities in the ER 8 expressed as macro-economic parameters

Parameter	GDP (R mil)			Employment (Numbers)			Capital (R mil)	Household Income (R mil)	
	Direct	Indirect & Induced	Total	Direct	Indirect & Induced	Total	Total	Total	Low
Irrigation agriculture	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Commercial forestry	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Industry	R 0.0	R 0.0	R 0.0	-	-	-	R 0.0	R 0.0	R 0.0
Eco-tourism	R137.6	R 121.2	R 258.8	943	948	1 891	R 607.3	R 212.1	R 74.9
Total	**R 137.6**	**R 121.2**	**R 258.8**	**943**	**948**	**1 891**	**R 607.3**	**R 212.1**	**R 74.9**

The direct employment created in the park is around 782 with about 146 in Magoebaskloof, while another 948 indirect and induced opportunities are created outside of the park and Magoebaskloof.

3.5.9 Regional Comparison

To determine the key sectors in the different ERs, the most dominant sector were identified which to be taken into account for the operational scenarios analysis. In addition, the other sectors will be ranked in accordance of the importance relating to their economic prominence in their different ERs in the catchment.

Table 3.16 Dominant sector in the ERs

Most dominant economic sector							
ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8
Irrigation agriculture, commercial forestry, sawmills and eco-tourism	Irrigation agriculture						Eco-tourism

In ER 1, above the Tzaneen Dam, the agricultural forestry as well as the eco-tourism sectors is prominent. Most of the economic regions are dominated by agricultural activities of which citrus, avocado and mangoes is the most prominent crops in the catchment. As ER 8 consists of the KNP, eco-tourism was the prominent sector. The dominant activity for the total catchment is irrigation agriculture, specifically citrus and tomato production.

4 STATUS QUO ASSESSMENT: WATER QUALITY

4.1 INTRODUCTION

The information presented in this introduction pertains specifically to catchment factors pertinent to water quality. The main industrial development points are at Tzaneen (along the Groot Letaba River downstream of Tzaneen Dam), Nkowankowa and Giyani, with a number of sewage works spread throughout the catchment. However, there is little industrial development in the catchment. Northern Canners at Politisi and the industrial complex at Nkowankowa near Tzaneen provide the major industries.

Approximately 80 to 90% of the population can be considered as rural, scattered throughout the WMA. A large proportion of the population depends on subsistence farming. Intensive irrigation farming is practised in the upper parts of the Klein Letaba River catchment, upstream and downstream of the Middle Letaba Dam, and particularly along the Groot Letaba and Letsitele rivers. Vegetables, citrus and a variety of fruits such as bananas, mangoes, avocados and nuts are grown. Land use in the catchment upstream of the Middle Letaba Dam is characterized by irrigated crop farming where tomato is the major crop (DWAF, 2004, cited in Tshikolomo *et al.*, 2012). The irrigated area varies during the cropping season from 2100 ha to 3700 ha with irrigation water pumped directly from the river.

The primary land use along the rivers is citrus and sub-tropical fruit production, with grazing in the less fertile sandy loam soils. Removal of the vegetative cover by overgrazing has led to erosion in some places, resulting in an increased sediment load in the rivers. Several old gold mines exist, which lie close to the Klein Letaba River towards the northern part of the study area. There are large areas consisting of national, provincial and private nature reserves and forest reserves.

Possible sources of pollution may be divided into two categories:

<u>Diffuse sources</u>

- Agricultural fertilizers
- Agricultural insecticides, rodenticides and fungicides (i.e. biocides)
- Atmospheric deposition
- Rural domestic and sewage effluent runoff

<u>Point sources</u>

- Industrial effluent, and micro-organic pollutants
- Domestic and treated sewage effluent
- Mining effluent

An overview of the catchment, showing associated land-use, is shown below (taken from DWAF, 2006b).

The Groot Letaba headwater streams originate in the Drakensberg Escarpment, are located upstream of Tzaneen Dam and include the Broederstroom, Politsi and Debengeni rivers. Natural grasslands have been replaced by commercial forestry. Settlements are generally concentrated in the foothills area below the escarpment, concentrating along the main river valleys and lines of communication.

The Politsi River enters the Lowveld downstream of Magoebaskloof Dam. Forestry plantations take up 30% of the total land cover of EcoRegion 5.05 in this area and 64% of the area upstream of Tzaneen Dam. Subsistence farming covers 35% and commercial farming 7% of EcoRegion 4.04. EcoRegion 5.05 in the Thabina and Letsitele catchments comprises 36% subsistence farming and 22% commercial farming. Small weirs along the Letsitele River allow abstraction for agricultural purposes and solid waste pollution occurs. The Letsitele River is also used for irrigation and washing of clothes.

Commercial agriculture, of which more than 42% is under irrigation, covers 55% of the Groot Letaba catchment within EcoRegion 5.05. Farming activities comprise nearly 25% of EcoRegion 5.02 in this catchment outside of the KNP. This is made up of about 55% subsistence farming (20 800 ha) and nearly 40% commercial irrigated farmlands (14 300 ha).

Towards the eastern part of the Letaba River, local communities over-utilise the vegetation in the riparian zone through cutting and grazing. Alien plants have invaded the remaining riparian vegetation. The condition of the northern bank is worse than that of the southern bank. Agricultural pesticides and fertilisers affect water quality and are the biggest threat to the western section of the Groot Letaba River.

The Klein Letaba, Nsama and Molototsi rivers are typical sandy Lowveld rivers, with deeply incised river channels.

The Molototsi River is a seasonal stream. The river is mostly a small trickle that disappears into the sand before it reaches the main river, but experiences occasional heavy flooding during the summer months. The Modjadji Dam, which stores water for domestic use along the Molototsi River, restricts flow downstream. This loss of flow is detrimental to the next 20 – 30 km of river. Overgrazing, vegetation cutting and other poor agricultural practices occur in the catchment. Subsistence farming is the main land-use in the Molototsi (36%), Nsama River (32%) and Klein Letaba (35%) catchments. Very little urban development occurs. There is no commercial farming and less than 8% subsistence farming downstream of the confluence with the Nsama River. Agriculture consists of small-scale farming by rural communities and large commercial banana, papino, paw-paw and mango plantations upstream from Giyani. The commercial fruit farms are fed by the Middel Letaba Canal Irrigation Scheme.

Rural communities and cattle grazing, impact on water quality along the Nsama, especially during the dry season. Washing, agriculture, cutting of trees and overgrazing within the riparian zone and other poor land use practices all contribute to this problem (WRC, 2001).

Below the confluence of the Groot and Klein Letaba rivers, (at the KNP border) the Letaba River channel takes on the characteristics of the Klein Letaba River. The Letaba River passes through a steep confined gorge just before joining the Olifants River near the Mozambique border. The Klein Letaba River carries high sediment loads because of erodible soils and poor land management in the catchment. At the confluence of the Groot and Klein Letaba rivers the gradient decreases and lower flow rates allow sediment to settle, aggravating the natural sand deposition. Impoundment and abstraction, mainly for agriculture, reduce the flow of the Groot Letaba River, causing further settling of sediment (WRC, 2001).

4.2 APPROACH

Two major studies inform this status quo assessment, i.e. the Comprehensive Ecological Reserve Water Quality study (DWAF, 2006b) and the outputs from the national Present Ecological State and Ecological Importance -Ecological Sensitivity (PESEIS) study recently completed (ref-frontend model) were consulted. Other literature sources was also reviewed – see Appendix A for a summary of sources reviewed

4.3 DESCRIPTION OF WATER QUALITY ISSUES

A number of water quality studies have been undertaken in the Letaba catchment, with the EWR or Reserve study completed in 2006 being one of those.

The Reserve study (DWAF, 2006b) showed that water quality was generally not the driver of the overall EcoStatus of rivers in the study area, as parameters such as flow and the status of the riparian vegetation were more instrumental in determining the health of the river. The river system was generally in a Good to Fair condition in terms of water quality, with a hot spot occurring at EWR 2, i.e. Letsitele Tank. Detailed results can be seen in Table 4.1 below.

Table 4.1 Summary of the water quality in the Letaba catchment

Description: Water quality sub-unit (WQSU) and location	PES	Comments
Groot Letaba River		
WQSU 1: Headwaters to upstream Ebenezer Dam (Broederstroom sampled).	A/B	
WQSU 2 (EWR 1): Downstream Ebenezer Dam to upstream Tzaneen Dam.	B	
WQSU 3: Downstream Tzaneen Dam to upstream confluence with the Letsitele.	B/C	Irrigation agriculture (cultivated lands – banana and citrus), industrial and urban/domestic water use (Tzaneen). Industrial activity noted - creosote plant and oxidation ponds (in Tzaneen), timber processing (before Letsitele Tank on the R71).
WQSU 4 (EWR 3): Downstream of confluence with Letsitele to upstream of Prieska Weir (after Hans Merensky Nature Reserve).	C	Main land use irrigation agriculture, namely citrus plantations (noted: Strong biocide odour in the air). Water quality impacts relating to salinisation release of biocides into the environment; nutrient elevation, pesticides, herbicides, and salts.
WQSU 5: Downstream of Prieska Weir (after Hans Merensky Nature Reserve) to upstream of the confluence with the Molototsi River tributary.	B	Dense rural settlements (limited subsistence agriculture, with livestock). Few citrus plantations or irrigation agriculture.
WQSU 6 (EWR 4): Groot Letaba downstream of confluence with the Molototsi River tributary to upstream of the confluence with the Klein Letaba (northern boundary of the Groot Letaba Nature Reserve).	B/C	Dense rural and informal settlements (limited subsistence agriculture and livestock), so rural/domestic water use and limited cultivated lands before the Nature Reserve.
Letaba River		
WQSU 7 (EWR 6 and 7): Letaba River downstream of the Klein Letaba confluence with the Groot Letaba into the KNP (eastern boundary) to the Mozambique border.	B/C	KNP
Letsitele River		
WQSU 8 and 9 (EWR 2): Upper and lower Letsitele	C	Upper Letsitele: Irrigation agriculture. Lower Letsitele: Predominantly urban/domestic water use with little cultivated lands. Noted is the Nkowankowa Sewage works. Water quality impacts relating to sewage effluent leading to eutrophication.
Middel Letaba River		
WQSU 10 and 11	B – B/C	Main land use is dense rural/urban settlements (limited subsistence agriculture, with livestock). Water quality impacts relating to sewage effluent leading to eutrophication.
Klein Letaba River		
WQSU 13 (EWR 5):	B – B/C	Main land use is dense urban settlements and informal settlements, Giyani etc (limited subsistence
WQSU 14	B	

Description: Water quality sub-unit (WQSU) and location	PES	Comments
		and cultivated agriculture, with livestock). Noted is the number of sewage works and waste disposal sites. Also area for malaria control (high risk area). Water quality impacts relating to sewage effluent leading to eutrophication.
Molototsi River		
WQSU 15	B/C	Main land use is rural informal settlements, Ka-Dzumeri (limited subsistence and cultivated agriculture, with livestock). Headwater region of Molototsi has cultivated lands with formal settlements.

One of the more recent studies, i.e. the Groot Letaba River Water Development Project (DWAF, 2008), was initiated in June 2006 by DWAF Directorate: National Water Resource Planning, to assess the water quality status of B8, based on recommendations from the Internal Strategic Perspective (ISP) completed in 2004 and in response to the raising of Tzaneen Dam wall or constructing a new dam (the proposed Nwamitwa Dam).

The main outcome of the study was that surface water quality is generally good and fit for all uses. Eutrophication, in the form of elevated phosphates, and nutrient loading resulting in algal growth, is evident to some degree across the area, with the highest impact being along the Letsitele due to extensive industry and citrus irrigation farming. These results are consistent with the SRK study of 1990 and that of the Reserve study completed in 2006. The SRK study showed that samples were generally fit for domestic use, although periodic increases in electrical conductivity, sodium and total alkalinity were observed at certain sites. High phosphate levels were also noted. Water quality deteriorated in a downstream direction, with a number of water-borne diseases (e.g. gastroenteritis and typhoid) prevalent in the study area (i.e. Groot Letaba system). Vlok and Engelbrecht (2000) also stated that the Groot Letaba River is not highly polluted and that the decline in its flow seems to be the greatest threat to the system.

Another useful study was the Environmental Management Framework (EMF) for the Olifants and Letaba River Catchment areas, with a number of reports available, e.g. a draft report on the status quo, opportunities, constraints and desired state produced in July 2009, and a river health report. Assessments from this study are shown in Table 4.2 below.

Table 4.2 Results of the EMF study for the Olifants and Letaba River Catchment areas

River name	Health state indicators		Comment
	SASS	Fish	
Broederstroom	Fair	Poor	Siltation from forestry; predatory trout; sand-mining.
Politsi	Natural	Poor	Siltation from bridge construction; agriculture; forestry; informal settlements.
Debengeni	Natural	Poor	
Politsi (below Magoebaskloof Dam)	Fair	Fair	Erosion from dam, roads and bridges. No capacity for releases from Magoebaskloof Dam.
Upper Letsitele	Good	Poor	
Lower Letsitele	Natural	Poor	Solid waste pollution occurs; the river is used for irrigation and washing of clothes, but quality still good.
Thabina	Fair	Fair	Thabina Dam no release capacity.
Upper Groot Letaba (ds Tzaneen Dam and us KNP)	Good	Poor	Bananas.
Middle Groot Letaba (us KNP)	Good	Fair	Agricultural pesticides and fertilisers; over-utilization of the riparian zone.

River name	Health state indicators		Comment
	SASS	Fish	
Molototsi	Fair (lower section)	Poor (lower section)	Subsistence agriculture dominant. Modjadji Dam for domestic use in upper river; no environmental releases. Over-grazing and erosion.
Nsama	- (dry)	- (dry)	Subsistence agriculture dominant. Rural communities and cattle impact on water quality of the lower Nsama River, especially during the dry season. Washing, agriculture, overgrazing within the riparian zone. Fishing with shade nets not a sustainable practice. No releases from the Nsami Dam. A canal system exists for irrigation of bananas from the dam.
Upper Klein Letaba	Fair	Poor	No environmental releases from Middle Letaba Dam. Sand-mining. Agriculture consists of small-scale farming by rural communities and large commercial banana, papino, paw-paw and mango plantations upstream from Giyani. The commercial fruit farms are fed by the Middel Letaba Canal irrigation scheme.
Lower Klein Letaba	Good	Poor	
Letaba in the KNP	Ecological health: Good		Klein Letaba carries high sediment loads because of erodible soils and poor land management in the catchment. Settles when joins with Groot Letaba due to change in gradient.

ds: downstream us: upstream wq: water quality -: not sampled

The following sections relate specifically to water quality impacts in the catchment.

4.3.1 Green Drop ratings

The 2012 Green Drop report for Wastewater Treatment Works (WWTW) in the study area and controlled by the Mopani District Municipality, showed the following wastewater risk ratings:

- Tzaneen WWTW in the upper reaches of the Groot Letaba River: Low Risk.
- Nkowankowa WWTW, the town is 15 km east of Tzaneen along the Letsitele River: Medium Risk, but with effluent quality issues. Manufacturing and processing industries are located here.
- Lenyenye WWTW; the town is 20 km south-east of Tzaneen and along the Thabina River: High Risk. Lenyenye serves as dormitory to the Nkowankowa industrial area.
- Ga-Kgapene WWTW; the town is 25 km north of Tzaneen and along the Molototsi River: High Risk. Ga-Kgapene acts as a service centre to other settlements in the region.
- Giyani WWTW on the northern bank of the Klein Letaba River: High Risk, but improving. Giyani acts as a service centre to other settlements in the region.
- Modjadjiskoof-Duiwelskloof WWTW on the Brandboontjies River: Critical Risk, but largely due to a lack of information on the functioning of the WWTW.

4.3.2 Mining

The following minerals are mined in the area: Gold, antimony, beryllium, zinc, magnetite, kainite, nickel, barites, corundum (DWA, 2012). Limited gold mining is also undertaken along the Nsama River, where arsenic and mercury is found in the river (Ashton *et al.*, 2001).

A water quality assessment undertaken to monitor the impact of mining in the sub-catchment demonstrated that the general water quality in the Groot and Middle Letaba rivers and their tributaries was good, despite mining impacts. The declining water quality along the length of the Groot Letaba River was reported to probably be due to irrigation return flows. The only point of concern regarding mining may be the alluvial mining along the Nsama River, and regular monitoring was recommended (Ashton *et al.*, 2001).

4.3.3 Industry: Groot Letaba River system

Water is required for the following industries in the Groot Letaba Catchment (DWA, 2012):

- Consolidated Murchison Mine.
- Letaba Citrus processors.
- Koedoe Co-operative.
- Addington Farms.
- Sapekoe.

4.4 STATUS QUO ASSESSMENT

The following key issues (pertaining to water quality) were identified in the EMF (2009):

- The water resource in the EMF area is already over allocated and any further significant allocation of water must come from the redistribution of existing water allocations.
- Impoundment of rivers (especially in the mountainous areas) may cause irreversible damage to the hydrological regime as well as the ecosystems and human enterprises that depend on it.
- Excessive pollution of water bodies and rivers has a negative impact on the user value of the water in the system and in some instances even have potential disastrous effects on ecological and economic processes that depend on the quality of the water.
- Erosion, turbidity and sediment deposition in hydrological systems that result from practices that remove vegetation cover in the catchment areas significantly diminish the potential of the hydrological system.
- Inadequate services and infrastructure remains a significant problem in certain areas.

An overview of the catchment therefore indicates that water quality issues are mainly related to nutrient enrichment, and fluctuating instream temperature and oxygen levels due to extensive flow regulation in the catchment. In addition to being highly regulated, conditions in the Groot Letaba River (particularly downstream from Die Eiland) are impacted by citrus plantations in the area, resulting in elevated nutrient levels and instream toxicity. Water samples taken in the study area for an SRK study in 1989 indicated that water quality was suitable for irrigation, livestock watering and industrial use.

4.5 IDENTIFICATION OF WATER QUALITY 'HOTSPOTS'

The largest impacts on water quality in the study area are listed below. Water quality hotspot areas are shown in red text.

- The highly regulated nature of the catchment. Eight main dams and numerous smaller dams are spread throughout the catchment, which impact on the movement of sediment, and temperature and oxygen levels in particular.
- Commercial plantations (afforestation) concentrated in the upper reaches of the Groot Letaba, Letsitele, Middle and Klein Letaba River Catchments (DWA, 2012).
- Poorly functioning WWTWs with concomitant impacts on elevated nutrients, salts and algal growth. These are in particular the Ga-Kgapene WWTW (Molototsi River; SQ B81G-00164); Modjadjiskloof-Duiwelskloof WWTW (Brandboontjies River; SQ B82C-00175); Lenyenye WWTW (Thabina River; SQ B81D-00277) and Giyani WWTW (Klein Letaba River; SQ B82G-00135).
- Extensive agricultural area of the Middle Letaba River, particularly upstream of Middle Letaba Dam, resulting in elevated nutrients, salts, algal growth and herbicides/fertilizers. Commercial fruit farms are fed by the Middle Letaba Canal Irrigation Scheme.

- Citrus plantations, particularly on the Groot Letaba downstream from Die Eiland and the Letsitele River (EWR 2 at Letsitele Tank), with increases in nutrients, salts, algal growth and herbicides/fertilizers.
- Industrial centres of Tzaneen, Nkowankowa and Giyani, with increases in toxics and metals.
- High sediment loads in the Molototsi due to erosion linked to dryland cultivation and over-grazing.
- High sediment loads in the Broederstroom due to forestry activities.

These hotspots are identified by impact ratings of 3, 4 and 5 (impact ratings 0 (no impact) to 5 (severe)) and illustrated in Fig 4.1 and 4.2.

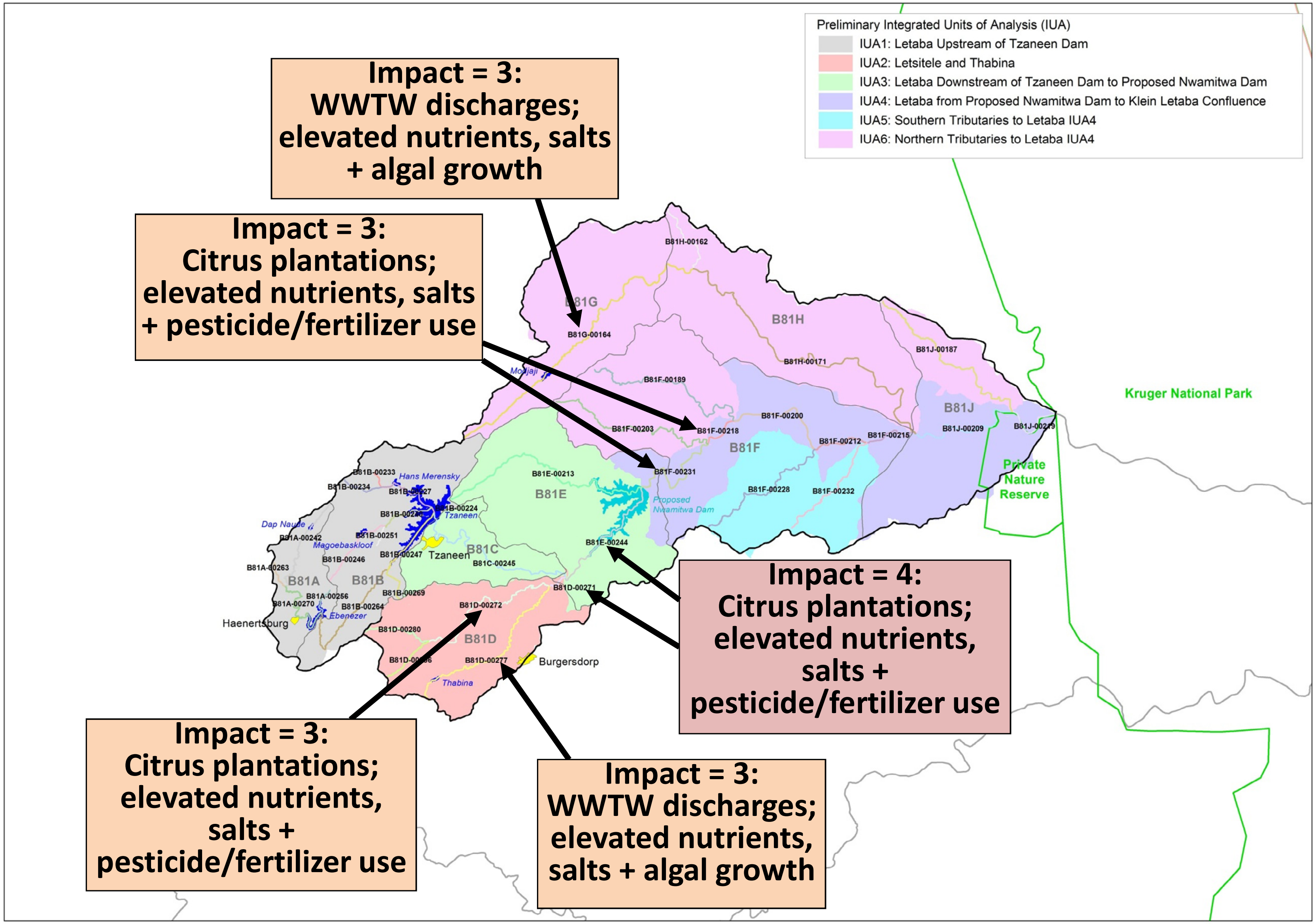


Figure 4.1 **Water quality hotspots in the Groot Letaba to the confluence with the Klein Letaba**

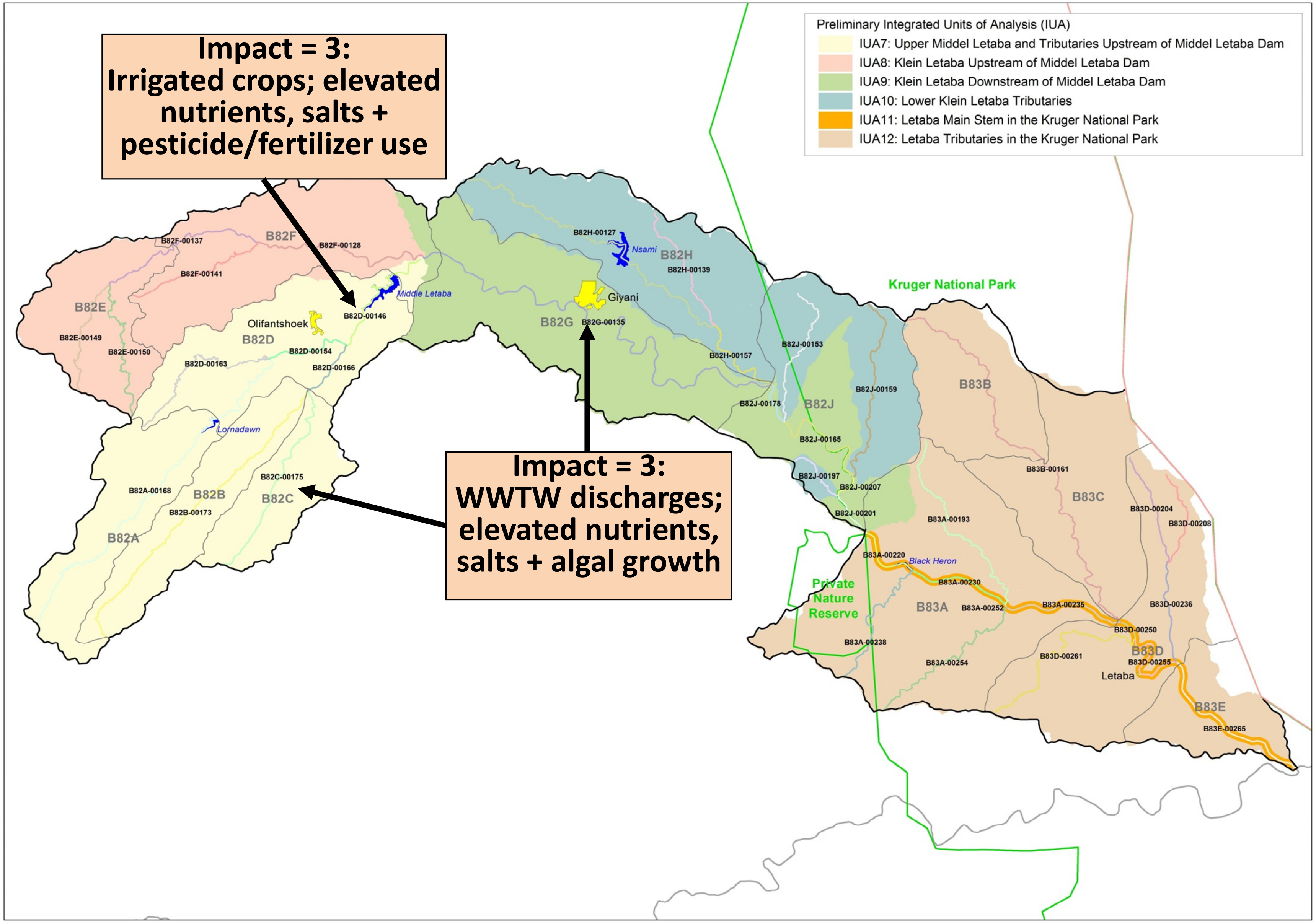


Figure 4.2 Water quality hotspots in the Klein and Middel Letaba Rivers and the Groot Letaba downstream of the Klein Letaba confluence

5 STATUS QUO ASSESSMENT: ECOLOGICAL GOODS, SERVICES AND ATTRIBUTES (EGSA)

5.1 INTRODUCTION

The Letaba River System, because of the nature of the communities that it intersects, plays an important role in maintaining important ecosystems goods and services to both on-site as well as other users. An ecosystem service is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. Ecosystem services are referred to as Ecological Goods, Services and Attributes (EGSA) within the National Water Resource Classification System (NWRCS). Natural capital and associated ecosystem services are now becoming scarce and the Millennium Ecosystems Assessment (MEA) partitions ecosystems services into four broad categories:

- Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, bio-chemicals, medicine, and genetic material, that are in many cases: directly consumed; subject to reasonably well-defined property rights (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are priced in the market.
- Cultural services are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being. These services are derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (non-consumptive uses); that have poorly-developed markets (with the exception of ecotourism); and poorly-defined property rights (most cultural services are regulated by traditional customs, rights and obligations); but are still used directly by people and are therefore open to valuation.
- Regulating services are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (Perrings, 2006); and are thus frequently undervalued in economic markets; many of these are indirectly used being intermediate in the provision of cultural or provisioning services.
- Supporting services are an additional set of ecosystem services referred to in the MEA, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (indirectly used); and are not evaluated separately (Mander *et al.*, 2007).

5.2 APPROACH

In terms of generating data for this report the most important step was to provide an integrated assessment of the current population of all three areas. Analysis was undertaken using four primary tools. These were:

- The 2001 census as adjusted and the 2011 census data that is available.
- The 2006 Letaba Catchment – Reserve Determination Study, undertaken for the Department of Water Affairs, included an overview of Ecological Goods and Services. This has been examined and updated.
- Geographic Information System (GIS) overlays of quaternary catchments and the census "sub place name" data. "Sub place name" data fields are the most detailed subsets of data released

by Statistic South Africa. This allows for the population for each quaternary to be calculated and a profile of the population for each unit to be analysed. Data was analysed to select areas in which populations likely to be dependent on riverine goods and services were possibly or probably present.
- Cross check of the GIS data sets with available mapping to determine likely livelihood styles and profiles.

A second level of analysis based on the typology of settlements in the area and their likely associated dependence on EGSA for livelihoods was undertaken for this report. This was sourced from information available from Statistics South Africa and cross referenced with an examination of aerial photography, largely that provided by Google Earth. This allowed for an analysis of land use types associated with the settlement typology.

Further, each quaternary catchment of the Letaba system has been examined in detail via the analysis of socio-cultural importance. The Socio Cultural Importance (SCI) was determined from direct observation and consideration of the literature available. During prior studies (not part of EWR assessments), a limited number of direct interviews were held with people who are resident proximate to the river. A key component of the SCI model is the category "Resource Dependence". This refers to the EGSA delivered by the river system and people's dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. The categories "Recreational Use" and "Ritual Use" were also examined. The SCI model was compared to the evaluation of likely areas of importance with regard to EGSA.

5.3 DESCRIPTION OF EGSA

It should be noted that the objective in describing and valuing the use of aquatic ecosystems is to determine the way in which aquatic ecosystems are currently being used in each socio-economic zone, and to estimate the value generated by that use. This provides the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared. It is important to point out that while EGSA will be identified and described in qualitative terms, a baseline value can often only be described for some of these, as the information required is not available without investing in a costly survey. As such it is therefore more practical to measure changes in EGSA values relative to a reference point rather than computing a baseline value. For the purposes of this exercise the baseline value is described as a value of 1. The most important EGSA associated with the overall system and likely to be impacted by changes in operational and management scenarios are the following:
- Recreational fishing.
- Subsistence fishing.
- Other recreational aspects associated with the rivers.
- Thatch grass harvesting.
- Reed harvesting.
- Other Riparian vegetation usage.
- Sand mining.
- Waste water dilutions.
- Floodplain agricultural usage of subsistence purposes.
- The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the Kruger Park.
- Dis-benefits associated with malaria, bilharzia, black fly and livestock disease.

5.4 STATUS QUO ASSESSMENT

The study area intersects with 4 district municipalities, namely the Capricorn, Vhembe, Mopani and Bohlabela District Municipalities, as defined in Census 2001. However, over the last decade structural adjustments have resulted in changes in the municipal administrative structure in the study area. Specifically this includes the incorporation of the Bohlabela District Municipality into the Mopani District Municipality. The study area extends to a limited degree into the Capricorn and Vhembe District Municipalities. The provincial capital, and economic centre, of Polokwane is located in the Capricorn District Municipality; however it does not fall directly into the study area. No other major centres or towns are present within the study area. The presence of significant rural townships is noted in the Vhembe-Mopani District Municipal boundaries.

The study area falls mostly within the Mopani District Municipality, which has approximately 352 settlements – comprised of 81 first order, 30 second order, and 190 third and fourth order settlements (Mopani District Municipality, 2006). District nodes include Giyani, Tzaneen, Polokwane, Modjadjiskloof, Phalaborwa and Lydenburg. The district IDP (Mopani District Municipality, 2006) effectively defined 16 growth points or population concentration points comprising of first and second order settlements – which accounts for nearly half of the district population. The remaining half is located in rural third and fourth order settlements.

The urban component of the Mopani District Municipality is limited, incorporating 20% of the population according to Census 2011 figures. However the district node of Phalaborwa shows a much higher level of urbanisation with almost half living in urban settlements. Phalaborwa, however, does not fall within the study area but plays a vital supporting role to local rural settlements.

The study area contains a number of local nodes or towns which vary in size and function. The highest density is located on the south-western portion of the study area which is linked to the regionally important node of Tzaneen. The remaining settlements are largely scattered thought-out the east and central area of the district municipality, while restricted in the western portions by the Kruger National Park.

The total population of the combined district municipalities is estimated to be 3,318,783 for 2001, and 3,648,975 for 2011, with an overall population growth rate of 0.90% per annum (Table 5.1). Population growth varies at the local municipal level, with both positive and negative growth trends. This is largely attributed to rural-urban migration to local town centres, as well as other parts of South Africa.

The study area does not align with district and local municipal boundaries, hence the population figures presented have been normalised based on catchment area. Based on the analysis of Census 2001 data, a population of 844,022 live within the study area, or 25% of the 3 district municipalities' total population. This increases to a projected population of 873,003 for 2011.

Table 5.1 Population numbers per district and local municipality (Statistics SA, n.d.)

District Municipality	Local Municipality	Census 2001	Census 2011	Population Growth (%)
Vhembe	Thulamela	584 559	618 462	0.55
	Makhado	497 080	516 031	0.37
	Mutale	-	-	-
	Musina	-	-	-
Sub-Total		**1 081 639**	**1 134 493**	0.47

District Municipality	Local Municipality	Census 2001	Census 2011	Population Growth (%)
Mopani	Greater Letaba	220 123	212 701	-0.35
	Greater Giyani	237 436	244 217	0.28
	Greater Tzaneen	375 584	390 095	0.37
	Ba-Phalaborwa	131 084	150 637	1.30
	Maruleng	-	-	-
Sub-Total		**964 227**	**997 650**	0.34
Capricorn	Blouberg	-	-	-
	Aganang	-	-	-
	Molemole	109 436	108 321	-0.10
	Polokwane	508 271	628 999	1.92
	Lepele-Nkumpi	-	-	-
Sub-Total		**617 707**	**737 320**	1.62
Total		**2 663 573**	**2 869 463**	0.72

The study area is located in a region that is largely rural in nature with a number of regionally important urban nodes and smaller satellite towns, as well as rural settlements. The distribution of population by either aggregated urban or rural settlement is depicted in **Error! Reference source not found.**. Caution is needed in terms of the interpretation of findings between Census 2001 and Census 2011, as the categories adopted in determining enumerator type differ. However general inferences may be made. The population in the study area is predominantly rural – accounting for 90% and 76% of the population in 2001 and 2011 respectively. The reduction in value within the last decade is largely attributed to rapid rural-urban migration, as well as the differing enumerator categories.

The average population density within the 3 district municipalities is 35 individuals per kilometre squared (km^2). However the density varies by local municipality – between 9 and 167 individuals per km^2. This variation can be attributed to the rural/urban divided and specifically the location of provincial and regional nodes. Population density in the study area (by quaternary catchment) varies from 0 to up to 353 individuals per km^2. The lower values are attributed to the presence of the Kruger National Park on the eastern portion of the study area. Higher densities are attributed to regional nodes (Tzaneen), large rural townships and the relatively smaller catchment area.

Table 5.2 Population by settlement type based on Census 2001 and Census 2011 enumerator type

District Municipality	Local Municipality	Census 2011				
		Urban Residential	Rural Settlements	Other	Total	Rural Settlement (& of Total Settlements)
Vhembe	Thulamela	107 088	503 112	8 262	618 462	81
	Makhado	31 471	460 444	24 116	516 031	89
	Mutale	-	-	-	-	-
	Musina	-	-	-	-	-
	Sub-Total	**138 559**	**963 556**	**32 378**	**1 134 493**	**85**
Mopani	Greater Letaba	15 858	184 422	12 421	212 701	87
	Greater Giyani	31 111	210 373	2 733	244 217	86
	Greater Tzaneen	43 970	317 455	28 670	390 095	81
	Ba-Phalaborwa	69 586	70 778	10 273	150 637	47
	Maruleng	-	-	-	-	-
	Sub-Total	**160 525**	**783 028**	**54 097**	**997 650**	**78**
Capricorn	Blouberg	-	-	-	-	-

District Municipality	Local Municipality	Census 2011				
		Urban Residential	Rural Settlements	Other	Total	Rural Settlement (& of Total Settlements)
	Aganang	-	-	-	-	-
	Molemole	16 937	84 013		108 321	78
	Polokwane	248 699	343 884		628 999	55
	Lepele-Nkumpi	-	-	-	-	-
Sub-Total		**265 636**	**427 897**		**737 320**	**58**
Total		**564 720**	**2 174 481**		**2 869 463**	**76**

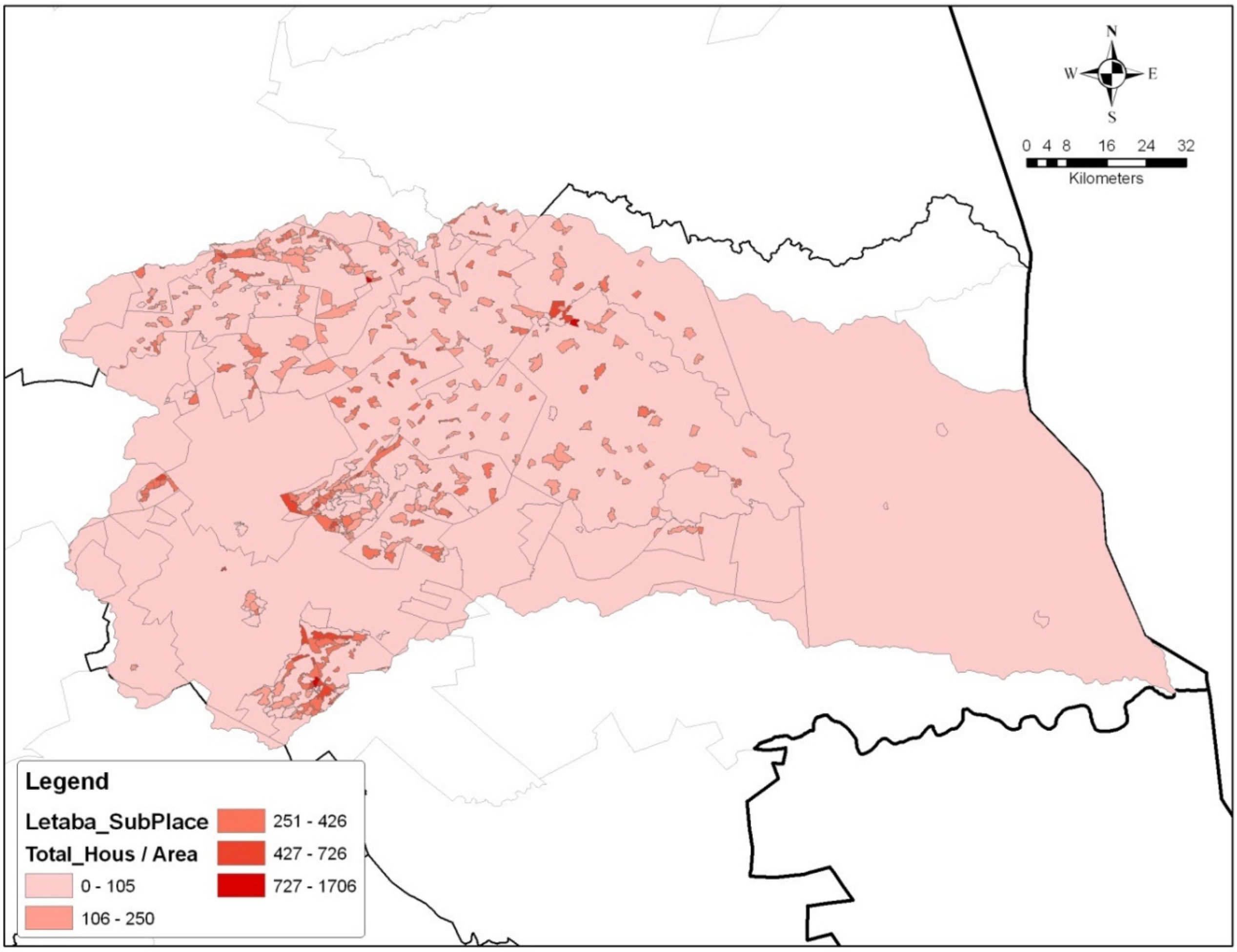


Figure 5.1 Study Area - Population Density

Important to this report is household dependency on informal water supply as determined by Census 2001 and Census 2011. Informal water supply includes all Census 2001 categories excluding water provided by pipes, as this assumes that piped water negates the need for the use of natural sources of water. Informal sources of water include borehole, spring, rain water, dam/pool, river/stream, water vendors or other.

In the Mopani District Municipality, the majority of the population has access to some form of formal water source. Ba-Phalaborwa Local Municipality shows the best performance with only 2% of the population still dependant on informal water sources. This is generally attributed to the smaller population and absence of scattered villages in Ba-Phalaborwa (Mopani District Municipality, 2006). The worse performing local municipality is Great Giyani, which is attributed to the spatially scattered pattern of settlements, which increases water infrastructure requirements.

An analysis of population density, settlement typology, and restriction in terms of dependence on infrastructure (in this case water services) is important as it serves to identify the communities most likely to be directly dependent on ecological goods and services. Evident from the analysis of the areas that are potentially dependant is that the bulk is poor and associated with areas that were neglected during the apartheid area. They include area associated with the former homeland system. Table 5.3 sets out the number of households per quaternary catchment that are either served by a formal water supply system or are dependent on an informal system. It is these households that are not connected to a formal system that are likely, although not inevitably, dependant on the EGSA generated by the river and associates systems. The overall percentage of households dependent on informal water sources can vary significantly by catchment – from 0 to up to 28% of the total households. The lowest values are recorded in the Kruger National Park and surrounds due to the minimal numbers of recorded households. The highest recorded dependencies are noted in catchments B81E, B81H, B81F, B81G and B81J.

Table 5.3 Households with formal vs informal water supply

Quaternary Catchment	Total Households	Households with Formal Water Supply	Households with Informal Water Supply	Per cent of Households without Formal Water Supply
B81A	709	638	71	10
B81B	2741	2518	223	8
B81C	3123	2864	259	8
B81D	9336	8047	1289	14
B81E	5143	3679	1463	28
B81F	7897	6461	1436	18
B81G	7678	6381	1297	17
B81H	5106	3784	1322	26
B81J	1262	1061	200	16
B82A	2522	2171	351	14
B82B	2467	2262	205	8
B82C	3135	2821	315	10
B82D	7724	7149	574	7
B82E	1030	868	162	16
B82F	4760	4105	655	14
B82G	10846	10095	751	7
B82H	1184	1138	47	4
B82J	128	122	5	4
B83A	233	207	26	11
B83B	6	6	0	0
B83C	8	8	0	0
B83D	21	21	0	0
B83E	4	4	0	0
Total	**77062**	**66411**	**10651**	

Further analysis of the catchment per sub-quaternary (SQ), as captured in Table 5.4, gives a summary of the overall socio-economic condition that pertains and likely significance of dependence on ecological goods and services attributed. Note that the km information provided is approximate and is relevant for the river length as obtained from Google Earth. Significance is scored as follows:

Insignificant: No communities likely to dependent on EGSA.

Insignificant but High Recreation Significance: Applies largely to the Kruger Park areas where there are no communities directly and permanently dependent on EGSA but where the aesthetic and associated recreation value of the river is critical as a tourism entity.[1]

Low significance: Some communities may be marginally dependent on EGSA but overall not likely to be a critical issue

Moderate significance: Communities, among whom there may be vulnerable groupings for who EGSA could form a significant part of livelihood dependence.

High significance: Either large numbers of people in communities with a significant dependence on EGSA or small communities but having critical dependence on EGSA.

Table 5.4 Overall socio-economic condition and likely significant of dependence on EGSA

SQ no	River	Causes/sources comment	Significance of dependence on EGSA
B81A-00242	Broederstroom	15 km. Exclusively rural, no towns or villages noted. Dominant land-use formal plantation forestry, associated infrastructure (buildings, roads and small dams).	Low Significance
B81A-00256		5 km, of which ⅔ is within the Ebenezer Dam reservoir. No towns or villages. Recreational activities / infrastructure present on or around the dam. Remaining ⅓ is dominated by formal plantation forestry including associated infrastructure (buildings, roads and small dams).	Low Significance
B81A-00263		5 km: Exclusively rural, with no towns or villages. Dominant land-use: formal plantation forestry, including associated infrastructure (buildings, roads and small dams). The formal town of Haenertsburg (formal town planning, large properties and structures - middle class) is located within 200 m of the river.	Low Significance
B81A-00270	Broederstroom	17 km of which ⅓ within the Ebenezer Dam reservoir. No town or villages present. Recreational activities / infrastructure present on or around the dam. Remaining ⅔ is dominated by formal plantation forestry, associated infrastructure (buildings, roads and small dams).	Low Significance
B81B-00233	Mahitse	4 km: Rural, with no towns or villages. Dominant land-use is plantation forestry and orchards accounting approximately half of land area.	Low Significance
B81B-00234	Mahitse	4 km: Exclusively rural, with no towns or villages. Dominant land-use is forestry and orchards (including farm/plantation infrastructure) accounting approximately 80% of land area. Remaining land is comprised of local vegetation.	Low Significance
B81B-00246	Politsi	10 km: Exclusively rural, with no town or villages. Land-use include natural vegetation (30% of extent) including tourism/recreational activities/infrastructure. Remaining 70% of extent is a mixture of formal forestry, farmland associated infrastructure.	Low Significance
B81B-00251		4 km: Exclusively rural, with one small unnamed village (formal town plan, minimal property size and small structures - low cost housing). Dominant land-use: Formal farming (regenerating farmland), associated infrastructure (buildings, roads, small dams)	Low Significance
B81B-00269	Morudi	7 km: Exclusively rural, with no town or village. Land-use is dominated by a mosaic of formal plantation forestry and river valley bottom vegetation, comprising nearly 90% of the river extent. Limited present of orchards noted.	Low Significance
B81B-00227	Mahitse	11 km: Exclusively rural, and 80% falls within the Tzaneen Dam reservoir. Limited tourism/recreational activities noted and limited to the Tzaneen Golf Course. Surrounding land-use is dominated by formal farmland (orchards) and forestry. The town of Politsi is located within 1.5km of the river (predominantly warehousing and limited residential)	Low Significance
B81B-00240	Politsi	9 km: Exclusively rural, (30% within the Tzaneen Dam). River crosses the Tzaneen Dam Nature Reserves and recreational/ tourism activities and infrastructure is present. The remaining 70% dominated by formal	Low Significance

[1] The 2006 Comprehensive Reserve Determination for the Letaba River separated the Kruger Park areas from the rest of the system and treated it under a separate analytical heading with respect to EGSA.

SQ no	River	Causes/sources comment	Significance of dependence on EGSA
		farmland (orchids) and forestry.	
B81B-00247	Great Letaba	12 km: Rural and urban elements. 60% of river extent falls within the Tzaneen Dam. Adjacent land-use is forestry and formal agriculture. Tzaneen is located on the southern side of the river and covers 40% of the river. Recreational and tourism activities and infrastructure.	Low Significance
B81B-00264	Great Letaba	22 km: Exclusively rural, and no town or village. The upper reaches fall within the Ebenezer Dam. The remaining extent is nearly exclusively comprised of formal plantation forestry, formal agriculture and natural vegetation.	Low Significance
B81C-00245	Great Letaba	32 km: Rural and urban elements. Upper reaches (<1 km located) located in the Tzaneen Dam. Urban elements include Tzaneen Town for 7 km (formal town, middle class) and Makgolobotho and Nkowankowa Townships (formal town plan, small properties and structure) 10 km of the river extent. Both towns are located on the southern side of the river. The remaining land-use is nearly exclusively formal agriculture.	Low Significance
B81D-00277	Thabina	30 km: Exclusively rural. River is flanked by townships for 85% - including Morang, Lelolo, Tlhabie and Lenyeenyee. Subsistence agricultural fields form a buffer between the river and the township and are the dominant land-use along the river extent. The remaining 15% of the river extent is natural/transformed vegetation, as well as the Thombena Dam.	High Significance
B81D-00280	Bobs	11 km: Exclusively rural, with no towns or villages. The dominant land-use is natural forest (Agatha Forest) accounting for 60% of the total river extent, although some forestry is in proximity to the river. The remaining 40% of the total river extent is comprised of formal agriculture and limited forestry.	Insignificant
B81D-00296	Mothlaka-Semeetse	9 km: Exclusively rural, with no towns or villages. Land-use is comprised of natural forest (33% of river extent), forestry (44%) and formal agriculture (23%).	Insignificant
B81D-00271	Letsitele	4 km: Rural. The Mariveni Township forms much of the north bank, and the Shinhungu Township is located on its south bank. Land-use other than townships include subsistence and formal agriculture.	High Significance
B81D-00272	Letsitele	26 km: Rural. Considerable presence of township - extending 15 km along the southern bank of the river including the Magoboya and Khujwana townships, as well as extending 9km along the northern bank of the river covering the Nkowankowa Township. It is noted that subsistence agriculture is undertaken along the river and functions as a buffer to the township proper. Formal agriculture is undertaken on a 15 km stretch of the river along the north bank.	High Significance
B81E-00213	Nwanedzi	37 km: Rural. Considerable presence of township - namely extending 16 km along the northern bank of the river including the Maleketla Townships, as well as extending 9km along the northern bank of the river covering the Mamitwa Township. There is limited evidence of subsistence agriculture. Formal agriculture on a 16 km stretch of the river along the south bank, and both sides of the river for an additional 9 km on the lower reaches of the river.	High Significance
B81E-00244	Great Letaba	21 km: Exclusively rural, with 2 towns - Letsitele (formal town plan, middle class) and Nkanbako township (<3 km of river extent). Near total dominant land-use is formal agriculture including associated infrastructure (buildings, roads and small dams).	Moderate Significance
B81F-00189	Merekome	30 km: Exclusively rural. Significant presence of townships along the river, including Marapalala, Ga-Moloko, Ga-Mawa Block 6 & 7, Gamela, and Merekame. Significant evidence of subsistence agriculture surrounding the townships.	High Significance
B81F-00203	Lerwatlou	30 km: Exclusively rural. A significant presence of townships along the river, including Botudi, Pjapjamelo, Mavele, Joppie, Runnymede, Xihoko and Nyakelani (cumulatively accounting for 15km (50%) of the entire extent of the river). Significant evidence of subsistence agriculture surrounding the townships. Formal agriculture is limited to the lower 6km of the river.	High Significance
B81F-00228	Reshwele	21 km: Exclusively rural. Entirely contained within the Ndzalama / Hans Merensky Nature Reserve.	Insignificant but High Recreational Significance
B81F-00232	Makwena	18 km: Exclusively rural. Entirely contained within the Ndzalama / Hans Merensky Nature Reserve. Noted some formal agriculture on lower 3 km	Insignificant but High Recreational

SQ no	River	Causes/sources comment	Significance of dependence on EGSA
		of the river.	Significance
B81F-00200	Great Letaba	20 km: Exclusively rural. A narrow band of formal agriculture along an 8km stretch, and thereafter the river flows into the Ndzalama/Hans Merensky Nature Reserve. The Makhwivirini and Prieska-A townships are located near the river however they cover a limited extent of the river.	Moderate Significance
B81F-00212	Great Letaba	9 km: Exclusively rural, with one township of Ka-Khaxan within 1 km north of the river. Land-use comprises open vegetation and limited formal agriculture. Evidence of subsistence based agriculture and/or smallholdings linked to Ka-Khaxan.	High Significance
B81F-00215	Great Letaba	9 km: Exclusively rural, with one township of Ka-Xihlakati within 1 km north of the river. Land-use comprises open vegetation and limited formal agriculture. There is also evidence of subsistence based agriculture and/or smallholdings linked to the township.	High Significance
B81F-00218	Great Letaba	4 km: Exclusively rural with no villages or towns noted. Exclusively formal agriculture.	Low Significance
B81F-00231	Great Letaba	18 km: Exclusively rural. The township of Nkambako is located on the north bank of the river and extends along the upper 3 km. Some evidence of subsistence agriculture between the township and the river. The remaining land-use (83%) is formal agriculture.	Moderate Significance
B81G-00164	Molototsi	50 km: Exclusively rural. Townships (numbering 15) flank the river on both sides for almost the entire extent of the river. Township density is reduced further downstream. There is extensive evidence of informal farming/smallholdings.	Moderate Significance
B81H-00162	Metsemola	12 km: Exclusively rural. Townships present include Basani and Nwa-Manekna East which extend for less than 10% of the river. Much of the river extent crosses open terrain with a small presence of informal farming/smallholdings.	Moderate Significance
B81H-00171	Molototsi	46 km: Exclusively rural. Ten townships are located in proximity to the river and there is evidence of informal farming/smallholdings within proximity to these townships, and near the river.	Moderate Significance
B81J-00187	Mbhawula	46 km: Exclusively rural. Four townships are located in proximity to the river and there is evidence of informal farming/smallholdings within proximity to these townships near the river.	Moderate Significance
B81J-00209	Great Letaba	20 km: Exclusively rural. Three townships are located in proximity to the river and there is evidence of informal farming/smallholdings within proximity to these townships near the river. Recreational / tourism activities and infrastructure on this stretch of the river.	Moderate Significance
B81J-00219	Great Letaba	10 km: Exclusively rural and entirely located in the Letaba Game Reserve. No towns or villages. Recreational/tourism activities and infrastructure on this stretch of the river.	Insignificant but High Recreational Significance
B82A-00168	Middel Letaba	60 km: Exclusively rural. The Ga-sekgapo township is located on the north bank of the river for approximately 8km, while a second township (Lemondokop) is located in proximity to the river. There is a near continuous band of informal farms/smallholding along a 30 km stretch of river between the two townships.	Moderate Significance
B82B-00173	Koedoes	54 km: Exclusively rural, with no towns or villages. The land-use along the river is nearly exclusively formal agriculture, with limited small-holding on the upper reaches. There remains some open terrain between the agricultural fields.	Low Significance
B82C-00175	Brandboontjies	32 km: Exclusively rural, with the exception that the river commences at Madjadjiskloof town (formal farm town, middle class). The land-use is dominated by a mosaic of open terrain and formal agriculture.	Low Significance
B82D-00163	Lebjelebore	30 km: Exclusively rural. Comprises deeply incised hills. Three townships. Evidence of both subsistence agriculture and small-holding along 70% of the river extent. Rest is open terrain.	Moderate Significance
B82D-00154	Middel Letaba	16 km: Exclusively rural. The township of Sephukhubje extends for 4km along the south bank of the river. Land-use is near exclusively formal agriculture and potential smallholding, which extend to over 90% of the extent of the river.	Moderate Significance
B82D-00166	Mosukodutsi	11 km: Exclusively rural. Two townships (Rotterdam and Blinkwater) are located in proximity to the river. Evidence of informal agriculture/smallholdings in proximity to the townships near the river.	Moderate Significance

SQ no	River	Causes/sources comment	Significance of dependence on EGSA
B82D-00146	Middel Letaba	25 km: Exclusively rural. Two townships are located in the upper 7 km reach of the river, namely Ximausa and Phikela. Evidence of informal agriculture/smallholdings in proximity to these townships and near the river. The river drains into the Middle Letaba Dam.	Moderate Significance
B82E-00149	Khwali	20 km: Exclusively rural, and entirely comprised of unutilised terrain/open vegetation. The township of GaMathule is located at the bottom reaches of this stretch of river. Presence of informal farming/smallholdings near the township for 2 km along the river.	Moderate Significance
B82E-00150	Little Letaba	25 km: Exclusively rural. The upper 25% of the river is comprised of formal agriculture, while approximately 50% of the extent of the river is unutilised land/open vegetation. Three townships are located in proximity to the river, namely Muila, Mamphagi and GaMathule. There is a mosaic of informal agricultural fields/smallholding close to the river.	High Significance
B82F-00141	Soeketse	24 km: Exclusively rural, with no noticeable formal agriculture. Three townships (Thovhalas-Kraal, Mukondeni and ha-Mashamba) with associated informal agricultural fields/smallholding - 70% of the river extent. The remaining 30% is comprised of deeply incised valley bottom vegetation and open vegetation.	High Significance
B82F-00128	Little Letaba	30 km: Exclusively rural. Significant presence of townships along the river, including 4 major settlements and a number of smaller unnamed settlements. Significant evidence of subsistence agriculture surrounding the townships. Inversely, there is a near lack of any formal plantations or agriculture.	High Significance
B82F-00137	Little Letaba	27 km: Exclusively rural. Significant presence of townships along the river, including 6 large settlements. Significant presence of informal agricultural fields/smallholdings near the townships. In combination, they account for 60% of the land-use along the river extent. The remainder is made up of unutilised/open terrain.	High Significance
B82G-00135	Little Letaba	70 km: Rural and urban elements. The river extent include 7 townships and 1 formal town (Giyani) the latter being the district municipal capital. Land-use is a mosaic of open unutilised land (44% of river extent) and informal agricultural fields/smallholding associated with the townships (46% of river extent). Limited, formal agriculture accounting for less than 10% of the river extent.	High Significance
B82H-00127	Nsama	50 km: Exclusively rural. Six townships, of which two townships include informal agricultural fields/smallholdings (25%). The river drains into the Hudson Ntsanwisi Dam. Remaining land-use is near exclusively unutilised open terrain/vegetation.	High Significance
B82H-00139	Magobe	23 km: Exclusively rural. Dominant landform is unutilised open terrain/land. Two townships (Khakhala and Gaula) are located in proximity to the river, and include limited presence of informal agricultural plots/smallholdings.	High Significance
B82H-00157	Nsama	17 km: Exclusively rural, and no villages or towns. Landform is exclusively unutilised /open terrain will minimal presence of informal agricultural fields/smallholdings.	Low Significance
B82J-00153	Nalatsi	25 km: Exclusively rural, and entirely comprised of unutilised/open terrain (potentially associated with the Kruger National Park). Minimal presence of one township (Macene) near the lower reaches of the river.	Moderate Significance
B82J-00159	Byashishi	25 km: KNP.	High recreation significance
B82J-00197	Ka-Malilibone	11 km: Exclusively rural. One township (Phalakubeni) located on the south bank. Informal agricultural fields/smallholdings associated with the township (6 km (55%)). The remaining 45% of land is comprised of unutilised/open terrain.	High Significance
B82J-00165	Little Letaba	20 km: KNP.	High recreation significance
B82J-00178	Little Letaba	7 km: Exclusively rural, with one township (Macene). Informal agricultural plots/smallholdings associated with the township (85%). Remaining 15% is unutilised/open terrain.	High Significance
B82J-00201	Little Letaba	7 km: KNP.	High recreation significance
B82J-00207	Little Letaba	4 km: KNP.	High recreation significance

SQ no	River	Causes/sources comment	Significance of dependence on EGSA
B83A-00193	Shipikani	37 km: KNP. Presence of small Stapelkop Dam.	High recreation significance
B83A-00238	Nharhweni	37 km: Exclusively rural. KNP. No noted recreational/tourism features. Presence of Luwekani-B township on the upper reaches of the river.	Moderate Significance
B83A-00254	Ngwenyeni	37 km: KNP. Noted some recreational/tourism features.	High recreation significance
B83A-00220	Letaba	11 km: KNP.	High recreation significance
B83A-00230	Letaba	18 km: KNP. Recreational/tourism features (bushcamp, lookouts points) noted.	High recreation significance
B83A-00235	Letaba	20 km: KNP. Some recreational/tourism features (lookouts points) noted.	High recreation significance
B83A-00252	Letaba	1 km: KNP. No recreational/tourism features noted.	High recreation significance
B83B-00161	Tsende	60 km: KNP. Significant recreational/tourism features (bushcamp, lookouts points etc.) noted.	High recreation significance
B83D-00204	Manyeleti	17 km: KNP. No recreational/tourism features noted. In proximity to the Mozambique border	High recreation significance
B83D-00208	Makhadzi	17 km: KNP. No recreational/tourism features noted. In proximity to the Mozambique border	High recreation significance
B83D-00261	Nwanedzi	35 km: KNP. Some recreational/tourism features (lookouts points, waterholes) noted.	High recreation significance
B83D-00236	Makhadzi	17 km: KNP. Some recreational/tourism features noted (picnic site). In proximity to the Mozambique border	High recreation significance
B83D-00250	Letaba	4 km: KNP. Some recreational/tourism features (lookouts points) noted.	High recreation significance
B83D-00255	Letaba	9 km: KNP. Recreational/tourism features (lookouts points, Letaba Campsite) noted.	High recreation significance
B83E-00265	Letaba	35 km: KNP. Recreational/tourism features (lookouts points, Letaba Campsite) noted.	High recreation significance

5.5 EGSA ZONES

Based on the status quo analysis the catchment has been divided into zones that reflect the EGSA as a direct dependent of land use attributed. Figure 5.2 reflects the zonal demarcation. For the purposes of this catchment five different land use forms that reflect types of EGSA that might be associated with the usage have been identified. It should be noted that as the building block for the analysis is the SQ a judgment call has to be made as to which land form dominates in the section under consideration. In some instance there are multiple land uses that apply to the SQ.

The land use based zones are:

- Commercial Agriculture and Plantation: This is largely given over to zones dominated by commercial farming entities. Utilisation of ecological goods and services tends to be low and restricted often to farm workers or incidental recreational aspects.
- Subsistence agriculture: These areas are dominated by subsistence agriculture but in areas where population densities are relatively low. Utilisation of ecological goods and services tends to be higher here and the populations that make use are often poor and marginal.
- Rural Closer Settlement – Subsistence: These are the former homeland areas that have generally higher population densities than the purely subsistence areas. In some instance densities are high enough to be categorised as closer settlement/informal urban. Utilisation of ecological goods and services tends to be higher here and the populations that make use are often poor and marginal. However, the population densities are such that resources tend to be under pressure.

- High Density Formal Urban: These are the SQs heavily influenced by the town of Tzaneen. The utilisation of ecological goods and services tends to be low as the populations tend to be urbanised and alienated from direct use of the resources.
- Recreational/Dams/Game Farms. These are areas given over to game farms (notably the Kruger Park) as well as SQs dominated by dams. Recreational usage tends to dominate ecological goods and services attributes.

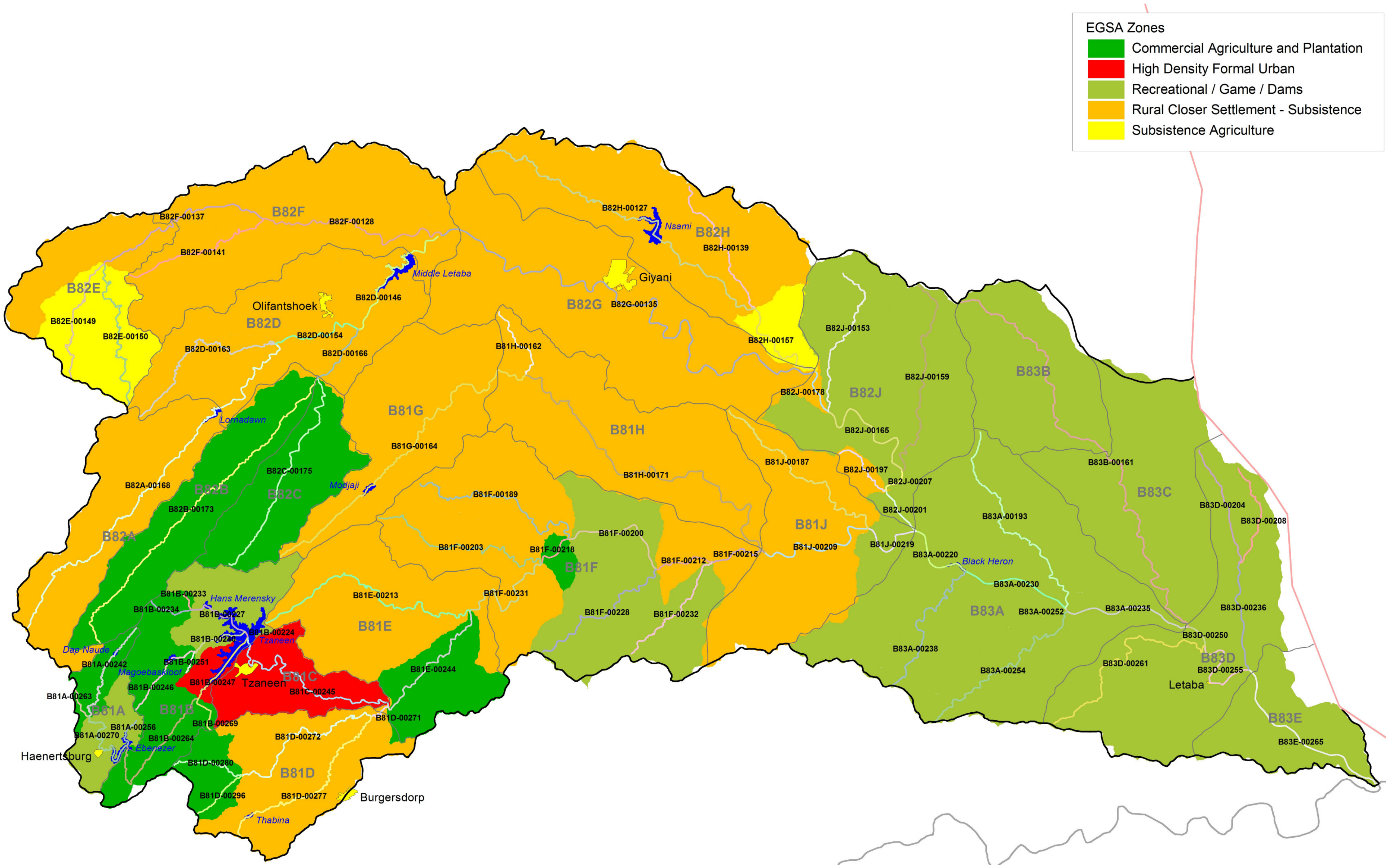


Figure 5.2: EGSA zones

6 STATUS QUO ASSESSMENT: ECOLOGICAL (WETLAND)

6.1 INTRODUCTION

An assessment was made to identify quaternary and sub-quaternary catchments that are potentially important due to the presence, frequency, extent or condition of wetlands. These wetlands were then evaluated to determine the Present Ecological State (PES) of each wetland. The assessment was conducted as a desktop exercise and made use of the Letaba Wetland Scoping report (DWAF 2006c), the National Freshwater Ecosystem Priority Areas (NFEPA) wetland classification and importance coverages, (Nel *et al.*, 2011) and the PESEIS work that was done for the B8 secondary catchment (Kotze *et al.,* 2012).

6.2 SELECTION OF WETLANDS FOR PES ASSESSMENT

6.2.1 Approach

Quaternary catchments within the B8 secondary catchment were assessed for potential wetland importance (Table 6.1) by combining the frequency of different wetland types (NFEPA classification) and the total extent of all wetland types (area) within each quaternary. The results were scored on a scale of 0 to 3 where 0 = no potential importance and 3 = high potential importance. NFEPA wetland spatial data were used for the analysis (Nel *et al.*, 2011), and the presence of NFEPA wetland clusters (non-riverine wetland clusters of significance) and wetland Freshwater Ecosystem Priority Area (FEPAs - the final wetland FEPAs selected by review) were also considered. Only wetlands classified as “natural” were used for the analysis.

The results were used together with a similar analysis at the SQ scale, to highlight a subset of SQs that warrant an assessment of PES and EIS (refer to Chapter 10) for the wetland component within the respective SQ (Table 6.2). All SQs that achieved a score of 3 (potential wetland importance due to frequency of occurrence) or contained a FEPA wetland were then assessed for PES using the Wetland IHI (DWAF, 2007a).

6.2.2 Wetlands selected for PES assessment

Quaternary catchments B82F, B82G and B83D contained wetland clusters of significance (Nel *et al.*, 2011), while B81C, B81D, B81E, B81F, B82F, B82G, B83J, B83A, B83B, B83C and B83D contained FEPA wetlands (Table 6.1) and B81B, B81C, B81D, B81E, B81F, B82B, B83A and B83D were highlighted for potential wetland importance (scores of 3 due to frequency of occurrence or large total aerial extent). B81A, B81B, B82A, B82B were highlighted as containing potential wetlands by DWAF (2006c), B81F and B82G have thermal springs associated with them (DWAF, 2006c), and B81C, B81D and B81E contain wetlands identified by NLC 2000 coverage (DWAF, 2006c).

Table 6.1 Expected wetland importance per quaternary catchment

Quat	NFEPA Wetland Type (frequency)								Wetland FEPA		Tot Wetland Area (NFEPA, 2013)	Screening
	Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep	Total	Wet Cluster (non riparian by definition)	Wetland FEPA (quat)		Expected Importance (0-3)
B81A	2		14		116	3		135			3517995.3	2
B81B	56		48		13	25	87	229			22103831.5	3
B81C	148		43		7	20	4	222		y	6655649.1	3
B81D	142		23		30	32	5	232		y	12163445.5	3
B81E	364		99		34	30	81	608		y	31531654.5	3
B81F	256	2	37		33	15	11	355		y	12794673.9	3
B81G	47	1	5		24	6		83			2693258.0	1
B81H	53	1	20		34	3	1	112			2411245.9	2
B81J	31		7	1	12	1		52			5059708.8	2
B82A	15		18		19	6	2	60			3097849.9	1
B82B	176		30		13	15	1	235			5481475.0	3
B82C	123		5		7	17	7	159			3660981.7	2
B82D	31		10	11	7	4	12	75			9239468.8	2
B82E	4		20		89			113			665880.3	2
B82F	74	2	8	1	30	5		120	y	y	2749462.9	2
B82G	97	4	26		36	23	8	194	y	y	3918277.3	2
B82H	23	2	12		26	6	6	75			6896971.8	2
B82J	25	11	17		2	5		60		y	2006215.5	1
B83A	30	5	10	7	39		1	92		y	11426316.5	3
B83B	7	5			1			13		y	1076602.6	1
B83C	14	12	11	4			10	51		y	7938018.8	2
B83D	5	3	2	37	6		11	64	y	y	12448583.5	3
B83E	4	2	1	1			5	13			7166247.7	2
Total	**1727**	**50**	**466**	**62**	**578**	**216**	**252**	**3352**	**3**	**11**	**176703814.7**	**8 (High)**

Table 6.2 Expected wetland importance per sub-quaternary catchments

Sub-quat		NFEPA Wetland Type (frequency of occurrence in sub-quat)								Wetland FEPA	Wetland Screening
Code	Name	Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep	Total	(only if associated with riparian)	Expected Wetland Importance (0-3)
B81A-00242	**Broederstroom**					6			6		1
B81A-00256						2			2		1
B81A-00263				3		7			10		2
B81A-00270	**Broederstroom**	2				19			21		3
B81B-00233	Mahitse										0
B81B-00234	Mahitse										0
B81B-00246	**Politsi**	3							3		1
B81B-00251		1					1		2		1
B81B-00269	Morudi										0
B81B-00227	Mahitse	6							6		1
B81B-00240	Politsi	2		2			3	7	14		2
B81B-00247	Great Letaba	1							1		1
B81B-00264	Great Letaba	3				4	3		10		2
B81B-00224	Mahitse	3							3		1
B81C-00245	**Great Letaba**	56		6			3	5	70	y	3
B81D-00277	**Thabina**	6					2		8	y	1
B81D-00280	Bobs										0
B81D-00296	Mothlaka-Semeetse						1		1		1
B81D-00271	Letsitele	1							1		1
B81D-00272	**Letsitele**	18					2		20	y	3
B81E-00213	**Nwanedzi**	54		1			2		57	y	3
B81E-00244	**Great Letaba**	25		6			3	1	35	y	3
B81F-00189	Merekome	4		1					5		1
B81F-00203	Lerwatlou	3				1			4		1
B81F-00228	Reshwele	5							5		1
B81F-00232	Makwena	8				1	1		10		2
B81F-00200	**Great Letaba**	16		1			2	2	21		3
B81F-00212	Great Letaba	14					1	1	16		2
B81F-00215	Great Letaba	10							10		2
B81F-00218	Great Letaba	7					1		8		1
B81F-00231	**Great Letaba**	24		1			2		27	y	3
B81G-00164	Molototsi	5		1		3	1	1	11		2
B81H-00162	Metsemola	4				4			8		1

B81H-00171	Molototsi	8		1			1		10		2
B81J-00187	Mbhawula	2							2		1
B81J-00209	Great Letaba	17							17		2
B81J-00219	Great Letaba	4			2				6		1
B82A-00168	**Middel Letaba**	7					2		9		1
B82B-00173	**Koedoes**	73		17		6	9		105		3
B82C-00175	Brandboontjies	50		3			3	3	59		3
B82D-00163	Lebjelebore					2			2		1
B82D-00154	Middel Letaba	2					1		3		1
B82D-00166	Mosukodutsi	3							3		1
B82D-00146	Middel Letaba	4		4	10		1	7	26		3
B82E-00149	Khwali					3			3		1
B82E-00150	Little Letaba					10			10		2
B82F-00141	Soeketse	3							3		1
B82F-00128	**Little Letaba**	33					1		34		3
B82F-00137	Little Letaba	9	1				1		11		2
B82G-00135	**Little Letaba**	41		2			3	1	47	y	3
B82H-00127	Nsama	4		7		2	2	5	20		3
B82H-00139	Magobe			1					1		1
B82H-00157	**Nsama**	3							3		1
B82J-00153	Nalatsi	1	1	1					3		1
B82J-00159	**Byashishi**		1	3					4	y	1
B82J-00197	Ka-Malilibone										0
B82J-00165	**Little Letaba**	7		3			2		12	y	2
B82J-00178	Little Letaba	4					2		6		1
B82J-00201	Little Letaba	3			3				6		1
B82J-00207	**Little Letaba**	1		1					2		1
B83A-00193	Shipikani	3				9			12		2
B83A-00238	Nharhweni					5			5		1
B83A-00254	Ngwenyeni	1							1		1
B83A-00220	Letaba	3			1				4		1
B83A-00230	Letaba	8							8		1
B83A-00235	Letaba	10			3				13		2
B83A-00252	Letaba										0
B83B-00161	**Tsende**	8	1	3	3			5	20	y	3
B83D-00204	Manyeleti	2							2		1
B83D-00208	Makhadzi										0
B83D-00261	Nwanedzi				1				1		1
B83D-00236	Makhadzi				2				2		1

B83D-00250	Letaba				3				3		1
B83D-00255	Letaba	1			12			11	24		3
B83E-00265	Letaba	4			3			1	8		1
Total		**600**	**4**	**68**	**43**	**84**	**56**	**50**	**905**	**10**	**15 High**

where:

NFEPA

Potential wetlands (Marneweck, 2006)

Wetlands identified by NLC 2000 coverage (Marneweck, 2006)

Thermal springs (Marneweck, 2006)

6.3 STATUS QUO

6.3.1 Approach to determine wetland PES

All SQs that achieved a score of 3 (potential wetland importance due to frequency of occurrence) or contained a FEPA wetland were assessed for determining the PES using a combination of Google Earth © (used mainly for verification of NFEPA data and impacts) and the Wetland IHI (DWAF, 2007a) where wetlands were floodplain or channelled valley-bottom wetlands. The Wetland IHI was frequently modified in its application: the impacts of mining/excavation were rated interchangeably with agricultural encroachment. This was done because frequently agricultural activities were the largest impacts on wetlands and are not directly rated in the Wetland IHI, whereas mining is frequently absent and cannot be overlooked in the Wetland IHI. Hydrology and water quality ratings in the Wetland IHI were substituted with overall ratings for flow modification and water quality from the PESEIS project (Kotze *et al.,* 2012) respectively.

6.3.2 PES results

The PES score represents an average score for wetlands associated with the SQ and is generally a C or D PES (Table 6.3). Wetlands in the Tsende River (B83B-00161) have an A/B PES and are well conserved within the KNP. Many of these wetlands (predominantly channelled valley-bottom wetlands) are associated with tributaries in B83C. The most common problem that has caused the PES is vegetation removal.

Table 6.3 Wetland PES and key drivers resulting in modification from natural

SQ code	River name	Wetland FEPA	Wetland PES			Key drivers causing PES
		associated with riparian	IHI score	%	Ecological Category	
B81A-00270	Broederstroom		1.64	67.3	C	Vegetation removal and to a lesser degree, flow impacts
B81C-00245	Great Letaba	y	2.19	56.1	D	Vegetation removal and agriculture.
B81D-00277	Thabina	y	2.59	48.3	D	Vegetation removal
B81D-00272	Letsitele	y	2.09	58.2	C/D	Flow changes and vegetation removal
B81E-00213	Nwanedzi	y	2.43	51.3	D	Vegetation removal and to a lesser degree, flow impacts
B81E-00244	Great Letaba	y	2.36	52.8	D	Vegetation removal, agriculture, inundation.
B81F-00200	Great Letaba		1.64	67.2	C	Vegetation removal and agriculture.
B81F-00231	Great Letaba	y	2.05	59	C/D	Vegetation removal and agriculture & some dams
B82B-00173	Koedoes		2.41	51.8	D	Vegetation removal, agriculture, overgrazing
B82C-00175	Brandboontjies		2.3	54	D	Vegetation removal, agriculture, overgrazing
B82D-00146	Middel Letaba		2.62	47.7	D	Flow
B82F-00128	Little Letaba		2	59.9	C/D	Vegetation removal
B82G-00135	Little Letaba	y	2.02	59.6	C/D	Vegetation removal
B82H-00127	Nsama		1.6	73.5	C	Vegetation removal
B83B-00161	Tsende	y	0.47	90.7	A/B	n/a
Total		**10**				

7 STATUS QUO ASSESSMENT: ECOLOGICAL (RIVERS)

7.1 INTRODUCTION

Determination of the Present Ecological State (PES), which in essence represents the ecological status quo of the rivers is undertaken as part of the EcoClassification process (Kleynhans and Louw, 2007). The EcoClassification process consists of 4 levels which refer increasing complexity and intensity of work from the Level I (Desktop) to Level IV. An additional level, Desktop evaluation, was developed by Dr Kleynhans (Kotze *et al.,* 2012) with the specific purpose of building up a country wide database of PES and Ecological Importance-Ecological Sensitivity (EI-ES). This project is referred to as the PESEIS project and is currently being finalised. The work undertaken for the B primary catchment in which the Letaba falls (secondary B8) has however been completed (Kotze *et al.,* 2012). This data was used as the baseline for the status quo assessment.

7.2 APPROACH

7.2.1 PES Model (Modified from Kleynhans and Louw, 2007)

The PES of a river is expressed in terms of various components, i.e. **drivers** (physico-chemical variables, geomorphology, hydrology) and **biological responses** (fish, riparian vegetation and aquatic invertebrates), as well as in terms of an integrated state, the **EcoStatus**. Different processes are followed for each component to assign a category from A→F (where A is natural, and F is critically modified) (Table 7.1). Ecological evaluation against the expected reference conditions, followed by integration of the categories of each component, provides a description of the Ecological Status or *EcoStatus* of a river. Thus, the EcoStatus can be defined as the totality of the features and characteristics of the river (instream and riparian zones) that influence its ability to support an appropriate natural flora and fauna (modified from: Iversen *et al*., 2000). This ability relates directly to the capacity of the system to provide a variety of goods and services.

Table 7.1 Ecological Categories (ECs) and descriptions

EC	DESCRIPTION OF EC
A	Unmodified, natural.
A/B	Boundary category between A and B.
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.
B/C	Boundary category between B and C.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
C/D	Boundary category between C and D.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
D/E	Boundary category between D and E.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E/F	Boundary category between E and F.
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 instances the basic ecosystem functions have been destroyed and the changes are irreversible.

It must be emphasised that the A→F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. Therefore there may be cases where there is uncertainty as to which category a particular entity belongs. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*., 2004). For practical purposes, these situations are referred to as boundary categories and are denoted as B/C, C/D etc. The B/C boundary category, for example, is indicated as the dark-blue to light-green area in Figure 7.1.

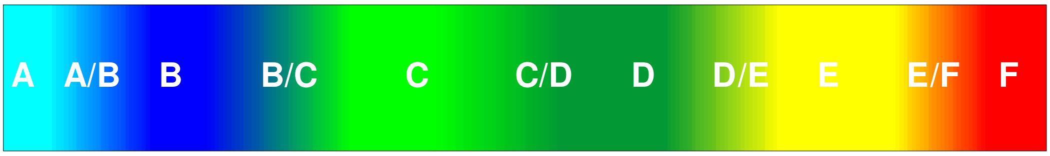


Figure 7.1 Illustration of the distribution of ecological categories on a continuum

The Desktop level EcoClassification was modified for use in the PESEIS project to deal with numerous SQ river reaches and the relationship between the Desktop Level EcoClassification and the modified desktop level used within the PESEIS project is illustrated in Figure 7.2.

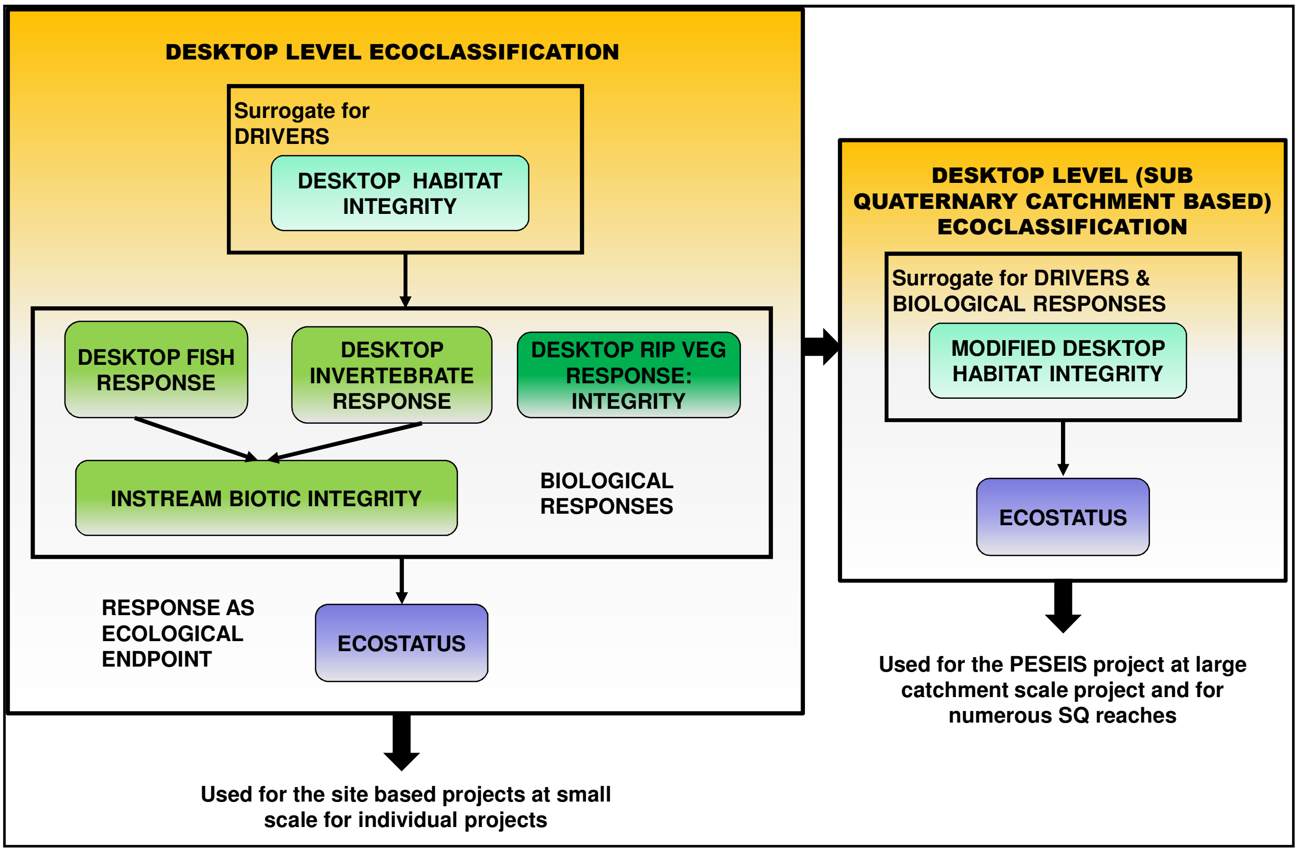


Figure 7.2 Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES

The PES is assessed according to 6 metrics that represents a very broad qualitative assessment of both the instream and riparian components of a river. The metrics used in the PES model and an explanation of what they refer to is explained in Table 7.2 (Front end model ref). Each metric is scored from zero to 5.

Table 7.2 PES metrics and explanations (Front end model ref)

Metrics	Comment
Potential instream habitat continuity modification	Modifications that indicate the potential that instream connectivity may have been changed from the reference. Indicators: Physical obstructions (e.g. dams, weirs, causeways). Flow modifications (e.g. low flows, artificially high velocities, physico-chemical "barriers").
Potential riparian/wetland habitat continuity modification	Modifications that indicate the potential that riparian/wetland connectivity may have been changed. Indicators: Physical fragmentation, e.g. inundation by weirs, dams; physical removal for farming, mining, etc.
Potential instream habitat modification activities.	Modifications that indicate the potential of instream habitats that may have been changed from the reference. Includes consideration of the functioning of instream habitats and processes, as well as habitat for instream biota specifically. Indicators: Derived likelihood that instream habitat types (runs, rapids, riffles, pools) may have changed in frequency (temporal and spatial). Assessment is based on flow regulation, physical modification and sediment changes. Land use/land cover (erosion, sedimentation), abstraction etc. may indicate the likelihood of habitat modification. The presence of weirs and dams are possible indicators of causes of instream habitat change. Certain introduced biota (e.g. carp, crustacea and mullusca) may also cause habitat modification. Eutrophication and resulting algal growth as well as macrophytes may also result in substantial changes in habitat availability.
Potential riparian/wetland zone modifications	Modifications that indicate the potential that riparian/wetland zones may have been changed from the reference in terms of structure and processes occurring in the zones. Also refers to these zones as habitat for biota. Indicators: Derived likelihoods that riparian/wetland zones may have changed in occurrence and structure due to flow modification and physical changes due to agriculture, mining, urbanization, inundation etc. Based on land cover/land use information. The presence and impact of alien vegetation is also included.
Potential flow modification	Modifications that indicate the potential that flow and flood regimes have been changed from the reference. Indicators: Derived likelihood that flow and flood regimes have changed. Assessment based on land cover/land use information (urban areas, inter basin transfers), presence of weirs, dams, water abstraction, agricultural return flows, sewage releases, etc.
Potential physico-chemical modification activities	Activities that indicate the potential of physico-chemical conditions that may have changed from the reference. Indicators: Presence of land cover/land use that implies the likelihood of a change of physico-chemical conditions away from the reference. Activities such as mining, cultivation, irrigation (i.e. agricultural return flows), sewage works, urban areas, industries, etc. are useful indicators. Algal growth and macrophytes may also be useful response indicators.

7.2.2 PES supporting information

For each SQ assessed a fact sheet was provided (Kotze *et al.,* 2012) that supports the information that is provided to populate the PES model described in 7.2.1. Furthermore, this information was used to identify what the impacts were and whether they are flow or non flow (including water quality) related. The fact sheets were based on an adjusted template from the Index of Habitat Integrity model (Kleynhans *et al.,* 2009) and are illustrated in Table 7.3. Observations on specific impacts that were of concern or importance were also backed-up by photos or images (mostly from Google Earth^{TM}). This will also be valuable for future users to gain an instant image of the specific SQ and its primary impacts, and will assist specialists in their evaluation of the PES metrics and distribution estimations (Kotze *et al.,* 2012).

Table 7.3 Example of the metrics and ratings used in the fact sheet evaluation

METRIC	IMPACT/SEVERITY	RATINGS
Abstraction,	Small	1
Agricultural fields,	None	0
Algal growth,	Moderate	2
Bed and Channel disturbance,	None	0
Canalization,	Serious	4
Chicken farms,	None	0
Low water crossings,	Critical	5
Large dams,	Large	2.5
Small (farm) dams,	Large	3
Erosion,	None	0
Alien aquatic macrophytes,	Small	0.5
Alien vegetation,	None	0
Feedlots,	None	0
Forestry,	None	0
Overgrazing/trampling,	None	0
Inundation,	None	0
Industries,	None	0
Interbasin transfers,	None	0
Increased flows,	None	0
Irrigation,	None	0
Mining,	Small	0.5
Natural areas/nature reserves,	None	0
Recreation,	None	0
Roads,	None	0
Runoff/effluent: Industries,	None	0
Runoff/effluent: Irrigation,	None	0
Runoff/effluent: Mining,	None	0
Runoff/effluent: Urban areas,	None	0
Sedimentation,	None	0
Pasture,	None	0
Urbanization,	None	0
Vegetation removal,	None	0

7.2.3 Database for PES information in an excel spreadsheet

The B8 (Letaba) secondary catchment has 75 SQ reaches. Individual spreadsheets for each SQ reach capturing all the specialist information, including the fact sheets and photo images, are available on a CD (Kotze *et al.,* 2012). The final modelled information in the model front end for B8 is available from Dr Kleynhans, DWA: RQS. Information was extracted in a 'master spreadsheet' that incorporated all the PESEIS results as well as the additional information required in this project. The spreadsheet will be available on the final data CD for this project and the columns pertaining to the PES is described below:

- Column B: SQ number: Individual code provided for each SQ by DWA and based on the codes used in the NFEPA assessment.
- Column C: River: River name where available.

- Column D: Quat: Quaternary catchment/s in which the SQ is situated.
- Column E: Flow Modification Activities: Metric value copied from the PESEIS front end model.
- Column F: Flow Mod Confidence: Confidence rating copied from the PESEIS front end model.
- Column G: WQ Confidence: Confidence rating copied from the PESEIS front end model
- Column H: WQ PES rating (PK): Metric value copied from the PESEIS front end model.
- Column I: WQ hotspots (PS): An evaluation by Dr Patsy Scherman to identify problem (ecology and user) water quality areas. Only hotspots which represent a 3, 4 or 5 rating were completed.
- Column J: Causes/sources comment: A summary of the fact sheet information copied into the PESEIS front end model and then into the Letaba master spreadsheet.
- Column K: Key PES Driver: An indication is provided whether the key PES driver that is mostly responsible for the changes from natural reference condition is flow, non-flow or water quality dominated, or a combination of both.
- Column L: River PES (value): PES value copied from the PESEIS front end model.
- Column M: River PES (EC): PES as an EC copied from the PESEIS front end model.
- Column N: Wetland PES (value): PES value generated for the selected wetlands only (see chapter 6).
- Column O: Wetland PES (EC): PES as an EC generated for the selected wetlands only (see chapter 6).
- Column P: Wetland PES driver: An indication is provided whether the key PES driver that is mostly responsible for the changes from natural reference condition is flow, non-flow or water quality dominated, or a combination of both .
- Column Q: Best condition River / Wetland PES: The river or wetland PES that represents the best condition is selected and the value provided.
- Column R: Final PES: This provides the PES as an EC which is the best condition for either wetlands or river.

7.3 STATUS QUO ASSESSMENT

The results of the PES are illustrated in Table 7.4 and Figure 7.3.

The Letaba catchment were characterised by large dams, of which the majority are concentrated in the upper reaches of the Letaba, irrigation of mainly orchards, a section flowing through the old homeland areas with the associated erosion and overgrazing problems and the conservation areas at the lower end (Kruger National Parks and Letaba Ranch). Flow modification in terms of decreased flows was one of the most severe impacts in the main rivers of this secondary catchment.

The main impacts upstream of Tzaneen Dam were related to abstraction, dams and their barrier effect, alien vegetation and irrigation.

The PES of the Letsitele River varied from a B Ecological Category (EC) (at the source) to a D EC for most of the rest of the river (Figure 7.3). This was mainly due to the presence of many tributary dams, irrigation, settlements and abstraction. The Thabina tributary was also in a D PES, but it must be noted that the source zone and some other small sections were in a much better state than a D PES.

Two of the north east flowing tributaries B81F-00228 and B81F-00232 were in a B PES which was because they both flow through private conservation areas.

The Middle and Klein Letaba Rivers were, outside of conservation areas, mostly in a D and C PES. The PES was mostly due to many dams (mainriver and mostly tributaries), irrigation and the presence of large settlements. Two of the rivers were in an E PES and the reasons for this were:

- B82C-00175: Intensive irrigation and many dams present throughout the whole reach.
- B82D-00146: Presence of a large dam in the reach which impacts on instream continuity and contributes to flow modification. There are also extensive canal systems present in this reach.

The lower section of the river in the conservation areas were a mix of mostly A PES for those rivers with their source and whole length of river in the conservation area, and a C PES for the main Letaba River. In these reaches the main Letaba River bears the brunt of all the severe utilisation of the water resources outside of the conservation areas, as well as sedimentation which impacts on the channel. In effect, the river is physically much smaller than natural within a very large macro channel which is maintained by the low frequency large floods that still come through.

Table 7.4 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
B81A-00242	Broederstroom	C	Non-flow[*1] (flow)
B81A-00256		D	Non-flow
B81A-00263		D	Flow[*2], non-flow
B81A-00270	Broederstroom	C	Non-flow (flow)
B81B-00233	Mahitse	C	Non-flow
B81B-00234	Mahitse	C	Non-flow
B81B-00246	Politsi	C	Non-Flow and Flow combo
B81B-00251		D	Non-flow
B81B-00269	Morudi	B	Non-flow
B81B-00227	Mahitse	D	Flow (non-flow)
B81B-00240	Politsi	C	Flow and non-Flow
B81B-00247	Great Letaba	C	Flow (non-flow)
B81B-00264	Great Letaba	C	Flow and non-Flow
B81B-00224	Mahitse	Within dam	
B81C-00245	Great Letaba	D	Combo (Flow, non-flow, water quality (WQ))
B81D-00277	Thabina	D	Combo (Non-flow>WQ>Flow)
B81D-00280	Bobs	B	Non-flow (flow)
B81D-00296	Mothlaka-Semeetse	B	Flow = non-flow (forestry)
B81D-00271	Letsitele	D	Combo (WQ> flow>non-flow)
B81D-00272	Letsitele	D	Combo (WQ> Non-flow>flow)
B81E-00213	Nwanedzi	D	Flow = non-flow (WQ)
B81E-00244	Great Letaba	D	Combo (Flow=WQ>non-flow)
B81F-00189	Merekome	C	Non-flow and related water quality
B81F-00203	Lerwatlou	C	Combo (flow and non-flow)
B81F-00228	Reshwele	B	Combo (flow and non-flow)
B81F-00232	Makwena	B	Non-flow
B81F-00200	Great Letaba	C	Flow
B81F-00212	Great Letaba	D	Flow and non-flow
B81F-00215	Great Letaba	D	Flow and non-flow
B81F-00218	Great Letaba	D	Flow (with WQ and non-flow)
B81F-00231	Great Letaba	D	Flow (with WQ and non-flow)
B81G-00164	Molototsi	D	Combo (flow, non-flow and WQ)

B81H-00162	Metsemola	C	Non-flow
B81H-00171	Molototsi	D	Combo (flow, non-flow and WQ)
B81J-00187	Mbhawula	C	Non-flow and flow
B81J-00209	Great Letaba	D	Combo (flow, non-flow and WQ)
B81J-00219	Great Letaba	C	Flow
B82A-00168	Middel Letaba	C	Water quality followed by sedimentation and vegetation removal (mainly due to grazing and trampling).
B82B-00173	Koedoes	D	Combination of flow and non-flow related impacts: Firstly flow, then water quality and agricultural activities.
B82C-00175	Brandboontjies	E	Combination of flow and non-flow related impacts: Firstly flow, then water quality and agricultural activities.
B82D-00163	Lebjelebore	C	Non-flow: Predominantly due to agriculture.
B82D-00154	Middel Letaba	D	Non-flow: Mainly vegetation removal due to agriculture.
B82D-00166	Mosukodutsi	D	Combination of flow and non-flow related impacts: Firstly flow, then water quality and agricultural activities.
B82D-00146	Middel Letaba	E	Combination of flow and water quality.
B82E-00149	Khwali	B	Non-flow: Grazing and trampling pressure
B82E-00150	Little Letaba	C	Non-flow: Vegetation removal and predominantly as a result of agricultural activities.
B82F-00141	Soeketse	C	Non-flow
B82F-00128	Little Letaba	C	Non-flow and related water quality.
B82F-00137	Little Letaba	D	Non-flow and related water quality.
B82G-00135	Little Letaba	D	Combo (flow and WQ)
B82H-00127	Nsama	C	Combo (WQ and non-flow)
B82H-00139	Magobe	B	Non-flow
B82H-00157	Nsama	B	Combo (Flow and non-flow)
B82J-00153	Nalatsi	A	N/A (Natural)
B82J-00159	Byashishi	A	N/A (Natural)
B82J-00197	Ka-Malilibone	B	Combo
B82J-00165	Little Letaba	C	Flow
B82J-00178	Little Letaba	C	Flow
B82J-00201	Little Letaba	B	Flow
B82J-00207	Little Letaba	B	Flow
B83A-00193	Shipikani	A	N/A (Natural)
B83A-00238	Nharhweni	A	Combo
B83A-00254	Ngwenyeni	A	N/A (Natural)
B83A-00220	Letaba	B	Flow
B83A-00230	Letaba	C	Flow
B83A-00235	Letaba	C	Flow
B83A-00252	Letaba	C	Flow
B83B-00161	Tsende	B	N/A (Natural)
B83D-00204	Manyeleti	A	N/A (Natural)
B83D-00208	Makhadzi	A	N/A (Natural)
B83D-00261	Nwanedzi	A	N/A (Natural)
B83D-00236	Makhadzi	A	N/A (Natural)
B83D-00250	Letaba	C	Flow
B83D-00255	Letaba	C	Flow
B83E-00265	Letaba	C	Flow

*1: Non-flow refers to non-flow related activities.

*2: Flow refers to flow related activities

7.4 ECOLOGICAL ZONES

The SQ reaches were grouped in logical units that represent areas with:

- Similar PES.
- Similar reasons for the PES - relates to similar landuse and impacts.

This resulted in zones that were homogenous in terms of PES and impacts and can be managed as an entity. As, in this case, the ecological zones resulted in the final Integrated Units of Analysis (IUAs), no further discussion or representation of the zones will be provided in this Chapter. The IUAs are described in Chapter 8 including the PES the impacts and the reasoning for the ecological zone (i.e. IUA) selection.

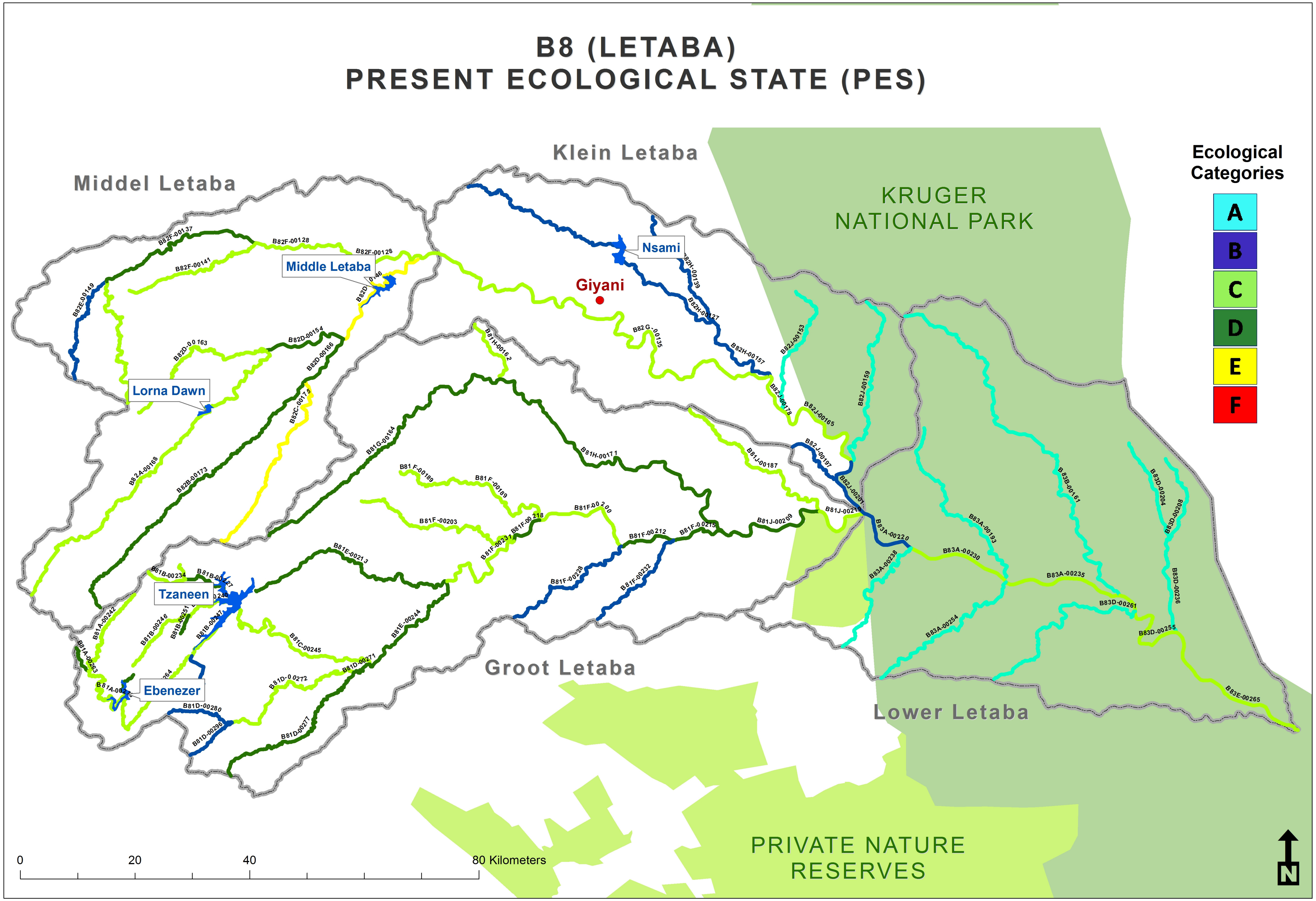


Figure 7.3 B8: Present Ecological State

8 PRELIMINARY IUAS AND STATUS QUO

8.1 PROCESS TO DETERMINE IUAS

An Integrated Units of Analysis (IUA) is a broad scale unit (or catchment area) that contains several biophysical nodes. These nodes define at a detail scale specific attributes which together describe the catchment configuration of the IUA. Scenarios are assessed within the IUA and relevant implications in terms of the Management Classes (MCs) are provided for each IUA. The objective of defining IUAs is therefore to establish broader-scale units for assessing the socio-economic implications of different catchment configuration scenarios and to report on ecological conditions at a sub-quaternary (SQ) scale.

Zones have been established for water resource use, economics, EGSA and ecology. All of these zones are based on the concept of identifying areas that are similar in terms of these specific components, have similar land use (and resulting impacts), and can be managed as a logical entity. Overlaying these zones leads to the identification of IUAs which are similar from all the various components perspective and, as it can be managed as an entity, is a logical unit for which scenarios can be designed and evaluated.

The process of IUA delineation is summarised in a flow diagram, Figure 8.1. Once the IUAs are delineated, biophysical nodes must be identified for different levels of EWR assessment.

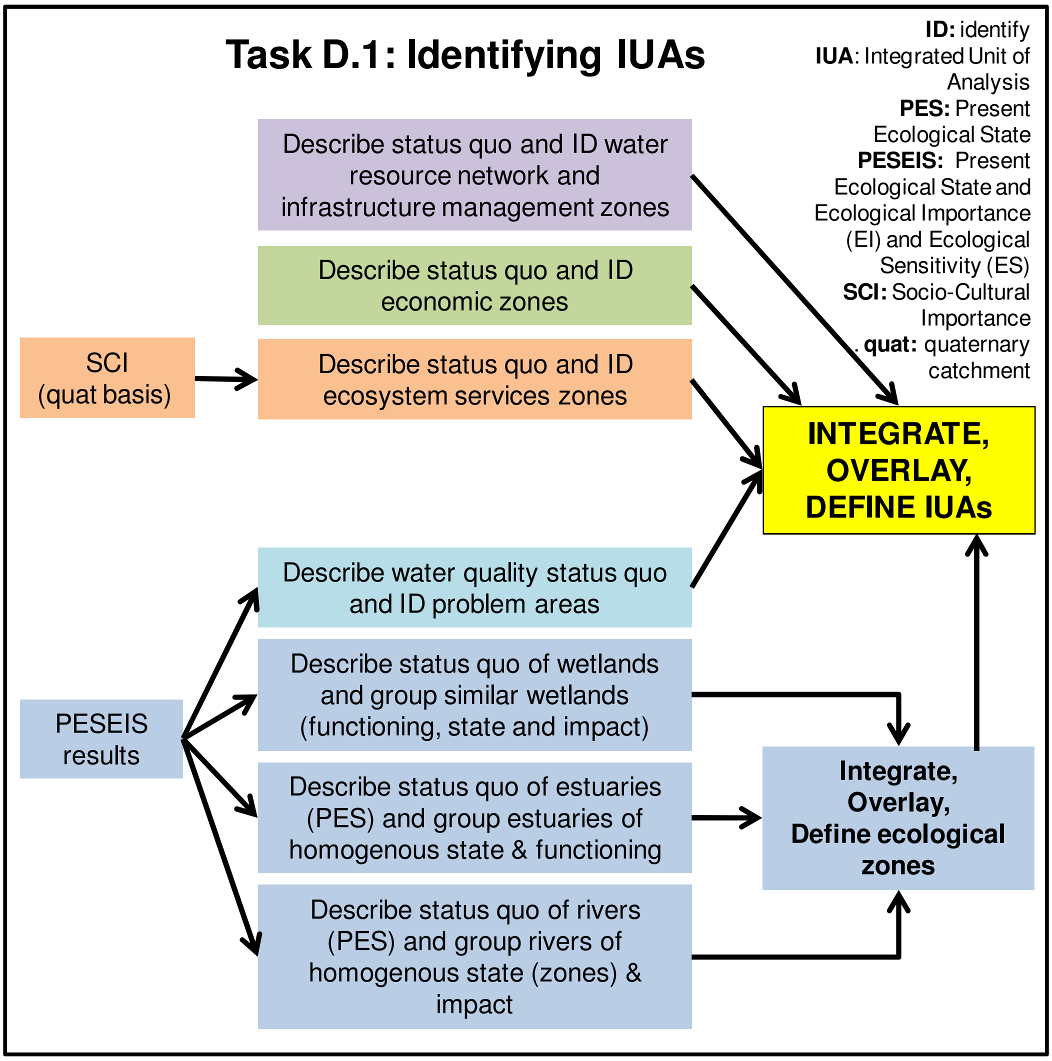


Figure 8.1 Summary of process to identify IUAs

8.2 DESCRIPTION OF STATUS QUO PER IUA

The selected IUAs are illustrated in Figure 8.2 at the end of the chapter. The status quo for all the different components is described for each IUA in the subsections below.

8.2.1 IUA 1: Letaba Upstream of Tzaneen Dam

Water resource use:

This zone includes all the rivers (14 SQ reaches) falling within quaternary catchments B81A and B81B. The IUA is highly regulated by four dams, namely Dap Naude, Ebenezer, Hans Merensky and Tzaneen Dams. Water is transferred out of the catchment from Dap Naude and Ebenezer dams to augment the water supply of Polokwane. There are a number of river abstractions mostly by the irrigation sector and significant volumes of groundwater are utilised by the irrigation sector, with most of the utilisable exploitation potential used in the IUA. Return flows generated from the irrigations sector enter the river systems which has a negative impact on the water quality. Abstractions from groundwater represent a high portion of the Utilisable Exploitation Potential (Potable) and will possibly cause reductions in base flow. The only future surface water resource development planned for the area is the raising of the Tzaneen Dam.

Water quality:

Water quality state is Good, with few impacts other than forestry.

Economy:

The main economic activities are the primary industries of sub-tropical fruits, commercial forestry, the secondary industry of tomato processing as well as the tertiary industry of eco-tourism.

EGSA:

This area is dominated by commercial farming and forestry. The population densities, relative to the rest of the catchment are on the lower side. Overall the livelihood reliance on ecological goods and services is limited. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. There are significant dams in the area and as such the recreational aspects of the ecological goods and services attributes are significant in this regard.

River and wetland ecology:

The PES of most rivers (Broederstroom, Great Letaba, Politsi and upper Mahitse) in this zone is predominantly a C PES with 57% of the SQ reaches in this zone falling in this Ecological Category. Thirty-six percent of the SQ reaches in this zone falls within a D PES (tributaries of the Broederstroom/Great Letaba, tributaries of the Politsi and the lower Mahitse), while only 1 SQ (7%) falls in a B PES (Morudi, a short tributary of the Great Letaba). The predominant land-use in this zone is forestry and agriculture, with the primary impacts being related to flow modification (damming and forestry), sedimentation, and alien vegetation encroachment.

This zone was highlighted as having potential wetlands (DWAF, 2006c), the bulk of which are seeps (particularly in B81A) and some channelled valley-bottom wetlands (mainly in B81B). The Broederstroom (B81A-00270) was noted in this study for wetland frequency, also mainly seeps and channelled valley-bottom wetland, with an overall wetland C PES.

IUA rationale:

Management of this IUA is related to the inter-basin transfers, forestry, run-of river and groundwater abstractions, and operation of various dams with limited operational capabilities. Impacts on the river ecology are mostly flow related, inundation, sedimentation and alien vegetation encroachment. Management options will be limited flow management and possible abstraction allocation reductions, and catchment management that include alien vegetation removal and establishment of a riparian buffer zone.

8.2.2 IUA 2: Letsitele and Thabina

Water resource use:

This zone includes mostly the rivers (5 SQs) falling within quaternary catchment B81D. There is some storage regulation in the IUA by Thabina Dam. There are number of river abstractions mainly for the irrigation sector and a significant amount of groundwater is utilised by both the urban/domestic and irrigation sector with most of the utilisable exploitation potential used in the IUA. Return flows or effluent is mainly produced from the urban/domestic sector, with some return flows from the irrigation sector, which has reduced the water quality of the river systems below these areas. There are no surface water resource developments planned in the IUA.

Water quality:

Water quality state is dominated by elevated nutrients, salts and algal growth due to discharges from a WWTW in the Thabina, and extensive irrigation agriculture in the middle and lower Letsitele River. Two water quality hotspots were identified in these reaches and the water quality state is generally Fair to Poor.

Economy:

The main economic activities are the primary industries of citrus and sub-tropical fruit and the secondary industry that consist of fruit juice processing.

EGSA:

The northern portion of the IUA consists of commercial forestry with the Agatha Forest Reserve a dominant feature. The recreational aspects associated with EGSA are of some importance here but overall utilisation is low. The southern portion is given over to very dense closer settlement that borders on formal urban development. Townships developed as satellites to Tzaneen are present. The utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high where utilisation does take place.

River and wetland ecology:

The upper reaches of the Letsitele (Bobs and Mothlaka-Semeetse) falls in a B PES with the primary land use being forestry. The middle Letsitele River falls in a C PES, receiving the impacts related to forestry, agriculture, urban and rural settlements. The Thabina and lower Letsitele rivers are currently in a D PES, with the primary impacts being associated with extensive rural settlements (sedimentation, and agriculture) and some flow modification (dams, and forestry).

The quaternary (B81D) is noted for wetland frequency and diversity of types, and the Letsitele specifically (B81D-00272) for frequent channelled valley-bottom wetlands. An overall PES for these wetlands indicates fairly poor condition with an EC of a C/D.

IUA rationale:

Management of this IUA is related to agriculture (formal and informal) with run-of river and groundwater abstraction as well as sedimentation. Some flow modification due to small dams and forestry occur. The dense population density in the lower reaches result in high utilisation of the natural resources with overgrazing and resulting sedimentation prevalent. Management options to improve the IUA (if necessary) will largely be catchment management options and some flow abstraction allocation reduction. No future water resources infrastructure is being planned in this IUA.

8.2.3 IUA 3: Letaba Downstream of Tzaneen to Proposed Nwamitwa Dam

Water resource use:

This zone includes mostly the rivers (3 SQ reaches) falling within quaternary catchments B81C and B81E. The flow in the Letaba River is regulated by releases from Tzaneen Dam located in IUA 1. There are a number of river abstractions mainly by the irrigation sector. Return flows generated from the irrigation sector enter the river systems which has a negative impact on the water quality. A future resource development planned at the outlet of the IUA is the development of the proposed Nwamitwa Dam at the confluence of the Nwanedzi, Letsitele and Groot Letaba Rivers. There is some potential for groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

Water quality:

Water quality state is dominated by elevated nutrients, salts and possible toxicants due to fertilizer / pesticide use associated with extensive (citrus) irrigation agriculture upstream of the proposed Nwamitwa Dam. Two water quality hotspots were identified in these reaches.

Economy:

The main economic activities are the primary industries of citrus fruit and commercial forestry which is used in the secondary industries of saw milling and fruit juice processing.

EGSA:

This IUA includes the formal town of Tzaneen in the western portion. The utilisation of EGSA tends to be low as the populations tend to be urbanised and alienated from direct use of the resources. The eastern part of the IUA is given over to commercial farming. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. The northern part is mixed land use with rural closer settlement dominating significant portions. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high

River and wetland ecology:

The Great Letaba River, downstream of the Tzaneen Dam is currently in a C PES, being impacted by flow modification (Tzaneen Dam), agriculture and runoff associated with Tzaneen town and surrounds. The lower reach of the Great Letaba in this zone, after the confluence of the Letsitele, falls in a D PES, receiving the impacts related to forestry, flow modification and urban and rural settlements of the upper reaches. This reach is also locally highly impacted by agriculture and flow modification related to tributary dams. The Nwanedzi River also falls in a D PES, with primary land use and impacts being associated with urbanization and agriculture. This zone ends in the area earmarked for the construction of the Nwamitwa Dam.

This zone has a markedly high frequency and diversity of wetlands, particularly the Great Letaba and its unnamed tributaries in the B81E quaternary and the Nwanedzi River. Many however are associated with small impoundments and the general PES is a D.

IUA rationale:

Formal irrigation occurs next to the Letaba River and the irrigation water is released from Tzaneen Dam and also stored in various weirs. Flow-related modification are needed to achieve the Recommended Ecological Category (REC) and alternative scenarios of operation releases from Tzaneen Dam, also considering the planned dam raising, will have to be assessed. Within a system context it is likely that scenarios of flow releases downstream of the proposed Nwamitwa Dam need to be evaluated. Due to the two major dams at the upstream and downstream ends of the IUA it forms a logical management unit. The ecology in the Nwanedzi tributary is mainly influenced by non-flow related impacts related to agriculture and urbanization.

8.2.4 IUA 4: Letaba from Proposed Nwamitwa Dam to Klein Letaba Confluence

Water resource use:

This IUA includes only the Letaba River downstream of the proposed Nwamitwa Dam site to the confluence with the Little Letaba. The IUA is currently regulated by Tzaneen Dam located in IUA 1 and water is mainly supplied to the irrigation sector. There are no surface water resource developments planned in the IUA. There is possibility for future groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

Water quality:

Water quality state is dominated by elevated nutrients, salts and possible toxicants due to fertilizer / pesticide use associated with extensive (citrus) irrigation agriculture. Two water quality hotspots were identified in these reaches.

Economy:

The main primary economic activities are citrus and mangoes. The tertiary economic activity is eco-tourism.

EGSA:

This IUA contains a portion of highly developed commercial farming where utilisation of ecological goods and services tends to be low. Some game farms are evident. Again ecological goods and services, bar those associated with the recreational and aesthetic aspects would be low. The northern portions are heavily dominated by the high density rural closer settlements characteristic of the former homeland areas. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology:

It includes 7 SQs which currently are all influenced by the operational rules of Tzaneen Dam, many instream weirs, inundation, abstraction, irrigation, private Reserves and some rural settlements. The last SQ is within the Greater Kruger National Park (Letaba Ranch). Four of the seven SQs are in a D EC and three are in a C EC. This zone has no notable wetlands.

IUA rationale:

The main Letaba River is the only source in this IUA which is operable and the potential for scenario development and different operating rules from the proposed Nwamitwa Dam makes this a logical unit. This is the major reason why in this case, a linear section of river has been selected as an IUA, rather than a catchment. The tributaries flowing into this IUA therefore form separate IUAs as operation and scenario options in those IUAs are very different to the Letaba River.

8.2.5 IUA 5: Southern Tributaries to Letaba in IUA 4

Water resource use:

Only two tributaries and SQs are situated in this zone, B81F-00228 (Reshwele River) and B81F-00232 (Makewena). The storage regulation is low in the IUA and there are no future resource developments planned in the IUA.

Water quality:

The water quality state is Fair to Good, with some impacts due to agricultural activities. No water quality hotspots were identified.

Economy:

The main primary economic activities are citrus and mangoes. The tertiary economic activity is eco-tourism.

EGSA:

This IUA is largely dominated by game farms and nature reserves, particularly the Ndzalema Reserve. Again EGSA, bar those associated with the recreational and aesthetic aspects would be low.

River and wetland ecology:

The source and most of the rivers flows through the Ndzalema Wildlife Reserve and other private Reserves. Downstream sections have some small dams, and fields. The rivers are seasonal, with very little direct uses and due to the large sections flowing through a Reserve, relatively protected resulting in a B PES.

IUA rationale:

Due to the very different hydrological characteristics, operation and land use from the Letaba River, these two SQs were placed in one IUA. No scenario development will be required.

8.2.6 IUA 6: Northern Tributaries to Letaba in IUA 4

Water resource use:

This zone includes 3 short ephemeral rivers (3 SQs) and the seasonal Molototsi River has 3 SQs. The IUA is only regulated by the Modjadji Dam located in the upper reaches of the Molototsi River. Water is supplied from the dam to the urban/domestic sector. Return flows generated from the irrigations sector enter the river systems which has a negative impact on the water quality. Groundwater is currently utilised by domestic users and there is some potential for additional groundwater development in the area, depending on the locality of the groundwater resources relative to the users and the viability for development thus needs to be confirmed. A possible future development requiring further investigation is the artificial recharge of groundwater at Mulele on Molototsi River.

Water quality:

The water quality state is dominated by elevated nutrients, salts and algal growth due to discharges from a WWTW in the Molototsi River, settlements and agricultural activities leading to increased instream turbidity levels.

Economy:

The main economic activities are citrus, mangoes and tomatoes that form part of the primary sector while tomato processing is identified as a secondary sector and the eco-tourism is part of the tertiary sector.

EGSA:
This area almost exclusively consists of the former homeland areas. As such the land use is rural closer settlement with clusters of dense village developments associated with the main road network and extensive subsistence farming. The utilisation of EGSA is likely to be relatively constrained – albeit not as high as in other parts of the catchment, and given the profile of the population in the IUA, the importance is likely to be high.

River and wetland ecology:
The Molototsi River is in a D PES and all the other tributaries are in a C PES. It must be noted that during the middle 1990's, a rare population of *Acacia erubuscens* was found in the flood plain of the Molototsi and a tributary. This zone is characterised by being much drier in nature then the Letaba River and largely dominated by rural settlements and subsistence agriculture. Due to the very different hydrological nature, operation and land use from the Letaba River, these tributaries were placed in one zone.

IUA rationale:
Due to the very different hydrological characteristics, operation and land use from the Letaba River, these three tributaries were placed in one IUA. These tributaries were also separated from the southern tributaries (IUA 5) due to the different ecological state and land use. Any scenario development will be limited to non-flow related issues associated with subsistence agriculture.

8.2.7 IUA 7: Upper Middle Letaba and Tributaries Upstream of Middle Letaba Dam

Water resource use:
This zone includes all the SQs within the B82A, B82B, B82C and B82D quaternary catchments. It includes the Middle Letaba, Koedoes, Brandboontjies, Lebjelebore and Mosukodutsi rivers. The IUA is regulated by the Lornadawn Dam (Middel Letaba River) and the Middel Letaba Dam at the bottom of the IUA. Water is mainly supplied to the urban and irrigation sectors, with the urban domestic supply increasing constantly resulting in a reduction in irrigation supply. Significant volumes of groundwater are also utilised in the IUA with over 50% of the Utilisable Exploitation Potential (Potable) used by the irrigation sector in B82A and the domestic sector in B82E. The viability for additional groundwater development needs to be confirmed. Return flows from both these sectors enter the river systems. There are no surface water resource developments planned in the IUA.

Water quality:
The water quality state of the upper section of the Middel Letaba River is dominated by elevated nutrients, salts and possible toxicants due to fertilizer / pesticide use associated with extensive crop irrigation e.g. tomato crops. There are also elevated nutrients due to a WWTW on the Brandboontjies River. Two water quality hotspots were therefore identified in these reaches.

Economy:
The main economic activities evolve from the tomato production as part of the primary sector. The secondary economic activity of tomato processing is also part of IUA 7.

EGSA:
The southern portion of the IUA is dominated by commercial farming and forestry. The population densities, relative to the rest of the catchment are on the lower side. Overall the livelihood reliance on EGSA is limited. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. The northern portion of the

IUA is heavily dominated by the high density rural closer settlements characteristic of the former homeland areas, including Olifantshoek. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology:

Five of the seven SQs have a D PES and the upper Middle Letaba and Lebjelebore have a C PES. Impacts are flow related, inundation, quality issues and other related to extensive agriculture. B82B and B82C have a high density and frequency of channelled valley bottom wetlands, with notable wetlands associated with B82B-00173 (Koedoes), B82C-00175 (Brandboontjies) and B82D-00146 (Middel Letaba). The wetlands are mostly in a D PES.

IUA rationale:

This area has extensive formal agriculture with water use from many farm dams in the rivers and tributaries. This area upstream of Middel Letaba Dam can mostly be managed through possible abstraction allocation reductions as well as better agricultural practices to address water quality. This therefore forms a logical unit up to the Middel Letaba Dam as downstream of the dam scenarios would be linked to the operation of the dam. It is however doubtful that the section of river in an E Ecological Category (SQ B82C-00175) can be improved as this will require the removal of farm dams.

8.2.8 IUA 8: Klein Letaba Upstream of Middle Letaba Dam

Water resource use:

IUA 8 includes B82E and almost all the SQs within the B82F quaternary catchment, and excludes only the Middle Letaba (B82D-00146), i.e. the zone ends where the Middle Letaba joins the Little Letaba. Other rivers included in this zone are the Khwali and Soeketse Rivers. The storage regulation is low in the IUA with no major dams present in the area. Water supply is predominantly to the urban sector which also generates some return flows that enter the river system. Significant volumes of groundwater are utilised in the IUA especially in B82E where over 70% of the Utilisable Exploitation Potential (Potable) is used by the urban sector. The viability for additional groundwater development needs to be confirmed. A possible future surface water resource development is the construction of a new dam at two possible sites that have been identified, namely the Majosi or Crystalfontein Dam sites.

Water quality:

No water quality hotspots were found in this area with water quality state generally being Good.

Economy:

The main economic activities is classified as part of the primary sector is identified as sub-tropical fruits and commercial forestry, while tomato processing as a secondary and eco-tourism as a tertiary sector is part of IUA 8.

EGSA:

The upper portion of the IUA has relatively low population densities with pockets of commercial farming interspersed with subsistence farming. The areas associated with subsistence farming and lower population densities are likely to have high EGSA dependence. However the lower (Eastern) potions of the IUA become very highly populated and dense closer settlement associated with the former Gazankulu homeland dominate. Again the utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology:

The PES ranges from a B (B82E-00149) to D (B82F-00137), but is predominantly a C PES. Impacts are non-flow related such as vegetation removal, trampling and water quality. B82E has a fairly high density of seep wetlands, none of which have been highlighted as important, while B82F-00128 (Little Letaba) has been noted for channelled valley bottom wetlands.

IUA rationale:

This area is a mixture of commercial farming and rural areas. As impacts are mostly non-flow related, and there is limited water resources infrastructure, scenarios will be limited to restrictions and catchment management options. Again this forms a logical IUA as downstream of the confluence with the Middel Letaba Dam, the operational options relates to possible flow regulation from Middel Letaba Dam.

8.2.9 IUA 9: KLEIN LETABA DOWNSTREAM OF MIDDLE LETABA DAM

Water resource use:

IUA 9 focuses on the remainder of the main channel of the Little Letaba River (SQs B82G-00135, B82J-00178, B82J-00165, B82J-00207 and B82J-00201) and excludes all its tributaries which fall into IUA 10. The IUA therefore starts at the confluence of the Middle and Little Letaba Rivers and ends at the confluence of the Little and Great Letaba Rivers. The IUA is regulated by upstream dams, mainly the Middel Letaba Dam. There are a number of river abstractions mainly by the urban/domestic sector from where return flows are also generated that enter the river systems. There are no surface water resource developments planned in the IUA.

Water quality:

There is a water quality hotspot around Giyani due to urban-related impacts, including the WWTW at Giyani. The water quality state is Fair to Poor, primarily due to elevated nutrients.

Economy:

The economic activities are minimal and consist mainly of banana production that forms part of the primary sector.

EGSA:

The IUA is very highly populated and dense closer settlement associated with the Giyani region of the former Gazankulu homeland dominate. The Giyani town is a formal urban area. Again the utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high. Along with the Tzaneen area this is possibly the most highly populated portion of the catchment. A portion of the eastern part of the IUA falls within the Kruger National Park. For these portions recreational and aesthetic aspects of EGSA utilisation is of importance but direct consumptive use is low.

River and wetland ecology:

The IUA has a predominant C PES, with the exception of the last 2 SQs (B82J-00207 and B82J-00201), which are short sections that have a B PES. The last 3 SQs of the Klein Letaba River (B82J-00165, B82J-00207 and B82J-00201) form the boundary of the KNP. The Klein Letaba (at B82G-00135) has been outlined for notable wetlands, both for frequency of occurrence and diversity of types of wetlands, including thermal springs. This section also has notable non-riparian wetlands outlined as important in the NFEPA Wetcluster coverage (Nel *et al.*, 2011).

IUA rationale:

This IUA forms a logical unit as it can be managed from Middel Letaba Dam. However, management is limited as the outlet capacity is minimal, even for releases for base flows. Also, the dam hardly ever spills. It is possible however to make a small adjustment to the current structure that will allow for improvement in river releases. The tributary catchment (not affected by Middel Letaba Dam) has therefore been grouped in a separate IUA.

8.2.10 IUA 10: Lower Klein Letaba Tributaries.

Water resource use:

This ecological zone includes the ephemeral tributaries (5 SQs) in the lower Klein Letaba up to the KNP boundary. The IUA is regulated by the Nsami Dam. Water is mainly supplied to the urban and irrigation sectors. Return flows from the urban sector enter the river systems resulting in a reduction in water quality. There are no future surface water developments planned in the IUA. There is possibility for future groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

Water quality:

Subsistence agriculture dominates in this area, with rural communities and cattle grazing impacting on water quality of the lower Nsama River, especially during the dry season. Washing, agriculture and overgrazing take place within the riparian zone. Water quality state is Good to Fair, with no water quality hotspots identified.

Economy:

The economic activities are minimal and consist mainly of banana production that forms part of the primary sector.

EGSA:

The western portion of the IUA is highly populated and again dense closer settlements associated with the former Gazankulu homeland dominate. The utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high. The lower (eastern) portion is located within the KNP. For these portions recreational and aesthetic aspects of EGSA utilisation is of importance but direct consumptive use is low.

River and wetland ecology:

The Nsama River including the Magobe tributary (3 SQs) are surrounded by rural settlements with associated impacts (overgrazing and riparian vegetation removal) with a PES ranging from a C to a B, while the Nalatsi and Byashishi originates in the KNP with only the lower reaches running through rural areas. Due to the protection within the KNP for most of its reach, the river is in an A PES.

The Nsama River (B82H-00127) is the only SQ that has been outlined for notable wetlands, both for frequency of occurrence and diversity of types of wetlands.

IUA rationale:

This IUA consists of the Little Letaba tributaries downstream of the Middle Letaba Dam. They are in a reasonable ecological state and all impacts are non-flow related. As scenarios that include the Middle Letaba Dam operation will not impact on these tributaries, they have been placed in a separate IUA.

8.2.11 IUA 11: Letaba Downstream of Klein Letaba confluence (KNP)

Water resource use:

The entire portion is located within the KNP and comprises the main Letaba River only. The Letaba River main stem in the IUA is regulated by upstream dams in the catchment. There are no major dams and there are also no surface water developments planned in the IUA.

Water quality:

Few impacts are found in this reach although the water quality state is still Fair to Good due to upstream impacts.

Economy:

The main economic activity is eco-tourism that forms part of the tertiary sector.

EGSA:

The entire portion is located within the KNP. For these portions recreational and aesthetic aspects of ecological goods and services utilisation is of importance but direct consumptive use is low.

River and wetland ecology:

This ecological zone comprises the lower Letaba from the Klein Letaba confluence to the Mozambique border. Although the main stem runs through a national park, lower flows due to abstraction and dams upstream, renders the 6 SQs mostly in a C PES. B83D-00255 has a B PES (well conserved within KNP).

One SQ has been outlined for notable wetlands: B83D-00255 (Letaba River) Floodplain wetlands.

IUA rationale:

This section of river is also a main river IUA because the operation of the Letaba River is distinctly different to the ephemeral tributaries in the KNP. The management of upstream storage structures (Tzaneen, Middel Letaba and proposed Nwamitwa dams) will influence the flow in this IUA and required extensive scenario analyses to find a balance between use and protection.

8.2.12 IUA 12: Letaba Main Stem – Kruger National Park

Water resource use:

IUA 12 consists of all the tributaries of the Letaba downstream from the Klein Letaba confluences within the KNP. The storage regulation is low in the IUA with no major dams present in the area. There are also no major surface or groundwater developments planned in the IUA.

Water quality:

As all these rivers are in the KNP, water quality will be Good.

Economy:

The main economic activity is eco-tourism that forms part of the tertiary sector.

EGSA:

The entire portion is located within the Kruger National Park or private game reserves. For these portions recreational and aesthetic aspects of ecological goods and services utilisation is of importance but direct consumptive use is low.

River and wetland ecology:

The 8 SQs of the tributaries to the Letaba all originate in the KNP and are largely natural, displaying ECs of mostly A and one B. The Tsende River is dominated by channelled valley-bottom wetlands and has an A/B PES (well conserved within KNP).

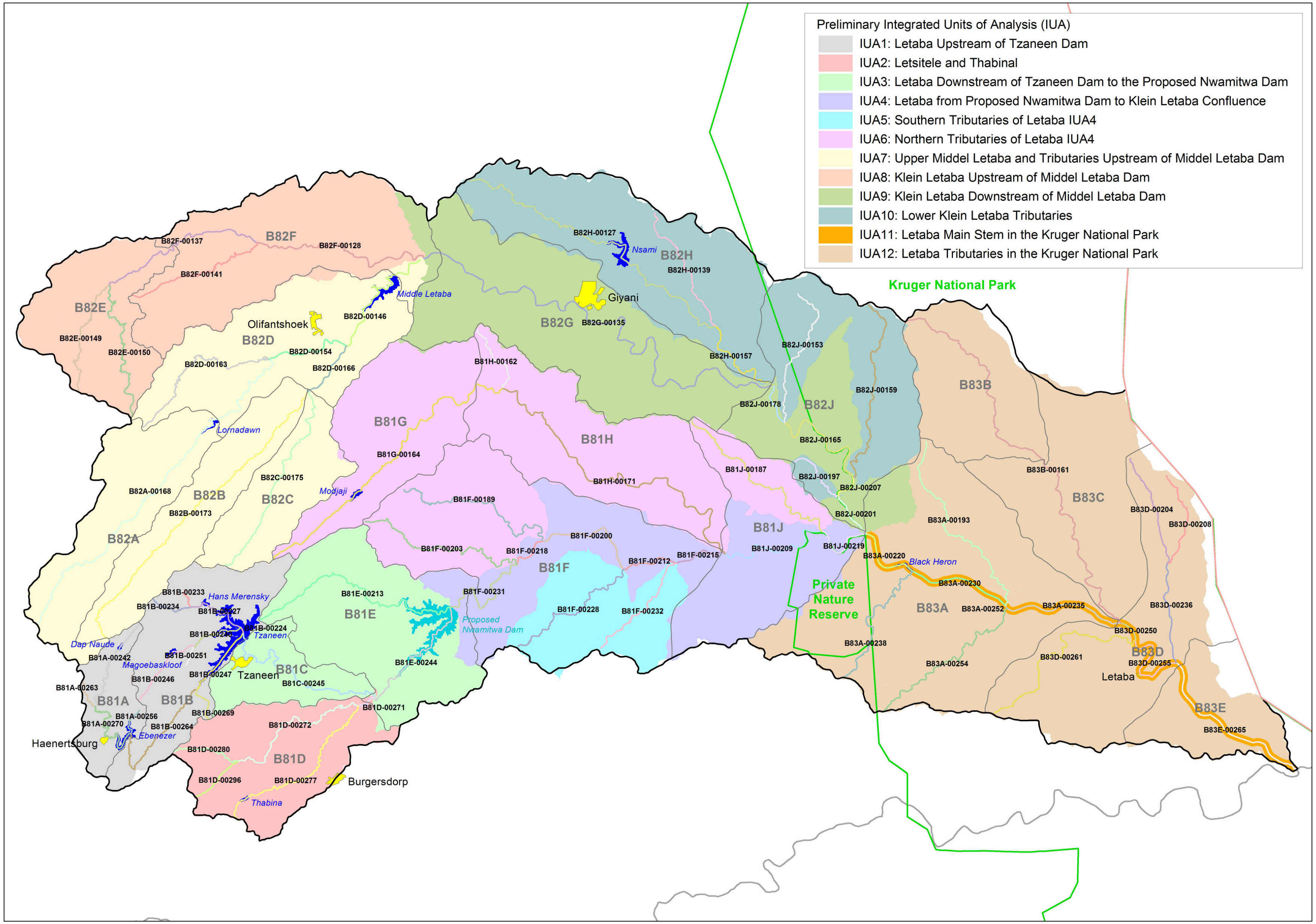


Figure 8.2 Letaba Catchment IUAs

9 METHOD TO IDENTIFY HOTSPOTS

A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance (IEI) which could be under threat due to its importance for water resource use. The hotspots are therefore an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future (Louw and Huggins, 2007; Louw *et al.,* 2010).

Classification is usually undertaken for a large area with many IUAs. IUAs are a combination of the socio-economic region defined in watershed boundaries, within which ecological information is provided at a finer scale. This requires that biophysical nodes be nested within the IUAs (DWA, 2007b). Ideally, each SQ reach being assessed represents a biophysical node which requires some level of EWR assessment. The hotspot identification will therefore provide an indication of the level of EWR assessment required at each biophysical node. In essence, this would be similar to a filtering process where the most detailed assessment is undertaken at hotspots, and less detailed assessments at the other areas. Nodes that are EWR sites represent the areas where most detailed EWR methods will be required.

As no new EWR sites will be selected, the purpose of the identification of hotspots for this study was the following:

- To ensure that there were no hotspots that were not addressed by an existing EWR site.
- To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the NWRCS.
- To provide an indication where scenario development and testing would be important.
- To provide guidance to areas with a very low hotspot evaluation as flow requirements for these might be not be necessary.

The process used is described in Figure 9.1 and relied on the results of the PESEIS study. The total number of initial biophysical zones was 75 river nodes. It was proposed that all the nodes were considered in terms of ecological requirements, but that approximately 50 desktop biophysical nodes should be selected for EWR estimation. Nodes that were excluded from the estimation process were those with:

- its source in the KNP;
- no water resource demands on them (often ephemeral drainage lines), and
- EWRs covered by key biophysical sites (EWR sites).

As part of this assessment, the Water Resource Use Importance (WRUI) was undertaken as well as the Socio-Cultural Importance (SCI). These were undertaken on a sub-quaternary scale but grouped where similar.

Figure 9.1 Summary of the process to identify biophysical nodes for EWR assessment

The steps used to identify the priority areas (hotspots) were:

- Desktop EcoClassification which included the determination of the Ecological Importance and Sensitivity (EIS); Socio-Cultural Importance (SCI) and Present Ecological State (PES).
- Determination of the Integrated Environmental Importance (IEI) by integrating the EIS, SCI and the PES. Significant wetlands (if present) were also identified and rated in terms of their PES and EIS. This information contributed to the determination of IEI.
- Determining the WRUI.
- Identification of the areas which were priority hotspots because of high IEI and/or WRUI and required more detailed studies.
- Provide recommendations for the locality of detailed EWR sites.

9.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

9.1.1 PES

The PES approach is described in Section 7.2.

9.1.2 Ecological Importance and Sensitivity

Rivers

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

The importance evaluation for rivers used for this study were those generated as part of the PESEIS study (Kotze *et al.,* 2012) from the front end models as provided by Dr Kleynhans, DWA:RQS. The Ecological Importance (EI) and Ecological Sensitivity (ES) of SQs were assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and able to recover from various forms of human use (Kleynhans - font end model, user guide). Further explanations of the functions of the model must be referred to DWA: RQS.

Wetlands

Ecological Importance and Sensitivity (EIS) was calculated for wetlands using data collated for the PESEIS study (Kotze *et al.,* 2012). The data used excluded riparian species and used the wetland species to complete the updated EIS model (Modified by Kleynhans for use in Louw *et al.,* 2010) which has a wetland component. The metrics considered were:

- Rare and endangered wetland vegetation.
- Unique wetland vegetation.
- Intolerant wetland vegetation.
- Wetland Species/taxon richness.
- Diversity of wetland habitat types and features.
- Importance of wetland habitat as a refuge and critical habitat.
- Migration corridors.
- Presence of natural areas, reserves, heritage sites.

A median score was used to evaluate the importance as Low, Moderate, High or Very High.

9.1.3 River NFEPAs

Freshwater Ecosystem Priority Areas (FEPAs) for SQ river reaches were indicated in the master spreadsheet. The reasons for the selection of a specific SQ as a NFEPA was not clear within the data (meta data or atlas) provided as part of the NFEPA documentation. The raw data such as the fish information provided for inclusion in the FEPA was not readily available. What was clear however wasthat the FEPA selection was dominated by the criteria that it had to meet a certain PES and that it was largely based on presence of important fish species. The base criteria of the river FEPA is the following:" Rivers had to be in a good condition (A or B PES) to be chosen as FEPAs" (Nel *et al*., 2011).

The current results of the PESEIS study (Kotze *et al.,* 2012) provided a higher confidence PES assessment as that on which the NFEPA study was based (which was largely the Kleynhans 2000 data based as well as some localised and expert data). The PESEIS study (Kotze *et al.,* 2012) included a Google Earth assessment by four specialists with different backgrounds and extensive local knowledge and it has to supersede (Kleynhans, *pers. comm.*) the NFEPA baseline.

The current results of the PESEIS study (Kotze *et al.,* 2012) also provided information for fish species for every SQ based on survey results and expert knowledge on the expected species to occur. These results will also supersede the fish information used for the NFEPA assessment.

Based on the above, the verification of the NFEPAs was essential prior to the NFEPA status being used to influence decision-making within the NWRCS. The following filtering process was followed to determine the NFEPA status.

- All FEPAs were identified from the shapefiles (Nel *et al.,* 2011) as well as correlating it with the data provided in the front end PESEIS models (ref).
- If the PES results from the PESEIS project indicated that the SQ was not a B or higher PES, it was not further considered as a FEPA.
- If the fish species on which the FEPA was based or partially based were indicated, the presence of these species in the SQ were verified using the information from the PESEIS study (Kotze *et al.,* 2012)

There were also Phase 2 FEPAs which were in a "present condition of a C (moderately modified) Ecological Category. According to Nel *et al*. (2011) the condition of these Phase 2 FEPAs should not be degraded further, as they may in future be considered for rehabilitation. This implied that all Phase 2 FEPAs should be in a C PES and maintained in the short term as a C PES. These Phase 2 FEPAs were therefore not further considered as the EcoClassification approach will never set the REC to be lower than the PES.

9.1.4 Socio-Cultural Importance

The SCI was generated by scoring each quaternary catchment based on the following features (Huggins *et a*l., 2010)

Ritual Use: This was scored between 0 - 5. The question that was asked was "How much ritual use of the river takes place?" Typically this would be for ceremonial purposes or for spiritual/religious activities. An example would be pools used for traditional initiation purposes. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for ritual use and significance relates to the degree to which the river is of critical importance to people.

Aesthetic Value: This was scored between 0 - 5. The question that was asked was "How important is the aesthetic value to people? Does the river stretch add value to people's life as an object of natural beauty? Would changing flows detract from this value?" Both intensity and significance of appreciation are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to view the river and appreciate its aesthetic value and significance relates to the degree to which the river is of critical aesthetic importance to people.

Resource Dependence: This was scored between 0 - 5. This refers to the goods and services delivered by the river system and peoples dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or "for financial gain" usage of resources is excluded from consideration in this instance. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to make use of the river for resource importance and significance relates to the degree to which the river is of critical importance to people. A sustainability modifier is allowed for.

Recreational Use: This was scored between 0 - 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?" Both intensity and significance of use are valued and the higher of the two scores is adopted Intensity relates to the number of people likely to make use of the river for recreational purposes and significance relates to the degree to which the river is of critical importance to people.

Historical/Cultural Value: This was scored between 0 - 5. The question that was asked was "Does the river have a strong cultural or historical value?" Examples would be Fugitives drift on the Buffalo River or components of the Mzimvubu River that have played a central role in Xhosa cultural history. Both intensity and significance of use are valued and the higher of the two scores is adopted. Intensity relates to the number of people likely to appreciate the river for its historical or cultural significance and significance relates to the degree to which the river is of critical importance to people

Scores were then modified to reflect the adjudged importance of each component relative to the other. In the model the following mechanism for arriving at the final score has been adopted with a relative weighting for the importance within the context of the catchment. So "Ritual Use" has a weighting of 40 points, "Aesthetic Value" a weighting of 20 points, "Resource Dependence" a weighting of 100 points, "Recreational Use" a weighting of 50 points, and "Historical Cultural" Value a weighting of 75 points.

The final scores were then combined to generate an overall score between 0 and 5. The meaning of the score is as set out in Table 9.1 below.

Table 9.1 SCI rating

SCI score	Category	Comment
0 - 0.99	**VERY LOW**	Of little or no socio-cultural importance.
1 - 1.99	**LOW**	Of some importance. PES not critical, but caution should be displayed with regard to negative impact on dependent communities.
2 - 2.99	**MODERATE**	Of moderate importance. PES should not be allowed to be negative affected without strong motivation.
3 - 3.99	**HIGH**	Of high importance. A score in this range motivates for maintain or potentially positive change to PES.
4 - 5	**VERY HIGH**	Of extreme importance. A score in this range motivates for positive change to PES.

9.1.5 Integrated Environmental Importance assessment

As described above, the Ecological and Socio-Cultural importance were assessed separately and were then integrated with the PES to determine the Integrated Environmental Importance. The PES forms part of the Integrated Environmental Importance as rivers in good condition are scarce, and therefore important in their own right. A river that is in very good condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is in good condition. The Integrated Environmental Importance also provides an indication of the restoration potential. The restoration potential refers to the probability of achieving the rehabilitation of the river to an improved state. For example, if a river has very high Ecological and Socio-Cultural importance, but is in bad condition, the restoration potential is often low and that will result in a low Integrated Environmental Importance.

The EIS and SCI ratings were not averaged, but the highest score of the two are used to integrate it with the PES. A matrix (Table 9.2) to aid in consistently providing an integrated rating comparing EIS, SCI, and PES was designed during 2006 (Louw and Huggins, 2007) and modified during this study to automate the process and thereby produce more consistent answers.

Table 9.2 Matrix used to determine a combined EIS/SCI and PES value which provides an Integrated Environmental Importance value

EI-ES&SCI (max)	**Very high**	**4-5**	3	3	4	4	5	5	5	
	High	**3-3.99**	3	3	3	3	4	5	5	
	Moderate	**2-2.99**	2	2	2	3	3	4	5	
	Low	**1-1.99**	1	1	2	2	3	4	4	
	Very low	**0-0.99**	1	1	1	2	2	3	4	
			3.5-5	**3**	**2.5**	**2**	**1.5**	**1**	**0.5**	**PES values**
			E/F	**D**		**C**		**B**	**A**	**Category**
			>3	**2.1-3**		**1.1-2**		**0.6-1**	**<0.6**	**Range**
			PES							

9.2 WATER RESOURCE USE IMPORTANCE

The Water Resource Use Importance (WRUI) (DWAF, 2007b) was assessed by assigning a qualitative score to a river reach for four variables that represented the status of the in-stream flow. The scores of the four variables were combined to determine (qualitatively) an overall score which represented the importance of the river reach in terms of the water resource use. Most often, the maximum value was used to represent the final score. Severity and extent of the variables had to be considered to determine whether the maximum was the appropriate rating for the quaternary catchment.

The variables included in the rating method aimed to represent the status and function of the river reach. The variables and the associated characteristics associated with a score ranging from zero to four are presented in Table 9.3.

Table 9.3 Water Resource Use Priority rating variables and scoring characteristics

Variables	Score range and associated characteristic descriptions	
	0	4
Current water balance of catchment contributing flow to the river reach.	Very little water use occurs in the upstream catchment. Low, maintenance and high flow is largely natural.	Significant utilisation of water from the upstream catchment. Low and maintenance flows have been reduced and/or there exists significant regulating storage in the

		catchment.
Utilisation of the river reach for operational purposes.	Minimum changes in the river flow due to operational purposes.	The river reach is utilised as a conveyance conduit.
Possible future developments and/or water use expected in the catchment.	No known development planned in the catchment that could change the flow in the river reach.	It is expected that future developments which could change the flow in the river could occur.
Water quality related problems, assimilative capacity.	The water quality in the river reach is excellent and large assimilative capacity is present.	The river contains very high loads of pollutants.
Overall score:	There is no reason to determine the EWR in the river reach from a water resource management perspective.	A comprehensive EWR determination is necessary from a water use point of view.

9.3 PRIORITY AREAS - HOTSPOTS

Hotspots (priority areas with overall importance) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (http://en.wikipedia. org/wiki/Biodiversity_hotspot). In the context used here, the hotspot represents a river reach with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use.

The hotspots are an indication of areas where detailed investigations would be required if development was being considered. These hotspots usually represent areas which are already stressed or will be stressed in future. This assessment can therefore guide decision-making with regard to which areas are in need of detailed EWR and other studies (modified from Louw and Huggins, 2007).

A matrix was designed (Louw and Huggins, 2007) and modified during this study to guide the consistent identification of hotspots (Table 9.4). The Y-axis is based on the Integrated Environmental Importance value derived from the first matrix (Table 9.2). The X-axis depicts an estimate of water resource use, with 0 being of no importance and 4 being of very high importance. The information derived from the matrix provides an indication of the level of studies required. Although the terminology used is the same as that used for the different levels of EWR studies in South Africa, it is a descriptive term which is relevant for any environmental assessment required.

As an example – an Integrated Environmental Importance of 2.5 and Water Resource Use importance value of 3.5 would require a comprehensive EWR assessment and this specific Management Resource Unit would represent a hotspot.

Table 9.4 Matrix used in assessing hotspots

			HOTSPOT								
IEI	**Very high**	**4-5**	2	2	2	2	3	3	4	4	4
	High	**3-3.99**	1	2	2	2	2	3	3	4	4
	Moderate	**2-2.99**	1	1	1	2	2	2	3	3	3
	Low	**1-1.99**	1	1	1	1	1	2	2	2	3
	Very low	**0-0.99**	1	1	1	1	1	1	1	2	2
			0	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**
			Very low	**Low**		**Moderate**		**High**		**Very high**	
			Water Resource Importance								

9.4 EXCEL MASTER SPREADSHEET USED FOR HOTSPOT ASSESSMENT

The relevant columns for the hotspot assessment in the master spreadsheet are explained below.

- Column S: River EI (rating): This provides the EI evaluation in terms of Low to Very High descriptors.
- Column T: River EI (Value): This provides the median EI score related to the description in column S.
- Column U: River ES (rating): This provides the ES evaluation in terms of Low to Very High descriptors.
- Column V: River EI (Value): This provides the median EI score related to the description in column U.
- Column W: Wetland EIS (rating): This provides the EIS evaluation in terms of Low to Very High descriptors for those wetlands evaluated.
- Column X: Wetland EIS (Value): This provides the median EIS score related to the description in column W.
- Column Y: Final River / Wetland EIS (rating): This provides the maximum rating between the EI, ES and wetland evaluation.
- Column Z: Final River / wetland EIS (value): This provides the maximum rating between the EI, ES and wetland evaluation and links to the evaluation as provided in column Y.
- Column AA: River FEPA: Any SQ with a river FEPA or second phase FEPA is indicted by completing the words FEPA etc in the appropriate cell.
- Column AB: FEPA comment: Each river FEPA is evaluated to determine what the overriding reason is for the FEPA and whether it complies to the requirement that it falls into a B or higher PES.
- Column AC: Adjusted EIS (NFEPA considered): EIS values adjusted based on the presence of a FEPA are indicated in this column and highlighted if changes are made to the Final EIS values that appear in Column Z.
- Column AD: SCI rating: This provides the score for the SCI.
- Column AE: SCI evaluation: This provides the evaluation for the score provided in column AD
- Column AG: Final Importance Score (max of EIS and SCI): This provides the maximum value of all the importance scores.
- Column AH: Final IS evaluation: This provides the evaluation for the score provided in column AG.
- Column AI: PES (value): A repeat of the PES value.
- Column AJ: PES (EC): A repeat of the PES EC relating to the PES value.
- Column AL: IEI: This provides the Integrated Environmental Importance value considering the Importance score and the PES.

10 IDENTIFICATION OF HOTSPOTS

10.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

10.1.1 PES results

The PES results are provided in Chapter 7.

10.1.2 River Ecological Importance and Sensitivity results

The results are provided from Kotze *et al.*, (2012) and modified where required. The results are also summarised for any High or Very High importance in Table 10.1.

Table 10.1 HIGH or VERY HIGH important SQs in terms of EI and ES

SQ number	River	River EI (rating)	River EI (Value)	River ES (rating)	River ES (value)
B81A-00242	Broederstroom	MODERATE	2.7	**HIGH**	3.2
B81A-00256		LOW	1.7	**HIGH**	3.0
B81A-00270	Broederstroom	MODERATE	2.6	**VERY HIGH**	4.1
B81B-00233	Mahitse	MODERATE	2.5	**HIGH**	3.4
B81B-00234	Mahitse	MODERATE	2.8	**HIGH**	3.7
B81B-00246	Politsi	MODERATE	2.7	**VERY HIGH**	4.3
B81B-00269	Morudi	MODERATE	2.8	**VERY HIGH**	4.1
B81B-00227	Mahitse	MODERATE	2.3	**HIGH**	3.6
B81B-00240	Politsi	MODERATE	2.6	**HIGH**	3.7
B81B-00247	Great Letaba	MODERATE	2.8	**HIGH**	3.7
B81B-00264	Great Letaba	**HIGH**	3.5	**VERY HIGH**	4.4
B81C-00245	Great Letaba	**HIGH**	3.2	**HIGH**	3.7
B81D-00277	Thabina	**HIGH**	3.3	**HIGH**	3.6
B81D-00280	Bobs	**HIGH**	3.4	**VERY HIGH**	4.4
B81D-00296	Mothlaka-Semeetse	**HIGH**	3.2	**VERY HIGH**	4.4
B81D-00271	Letsitele	**HIGH**	3.0	**HIGH**	3.5
B81D-00272	Letsitele	**HIGH**	3.0	**VERY HIGH**	4.0
B81E-00213	Nwanedzi	MODERATE	2.6	**HIGH**	3.1
B81E-00244	Great Letaba	**HIGH**	3.0	**HIGH**	3.8
B81F-00203	Lerwatlou	MODERATE	2.9	**HIGH**	3.1
B81F-00228	Reshwele	MODERATE	2.8	LOW	1.7
B81F-00232	Makwena	MODERATE	2.7	LOW	1.0
B81F-00200	Great Letaba	**HIGH**	3.2	**HIGH**	3.7
B81F-00212	Great Letaba	MODERATE	2.9	**HIGH**	3.7
B81F-00215	Great Letaba	MODERATE	2.7	**HIGH**	3.7
B81F-00218	Great Letaba	MODERATE	2.7	**HIGH**	3.7
B81F-00231	Great Letaba	MODERATE	2.9	**HIGH**	3.7
B81J-00209	Great Letaba	MODERATE	2.9	**HIGH**	3.7
B81J-00219	Great Letaba	**HIGH**	3.5	**HIGH**	3.8
B82D-00163	Lebjelebore	MODERATE	2.6	**HIGH**	3.0
B82D-00146	Middel Letaba	MODERATE	2.2	**HIGH**	2.9
B82E-00149	Khwali	**HIGH**	3.1	**LOW**	1.3
B82G-00135	Little Letaba	**HIGH**	3.3	**HIGH**	3.4
B82H-00127	Nsama	MODERATE	2.7	**HIGH**	3.0
B82J-00153	Nalatsi	**HIGH**	2.9	VERY LOW	0.7

SQ number	River	River EI (rating)	River EI (Value)	River ES (rating)	River ES (value)
B82J-00159	Byashishi	**HIGH**	3.2	LOW	1.3
B82J-00165	Little Letaba	**HIGH**	3.1	MODERATE	2.8
B82J-00201	Little Letaba	**HIGH**	3.1	MODERATE	2.8
B82J-00207	Little Letaba	**HIGH**	3.2	MODERATE	2.8
B83A-00193	Shipikani	**HIGH**	3.1	VERY LOW	0.7
B83A-00238	Nharhweni	**HIGH**	3.2	VERY LOW	0.7
B83A-00254	Ngwenyeni	**HIGH**	3.2	LOW	1.0
B83A-00220	Letaba	**HIGH**	3.1	**HIGH**	3.2
B83A-00230	Letaba	**HIGH**	3.3	**HIGH**	3.2
B83A-00235	Letaba	**HIGH**	3.3	**HIGH**	3.2
B83A-00252	Letaba	**HIGH**	3.1	**HIGH**	3.2
B83B-00161	Tsende	**HIGH**	3.6	MODERATE	2.8
B83D-00208	Makhadzi	**HIGH**	3.1	LOW	1.0
B83D-00236	Makhadzi	**HIGH**	3.4	MODERATE	2.3
B83D-00250	Letaba	**HIGH**	3.1	**HIGH**	3.1
B83D-00255	Letaba	**HIGH**	3.3	**HIGH**	3.1
B83E-00265	Letaba	**HIGH**	3.3	**HIGH**	3.6

Riverine Fauna:

Great Letaba and Letsitele sub-quaternary catchments (B81A, B81B, B81C, B81D and B81E) originate from mountainous terrain as small mountain streams with riffles, waterfalls and rapids and small pools under canopy forest. Downstream the rivers become incised and are creating the following habitats: seepage wetlands, grassy edges, and riparian shrubs and trees, sometimes forming dense canopy cover. Due to the perennial flows and the mountain stream characteristics of the streams, the Ecological Sensitivity (ES) is rated “high”. Although the habitat seems favourable, the importance is “moderate” due to exotic forestry, dams resulting in regulation, lowered flows due to abstraction for agriculture, vegetation removal, and effluent from developed areas.

Downstream of this mountainous catchment, the Great Letaba (B81F) flows through an area covered with extensive irrigation farming. Despite the intensive abstraction and regulation of flows in the area, the river creates favourable habitats in the form of pools, rapids, reeds, grassy edges, alluvial sand banks and riparian trees and shrubs. The perennial flows (regulated) and the favourable habitat render both the ES and Ecological Importance (EI) “high”. Most of the tributaries joining the Great Letaba in this reach (B81F) are seasonal or ephemeral, and apart from occasional pools, have no surface flows. Additional habitat for riverine fauna includes alluvial sand beds, grassy edges, and riparian shrubs and trees. The lack of surface flows renders the EI and ES as “low”.

When the Great Letaba enters the Lowveld (B81J, B83A and B83D), the habitat formed by the sluggish flows include multi-channels, pools, less riparian trees and shrubs, grassy edges, alluvial sand banks, some rapids, and abundant reeds. The human-related factors that impact on the river even this far downstream, are low flows due to abstraction and regulation taking place in the upper catchments. The final reach (B83E) before it flows into the Olifants River, runs through a gorge with rapids, alluvial sand banks, reeds, and riparian trees (less than upstream) and shrubs. Despite the constant stress on water volumes, the habitat created by the flows, and the number of riverine fauna utilizing even the low flows, renders this reach “high” in EI and ES.

In this lower part of the Great Letaba River, most of the tributaries are either seasonal or ephemeral (B83A, B83B and B83D). The surface water during the dry season will consist of a few semi-permanent pools, flanked by riparian shrubs and trees. The lack of surface flows is impacting on the EI and ES of the reach, resulting in a "low" rating. The Tsende River (B83B-00161) is the only seasonal river with ample surface water and has "high" EI and "moderate" ES values.

The sub-quaternary catchments of B81G and B81H in the central part of this region are also seasonal, and the habitats consist of drainage lines with sandy bottoms flanked by riparian shrubs and trees. The system is lacking surface flows and thus rated as "low" regarding EIS.

The upper catchment of the Middle Letaba River consists of tributaries (B82A, B82B, B82C, B82D, B82E and B82F) that are either ephemeral or seasonal drainage lines in a mountainous terrain. Riverine habitats include sandy river beds with grassy edges and riparian shrubs and trees, but the only surface water is in seasonal pools. The flows in the rivers are further impacted by a large dam, smaller dams and abstraction. Thus the lack of surface flows and associated riverine habitats is impacting on the EI, resulting in a "low" rating, while the maintenance of pools in the system are very important for riverine fauna, rendering the ES as "moderate".

The Little Letaba (B82G and B82J) is an alluvial river with surface water in pools, reeds and grass on the edges, and riparian trees and shrubs on the banks. A large dam is intercepting flows, resulting on low flows downstream. These pools (perhaps maintained by seepage from the dam) supply good habitat as surface water and the sub-surface water maintain the riparian vegetation. Considering these factors, the maintenance of the pools in the system is important to riverine fauna, rendering the ES as "moderate". The good riparian habitats and pool environments, results in "high" EI ratings.

The tributaries to the Little Letaba joining from the north (B82H and B82J) are ephemeral and thus the lack of surface water and associated habitats results in "low" ES and EI.

Riparian vegetation:

There are 211 wetland and riparian species, which is 62% of all the wetland and riparian species expected in the B secondary catchment. Of these 49% are wetland obligates and 82% are riparian obligate species.

Ecological sensitivity is Low. This is due to a low proportion (<40%) of marginal and permanent zone riparian and wetland obligates respectively, which is usually in accordance with dryer more seasonal or intermittent systems.

Ecological importance for the catchment is generally low to moderate (no high scores). This is mainly due to a low proportion of threatened or endemic riparian and wetland species. Moderate scores are usually associated with SQs in reserves where there are usually 4 or more threatened or protected riparian / wetland species.

Fish:

Thirty-eight indigenous fish species are expected under present conditions. The most common and widespread species were (in decreasing order of number of SQs where present) *Barbus trimaculatus*, *Pseudocrenilabrus philander*, *Tilapia rendalli*, *Clarias gariepinus*, *Oreochromis mossambicus*, *Barbus viviparus*, *Barbus unitaeniatus* and *barbus toppini*). The rarest fish species were (in increasing order of number of SQs where present) *Opsaridium peringueyi*, *Chiloglanis swierstrai*, *Labeo congoro*, *Anguilla mossambica*, *Barbus lineomaculatus*, *Hydrocynus vittatus* and

Petrocephalus wesselsi. The fish species most intolerant to flow changes and water quality alteration were *Opsaridium peringueyi*, *Chiloglanis swierstrai*, *Labeo congoro*, *Barbus lineomaculatus*, *Amphilius uranoscopus*, *Barbus eutaenia* and *Chiloglanis pretoriae*.

Aquatic macroinvertebrates:

Eighty-one invertebrate taxa are expected under present conditions. The most common and widespread taxa in secondary catchment B1 were (in decreasing order of number of SQs where present) Chironomidae, Notonectidae, Potamonautidae, Oligochaeta, Corixidae, Dytiscidae, Culicidae, Nepidae, Ceratopogonidae, Coenagrionidae and Turbellaria. The rarest invertebrate taxon were (in increasing order of number of SQs where present) Calopterygidae, Calamoceratidae, Protoneuridae, Prosopistomatidae and Empididae. The taxa most intolerant to alterations in flow and velocity include Oligoneuridae, Blephariceridae, Empididae, Perlidae, Prosopistomatidae, Hydropsychidae, Psephenidae, Philopotamidae, Heptageniidae and Tricorythidae, while the taxa with the highest requirement for unmodified water quality were Oligoneuridae, Blephariceridae, Perlidae, Prosopistomatidae, Polycentropodidae, Helodidae, Crambidae and Heptageniidae.

10.1.3 River NFEPA results

The SQs with associated NFEPAs are listed and verified (see Chapter 9) in Table 10.2.

Table 10.2 FEPA verification based on PES data and fish information

SQ number	River	PES	River FEPA	Verification	FEPA comment
B82J-00159	Byashishi	A	FEPA	✓	In an A PES
B82J-00197	Ka-Malilibone	B	FEPA	✓	In a B PES
B82J-00201	Little Letaba	B	FEPA	✗	*Hydrocynus vittatus* (HVIT) indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model).
B82J-00207	Little Letaba	B	FEPA	✗	HVIT indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model).
B83A-00193	Shipikani	A	FEPA	✗	HVIT indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model).
B83A-00238	Nharhweni	A	FEPA	✗	HVIT indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model).
B83A-00254	Ngwenyeni	A	FEPA	✗	HVIT indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model).
B83A-00252	Letaba	C	FEPA	✗	PES is a C, therefore it does not qualify.
B83B-00161	Tsende	B	FEPA	✗	PK: HVIT indicated as FEPA_fish spp-This spp is not present in this SQ (Front end model) as it is seasonal. Rationale could possibly to protect this tributary of the main stem where HVIT occurs. This spp also introduced into Pionier Dam in Tsende River.
B83D-00261	Nwanedzi	A	FEPA	✓	In an A PES.

10.1.4 Wetlands EIS results

Fifteen SQs were highlighted as having potentially high wetland importance (Table 10.1). These generally coincided with wetland FEPAs (Nel *et al.*, 2011) or areas highlighted in the wetland scoping report (DWAF, 2006c). These 15 SQs, together with SQs that did not score 3 for potential wetland importance but contained FEPA wetlands, were assessed in more detail to obtain a score for integrated EIS (Table 10.3). Only B83D-00255 (Letaba River) which scored a 3 for potential wetland importance was excluded from the assessment. This was because the floodplain wetland at Letaba Rest Camp (KNP) is fragmented by the weir and this resulted in an artificially high frequency score. For most assessed SQs, the integrated (median) EIS was moderate, with only the Great Letaba (B81C-00245) and Thabina (B81C-00245) rivers scoring high. The main reason for the high score was high levels of taxon richness and endemism, as well as threatened wetland species (3 species each).

Table 10.3 Wetland EIS results

SQ CODE	RIVER	WETLAND								NATURAL AREAS, GAME RESERVES, NATIONAL PARKS	RESULTS		CONFIDENCE (1-5)
		BIOTA				HABITAT							
		RARE AND ENDANGERED	UNIQUE	INTOLERANT	SPECIES/ TAXON RICHNESS	DIVERSITY OF TYPES AND FEATURES	REFUGIA AND CRITICAL	SENSITIVITY TO FLOW CHANGES	MIGRATION CORRIDOR		MEDIAN SCORE	IMPORTANCE	
B81A-00270	Broederstroom	2.5	2	1.0	4.0	2.0	2.0	2.0	2.5		2.0	MODERATE	3
B81C-00245	Great Letaba	2.5	2.5	1.0	4.0	3.0	2.0	2.0	2.0		2.3	HIGH	3
B81D-00277	Thabina	2.5	3	1.0	4.0	3.0	2.0	2.0	2.0		2.3	HIGH	3
B81D-00272	Letsitele	2.5	3	1.0	4.0	2.0	2.0	1.5	2.0		2.0	MODERATE	3
B81E-00213	Nwanedzi	1.5	1	1.0	2.0	3.0	2.0	1.5	1.5		1.5	MODERATE	3
B81E-00244	Great Letaba	1.5	1	1.0	2.0	4.0	2.0	1.5	2.5		1.8	MODERATE	3
B81F-00200	Great Letaba	0.0	2	1.0	3.0	2.0	2.0	1.5	2.5	2.0	2.0	MODERATE	3
B81F-00231	Great Letaba	0.0	2	1.0	3.0	3.0	2.0	1.5	2.5		2.0	MODERATE	3
B82B-00173	Koedoes	1.0	3	1.5	4.0	2.0	2.0	1.5	2.5		2.0	MODERATE	3
B82C-00175	Brandboontjies	2.0	3	1.5	4.0	1.5	2.0	1.5	2.0		2.0	MODERATE	3
B82D-00146	Middel Letaba	2.0	1	1.5	3.0	2.0	2.0	1.5	2.0		2.0	MODERATE	3
B82F-00128	Little Letaba	2.0	1	1.5	3.0	1.5	2.0	1.5	2.0		1.8	MODERATE	3
B82G-00135	Little Letaba	0.0		1.0	2.0	3.5	2.0	1.5	2.0		1.8	MODERATE	3
B82H-00127	Nsama	0.0		1.0	2.0	2.5	1.5	1.5	1.5		1.5	MODERATE	3
B83B-00161	Tsende	0.0		1.0	1.0	3.0	1.0	1.0	1.0	5.0	1.0	LOW	3
B83D-00255	Letaba	0.0		1.0	1.0	1.0	1.5	1.0	2.5	5.0	1.0	LOW	3

10.1.5 Socio-Cultural Importance (SCI) results

The following SQs, as set out in the Table 10.4 below, scored "High". There were no scores in the "Very High" range. The bulk of those scoring "High" did so either because of the recreation and aesthetic value associated with the Game Parks or the high dependence on resources associated with poor and vulnerable communities located within the SQ.

Table 10.4 SQs scoring "High" with respect to SCI

SQ number	River	Quat	SCI
B83A-00238	Nharhweni	B83A	**3.9**
B82J-00153	Nalatsi	B82J	**3.8**
B82J-00159	Byashishi	B82J	**3**
B82J-00207	Little Letaba	B82J	**3**
B83A-00193	Shipikani	B83A	**3**
B83A-00220	Letaba	B83A	**3**
B83A-00230	Letaba	B83A	**3**
B83A-00235	Letaba	B83A	**3**
B83A-00254	Ngwenyeni	B83A	**3**
B83B-00161	Tsende	B83B & B83C	**3**
B83D-00236	Makhadzi	B83D	**3**
B83D-00250	Letaba	B83D	**3**
B83D-00255	Letaba	B83D	**3**
B83D-00261	Nwanedzi	B83D	**3**
B83E-00265	Letaba	B83E	**3**

10.1.6 Integrated Environmental Importance results

The IEI results for the ratings of a 4 and 5 are provided in Table 10.5. A map showing all the evaluation is provided in Figure 10.1.

Table 10.5 IEI HIGH and VERY HIGH results

SQ number	River	IEI
B81A-00270	Broederstroom	5
B81B-00233	Mahitse	4
B81B-00246	Politsi	5
B81B-00269	Morudi	5
B81B-00264	Great Letaba	5
B81D-00280	Bobs	5
B81D-00296	Mothlaka-Semeetse	5
B81D-00272	Letsitele	5
B81F-00228	Reshwele	4
B81F-00232	Makwena	4
B81F-00200	Great Letaba	4
B81J-00219	Great Letaba	4
B82E-00149	Khwali	5
B82H-00139	Magobe	4
B82H-00157	Nsama	4
B82J-00153	Nalatsi	5
B82J-00159	Byashishi	5
B82J-00197	Ka-Malilibone	4
B82J-00165	Little Letaba	4
B82J-00201	Little Letaba	5
B82J-00207	Little Letaba	5
B83A-00193	Shipikani	5
B83A-00238	Nharhweni	5
B83A-00254	Ngwenyeni	5
B83A-00220	Letaba	5

SQ number	River	IEI
B83A-00230	Letaba	4
B83A-00235	Letaba	4
B83B-00161	Tsende	5
B83D-00204	Manyeleti	5
B83D-00208	Makhadzi	5
B83D-00261	Nwanedzi	5
B83D-00236	Makhadzi	5

10.2 WATER RESOURCE USE IMPORTANCE

The Water Resource Use Importance (WRUI) was assessed by assigning a qualitative score to a river reach for four variables that represent the status of the in-stream flow as discussed in Section 9.3. The detailed Excel spreadsheet will be made available on the CD with all data provided with the main report. The HIGH evaluation and the metric resulting in the evaluation is provided in Table 10.6.

Table 10.6 WRUI evaluation for SQ with a VERY HIGH rating

SQ	Max rating	Comment
B81A-00242	4	Significant use and regulation
B81A-00270	4	Significant use and regulation
B81B-00247	4	Significant use and regulation and conveyance conduit
B81B-00264	4	Significant use and regulation
B81B-00264	4	Significant use and regulation
B81B-00264	4	Significant use and regulation
B81B-00264	4	Significant use and regulation
B81C-00245	4	Significant use and regulation and conveyance conduit
B81E-00244	4	Significant use and regulation and conveyance conduit
B82D-00146	4	Significant use and regulation
B82G-00135	4	Significant use and regulation
B83E-00265	4	Significant use and regulation

10.3 PRIORITY AREAS – HOTSPOTS

The identified hotspots are illustrated in Table 10.7 and the map in Figure 10.2. The RED colouring relates to the hotspot, i.e. where the most detailed work is required. This would normally be where one would focus EWRs following the Comprehensive or Intermediate EWR methodology. The ORANGE areas are those that require more detailed work than just desktop assessments. YELLOW would require desktops or some more detailed work to be undertaken whereas desktop work would be sufficient in the GREY areas.

The hotspots in the Letaba are mainly focussed on the main Letaba River and this is also where the seven EWR sites are situated.

Table 10.7 Hotspot results

SQ Number	River	IEI	WRUI	Hotspot
B81A-00242	Broederstroom	3	4	4
B81A-00256		3	3	3
B81A-00263		2	3	3
B81A-00270	Broederstroom	5	4	4
B81B-00233	Mahitse	4	2	3

SQ Number	River	IEI	WRUI	Hotspot
B81B-00234	Mahitse	3	2	2
B81B-00246	Politsi	5	3	4
B81B-00251		2	2	2
B81B-00269	Morudi	5	2	3
B81B-00227	Mahitse	3	3	3
B81B-00240	Politsi	3	3	3
B81B-00247	Great Letaba	3	4	4
B81B-00264	Great Letaba	5	4	4
B81C-00245	Great Letaba	3	4	4
B81D-00277	Thabina	3	3	3
B81D-00280	Bobs	5	1	2
B81D-00296	Mothlaka-Semeetse	5	1	2
B81D-00271	Letsitele	3	3	3
B81D-00272	Letsitele	5	3	4
B81E-00213	Nwanedzi	3	3	3
B81E-00244	Great Letaba	3	4	4
B81F-00189	Merekome	3	2	2
B81F-00203	Lerwatlou	3	2	2
B81F-00228	Reshwele	4	1	2
B81F-00232	Makwena	4	1	2
B81F-00200	Great Letaba	4	3	4
B81F-00212	Great Letaba	3	3	3
B81F-00215	Great Letaba	3	3	3
B81F-00218	Great Letaba	3	3	3
B81F-00231	Great Letaba	3	3	3
B81G-00164	Molototsi	2	2	2
B81H-00162	Metsemola	3	1	2
B81H-00171	Molototsi	2	3	3
B81J-00187	Mbhawula	3	2	2
B81J-00209	Great Letaba	3	3	3
B81J-00219	Great Letaba	4	3	4
B82A-00168	Middel Letaba	3	2	2
B82B-00173	Koedoes	2	3	3
B82C-00175	Brandboontjies	3	3	3
B82D-00163	Lebjelebore	3	2	2
B82D-00154	Middel Letaba	2	2	2
B82D-00166	Mosukodutsi	2	3	3
B82D-00146	Middel Letaba	2	4	3
B82E-00149	Khwali	5	1	2
B82E-00150	Little Letaba	3	1	2
B82F-00141	Soeketse	3	2	2
B82F-00128	Little Letaba	3	3	3
B82F-00137	Little Letaba	2	3	3
B82G-00135	Little Letaba	3	4	4
B82H-00127	Nsama	3	3	3
B82H-00139	Magobe	4	1	2
B82H-00157	Nsama	4	3	4
B82J-00153	Nalatsi	5	0	2
B82J-00159	Byashishi	5	0	2
B82J-00197	Ka-Malilibone	4	1	2

SQ Number	River	IEI	WRUI	Hotspot
B82J-00165	Little Letaba	4	3	4
B82J-00178	Little Letaba	3	3	3
B82J-00201	Little Letaba	5	3	4
B82J-00207	Little Letaba	5	3	4
B83A-00193	Shipikani	5	1	2
B83A-00238	Nharhweni	5	1	2
B83A-00254	Ngwenyeni	5	0	2
B83A-00220	Letaba	5	3	4
B83A-00230	Letaba	4	3	4
B83A-00235	Letaba	4	3	4
B83A-00252	Letaba	3	3	3
B83B-00161	Tsende	5	1	2
B83D-00204	Manyeleti	5	0	2
B83D-00208	Makhadzi	5	0	2
B83D-00261	Nwanedzi	5	0	2
B83D-00236	Makhadzi	5	0	2
B83D-00250	Letaba	3	3	3
B83D-00255	Letaba	3	3	3
B83E-00265	Letaba	3	4	4

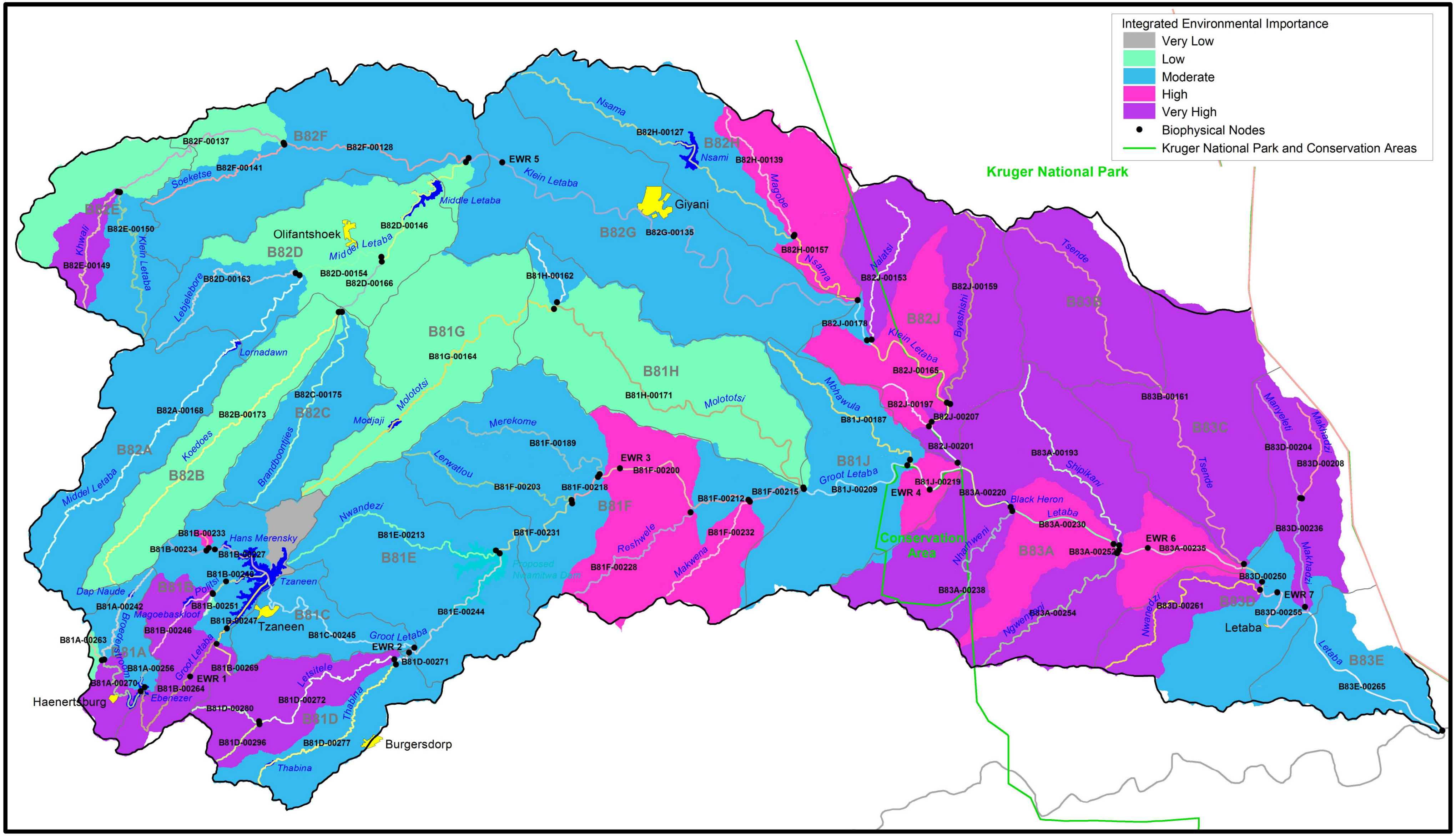


Figure 10.1 IEI results in the Letaba Catchment

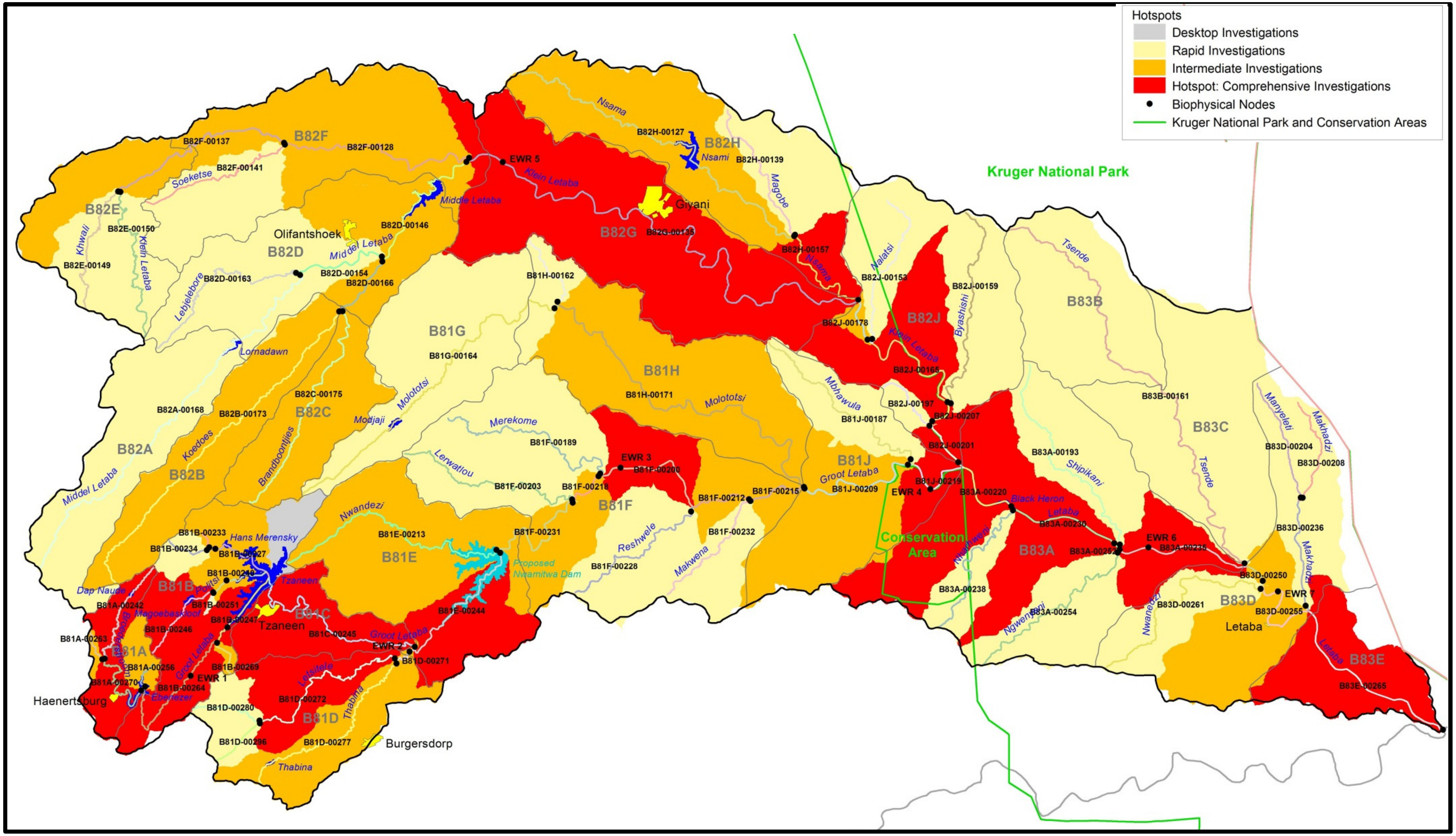
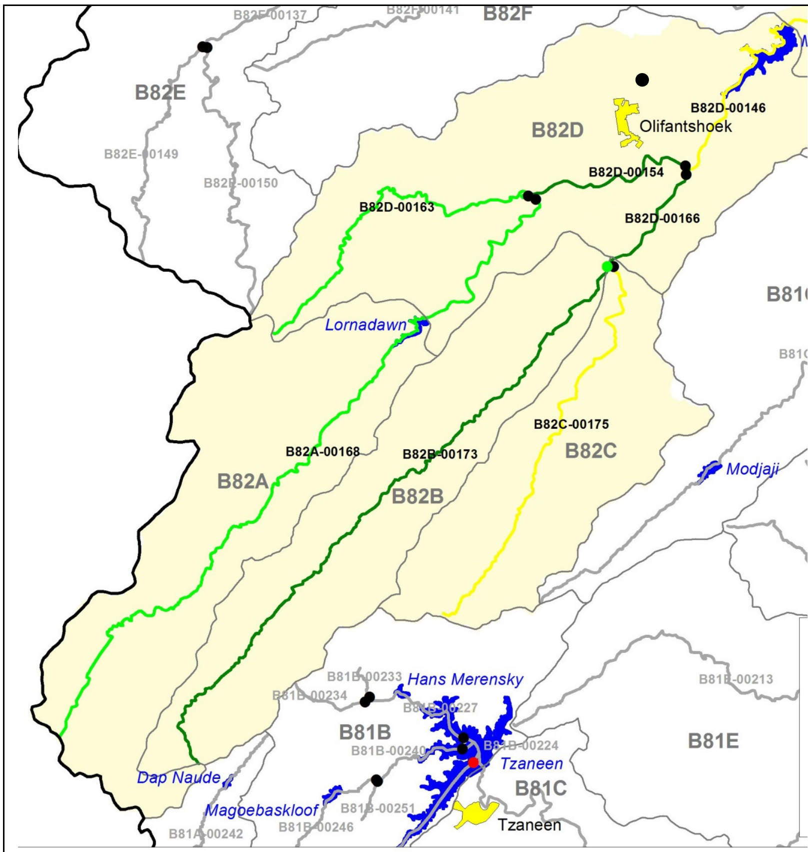


Figure 10.2 Hotspots in the Letaba Catchment

11 BIOPHYSICAL NODES

11.1 IDENTIFICATION OF BIOPHYSICAL NODES

IUAs are a combination of the socio-economic zones defined in watershed boundaries, within which ecological information is provided at a finer scale. IUAs therefore represent a catchment or a linear stretch of river. Nested in an IUA are Resource Units (RUs) (lengths of river referred to in this study as SQ reaches). Each RU is represented by a biophysical node. Biophysical nodes are therefore nested within the IUAs (DWAF, 2007b) and represents flow requirements and ecological state relevant for the RU (SQ). This is illustrated in Figure 11.1



- IUA represented by the yellow catchment.
- RUs or SQ reaches represented by 7 river reaches each identified by a code e.g. B82A-00168.
- Each SQ is represented by a node - the 7 black and green dots within the IUA

Figure 11.1 Illustration of biophysical nodes and RU (SQ reaches) nested within an IUA

11.2 BIOPHYSICAL NODES

Each SQ unit is a surrogate for a desktop RU and must be represented by a desktop biophysical node. As there were 75 SQs, this meant 75 biophysical nodes. As one SQ fell within Tzaneen Dam and could therefore be ignored, the total number of nodes was 74. These nodes were plotted at the end of each SQ (Figure 11.2).

There were seven EWR sites, i.e. key biophysical nodes (Figure 11.2). The key biophysical sites replaced 7 of the desktop biophysical nodes and therefore there were 67 desktop biophysical nodes and 7 key biophysical nodes.

The 7 EWR sites each fell within a hotspot with only the main river in B82C which is a hotspot and does not contain an EWR site.

The list of nodes and the coordinates are provided in Table 11.1. The colouring in the table correlates to the colours of the IUAs on the IUA map.

Table 11.1 Desktop and key biophysical nodes and coordinates

Node Number	Latitude	Longitude	IUA
B81A-00242	-23.894766	29.929583	IUA 1
B81A-00256	-23.931493	29.986368	IUA 1
B81A-00263	-23.895447	29.926083	IUA 1
B81A-00270	-23.936362	29.980707	IUA 1
B81B-00233	-23.750399	30.078479	IUA 1
B81B-00234	-23.753964	30.075103	IUA 1
B81B-00246	-23.80922	30.083294	IUA 1
B81B-00251	-23.810231	30.084098	IUA 1
B81B-00269	-23.875012	30.088541	IUA 1
B81B-00227	-23.752474	30.087183	IUA 1
B81B-00240	-23.794011	30.102626	IUA 1
B81B-00247	-23.855169	30.103565	IUA 1
EWR 1	-23.91769	30.05083	IUA 1
B81D-00277	-23.903248	30.342586	IUA 2
B81D-00280	-23.976655	30.148145	IUA 2
B81D-00296	-23.980357	30.148578	IUA 2
EWR 2	-23.88806	30.36125	IUA 2
B81D-00272	-23.896817	30.340316	IUA 2
B81C-00245	-23.881822	30.368689	IUA 3
B81E-00213	-23.755704	30.484794	IUA 3
B81E-00244	-23.759511	30.490076	IUA 3
EWR 3	-23.64939	30.66064	IUA 4
B81F-00212	-23.690558	30.842038	IUA 4
B81F-00215	-23.676692	30.920789	IUA 4
B81F-00218	-23.660284	30.629575	IUA 4
B81F-00231	-23.694532	30.592761	IUA 4
B81J-00209	-23.645784	31.06698	IUA 4
EWR 4	-23.67753	31.09864	IUA 4
B81F-00228	-23.70647	30.760409	IUA 5
B81F-00232	-23.692646	30.844333	IUA 5
B81F-00189	-23.656814	30.631966	IUA 6
B81F-00203	-23.690531	30.592164	IUA 6
B81G-00164	-23.441665	30.568091	IUA 6
B81H-00162	-23.433379	30.57215	IUA 6
B81H-00171	-23.674791	30.920013	IUA 6
B81J-00187	-23.638615	31.070883	IUA 6
B82A-00168	-23.396494	30.209032	IUA 7
B82B-00173	-23.444787	30.264024	IUA 7
B82C-00175	-23.444665	30.268783	IUA 7
B82D-00163	-23.393984	30.203419	IUA 7
B82D-00154	-23.373329	30.324541	IUA 7
B82D-00166	-23.379501	30.32529	IUA 7
B82D-00146	-23.250322	30.444398	IUA 7
B82E-00149	-23.286323	29.9532	IUA 8

Node Number	Latitude	Longitude	IUA
B82E-00150	-23.286945	29.956688	IUA 8
B82F-00141	-23.226716	30.18857	IUA 8
B82F-00128	-23.245214	30.44833	IUA 8
B82F-00137	-23.224625	30.187538	IUA 8
EWR 5	-23.25081	30.49572	IUA 9
B82J-00165	-23.56419	31.122732	IUA 9
B82J-00178	-23.483144	31.009724	IUA 9
B82J-00201	-23.642554	31.138075	IUA 9
B82J-00207	-23.588957	31.101152	IUA 9
B82H-00127	-23.347941	30.906261	IUA 10
B82H-00139	-23.346229	30.907711	IUA 10
B82H-00157	-23.43102	30.996622	IUA 10
B82J-00153	-23.482271	31.016436	IUA 10
B82J-00159	-23.565796	31.127522	IUA 10
B82J-00197	-23.595182	31.097251	IUA 10
B83A-00220	-23.699633	31.213023	IUA 11
B83A-00230	-23.747566	31.358652	IUA 11
EWR 6	-23.75264	31.40731	IUA 11
B83A-00252	-23.755554	31.36645	IUA 11
B83D-00250	-23.796087	31.569096	IUA 11
EWR 7	-23.80983	31.59081	IUA 11
B83E-00265	-23.988813	31.825606	IUA 11
B83A-00193	-23.749066	31.366869	IUA 12
B83A-00238	-23.704821	31.21554	IUA 12
B83A-00254	-23.759709	31.36382	IUA 12
B83B-00161	-23.773025	31.543311	IUA 12
B83D-00204	-23.687242	31.62259	IUA 12
B83D-00208	-23.687503	31.625239	IUA 12
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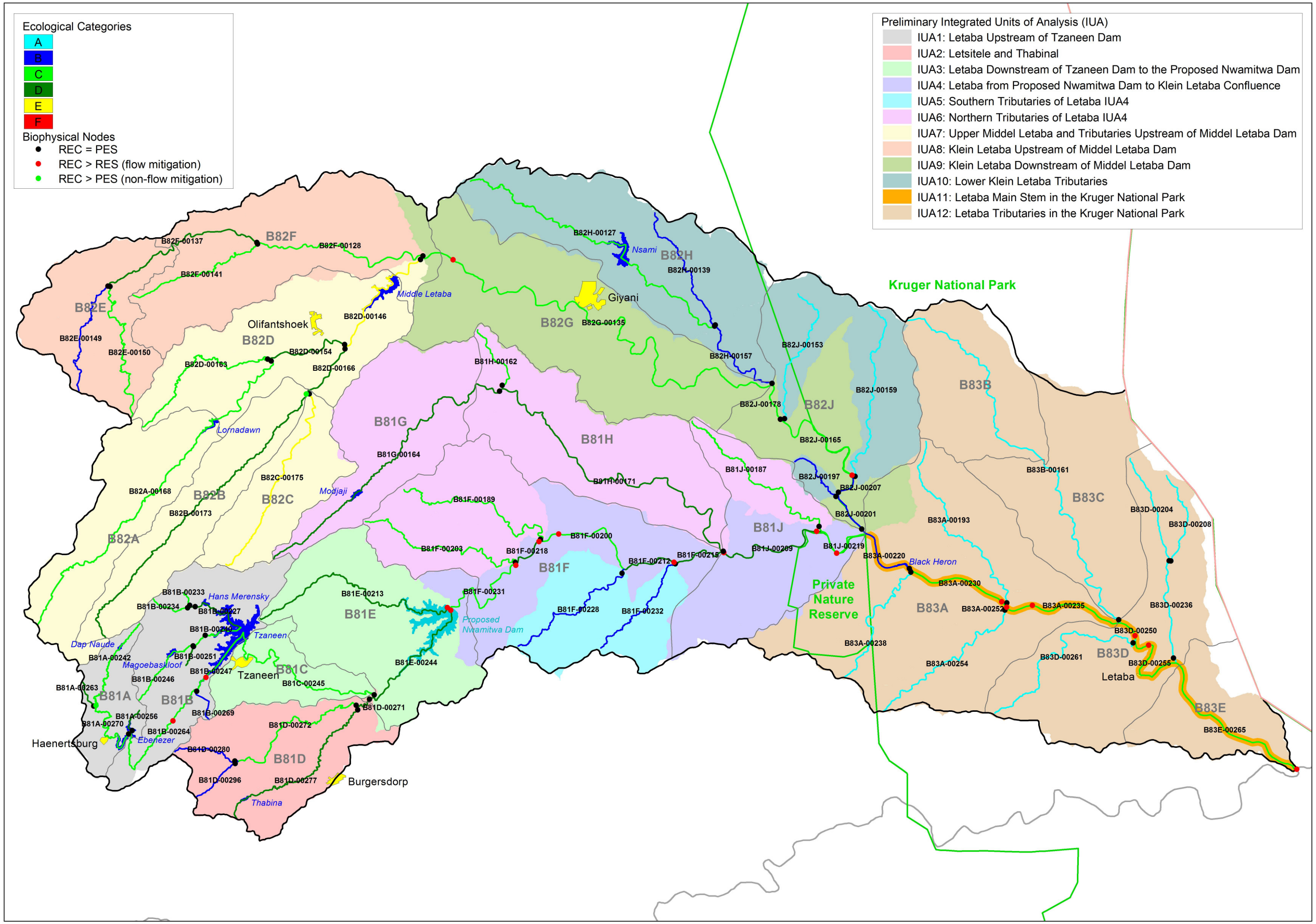

Figure 11.2 IUA map with biophysical nodes

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13 APPENDIX A: WATER QUALITY LITERATURE REVIEW

The table below shows a search per river and information or literature sourced for the water quality component of this study.

Main Catchment River	Searched Internet	Found Info	Literature
Bobs	Y	N	
Brandboontjies	Y	Y	Limited. Brandbootjies Forest management – sedimentation impacts.
Broederstroom	Y	Y	EMF document; State of River report, Reserve.
Byashishi	Y	N	Only River Health Programme (RHP) monitoring sites.
Debengeni			State of River report.
Great Letaba	Y	Y	NB report: Development of a Reconciliation Strategy for the Luvuvhu & Letaba Water Supply System (Literature Review Report), Water Development Project, Mining impacts, State of River report.
Hlangana	Y	Y	Groot Letaba WDP.
Ka-Malilibone	Y	N	Only RHP monitoring sites.
Khwali	Y	N	Only RHP monitoring sites.
Koedoes	Y	N	State of River report.
Lebjelebore	Y	N	
Lerwatlou	Y	N	(mentioned) Water Development Project – Appendix H and Volume 6, Nwandezi, Hlangana, Mphuphule, Shilovolwe, Lerwatlou and Merekome rivers.
Letaba	Y	Y	State of River report, Water Development Project.
Letsitele	Y	Y	State of River report, Water Development Project.
Little Letaba /Klein Letaba	Y	Y	In main Letaba docs, State of River report.
Magobe	Y	N	
Mahitse	Y	N	
Makhadzi	Y	N	
Makwena	Y	N	Only RHP monitoring sites.
Manyeleti	Y	N	
Mbhawula	Y	N	Only RHP monitoring sites.
Merekome	Y	Y	Limited. Water Development Project.
Metsemola	Y	N	Only RHP monitoring sites.
Middel Letaba	Y	Y	In main Letaba docs, State of River report.
Molototsi	Y	Y	State of River report, Environmental Management Framework (EMF) etc.
Morudi	Y	N	Only RHP monitoring sites, Delineation report.
Mosukodutsi	Y	N	Only RHP monitoring sites, Delineation report.
Mothlaka-Semeetse	Y	N	Only RHP monitoring sites.
Mphuphule	Y	Y	Limited, mentioned in Groot Letaba Water Development Project (WDP) (Annex H).
Nalatsi	Y	N	
Ngwenyeni	Y	Y	Limited. Mining impacts but not specific to this river.
Nharhweni	Y	N	Only RHP monitoring sites.
Nsama	Y	Y	State of River report, etc.
Nwanedzi	Y	N	
Politsi	Y	Y	In main Letaba docs, State of River report.
Reshwele	Y	N	Only RHP monitoring sites.
Shingwedzi	Y	Y	In main Letaba docs (not in catchment, so excluded).

Main Catchment River	Searched Internet	Found Info	Literature
Shipikani	Y	Y/N	Limited, mining impacts.
Shilovolwe	Y	Y	Limited, mentioned in Groot Letaba WDP (Annex H).
Soeketse	Y	Y	State of River report, EMF, Status quo.
Thabina	Y	Y	State of River report.
Tsende	Y	Y	Groot Letaba WDP, EMF, Mining impacts.

14 APPENDIX B: REPORT COMMENTS

Page &/ or Section	REPORT STATEMENT	COMMENTS	ADDRESSED IN REPORT?	AUTHOR COMMENT
Comments from Rufus Nengovhela				
General		Front pages, spelling, formatting	Yes	
Page 2.2 Sec 2.4.2	N&N Weir	Is this the correct spelling	No	Spelling on the web page
Page 2.6, above table 2.11	List of quaternaries	These are not the right quaternaries	Yes	
Page 2.6, KI-3	The Nsami Dam itself supplies water to Giyani Town 58 Villages and Giyani Town from the treatment works at the Nsami Dam.	Is this not duplicated? Rephrase	Yes	
Page 4.2	(ref-frontend model)	?	NO	Am awaiting reference from Barbara and Nadene
Page 9.6	The X-axis is based on the Integrated Environmental Importance value derived from the first matrix (Table 9.2). The Y-axis depicts an estimate of water resource use, with 0 being of no importance and 4 being of very high importance.	According to the table the IEI is on Y axis and water resource use on X axis.	Yes	
Page 9.6, Table 9.4	(4 evaluation)	Is this not supposed to be for and not 4	Yes	It must be a 4, but have changed it to avoid confusion.