water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

THE DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE INKOMATI WATER MANAGEMENT AREA









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

Report Number: RDM/WMA05/00/CON/CLA/0213

SEPTEMBER 2013

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REFERENCE

This report is to be referred to in bibliographies as:

Department of Water Affairs, South Africa, September 2013. The determination of water resource classes and associated resource quality objectives in the Inkomati Water Management Area: Status Quo assessment, Integrated Unit of Analysis delineation and biophysical node identification.Prepared by: IWR Water Resources. Authored by: Mallory S, Louw D, Deacon A, Holland, M, Huggins G, Kotze P, Mackenzie J, Scherman P, Van Jaarsveld P,. DWA Report, RDM/WMA05/00/CON/CLA/0213.

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ACKNOWLEDGEMENTS

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REPORT SCHEDULE

Version	Date
First draft	September 2013
Second Draft	October 2013
Final Draft	January 2014

EXECUTIVE SUMMARY

INTRODUCTION

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2013 for the provision of professional services to undertake the determination of water resource classes and associated resource quality objectives in the Inkomati WMA. IWR Water Resources was appointed as the Professional Service Provider (PSP) to undertake this study.

The purpose of the Status Quo report was 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 and to identify the Integrated Units of Analysis (IUA).

WATER RESOURCES STATUS QUO ASSESSMENT

Water resource zones(based on similar water resource operation), location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments within the context of the larger system were identified and are described in this report.

Upper Komati (X11 and X12): The water resources of the upper Komati is dominated by two large dams, the Nooitgedacht and Vygeboom dams from which water is transferred out of the catchment to power stations. There is limited other use in these upper reaches, although domestic requirements are increasing rapidly and there are large areas under commercial forestry.

Lower Komati (X13): The Lower Komati is dominated by extensive irrigation, mostly sugarcane. Water for these activities is supplied mostly from the Maguga Dam, located in Swaziland. Domestic use in this area is increasing rapidly as towns and villages expand and water service delivery improves.

Lomati (X14): The Lomati catchment is similar to the Lower Komati with extensive irrigation, supplied in this case from the Driekoppies Dam which is located on the border of Swaziland and South Africa. Domestic use is also significant in this catchment. Two smaller dams (Lomati and Shiyalongubo) located in the upper reaches of the Lomati catchment (upstream of Swaziland) transfer water to the Kaap River catchment. There are also significant areas of afforestation in the upper reaches of the Lomati catchment.

Upper Crocodile (X21): The Kwena Dam, located in the Upper Crocodile, is by far the most important dam in the Crocodile catchment. Water from this dam supplements the water supply to irrigators along the Crocodile as well as to major urban centres of Nelspruit and Kanyamazane. While a large proportion of the water used in the Crocodile catchment is sourced from the Upper Crocodile, water use in the upper Crocodile itself is limited. There is limited irrigation in the Elands River catchment and in Schoemanskloof along the Crocodile River. Commercial forestry is however a major water user in this area as is the industrial water use associated with the paper mill located at Ngodwana. Domestic water use is limited.

Middle Crocodile (X22): The Middle Crocodile has limited water resources of its own with the large irrigators and domestic users (Mbombela municipality) abstracting water from the Crocodile River, supplemented with releases from the Kwena Dam. However, within the White River area several small dams are located, including the Witklip, Klipkopjes, Longmere and Primkop dams which supply water to the town of White River as well as to irrigators. There are also large areas of forestry in the Middle Crocodile with resulting streamflow reduction.

Kaap (X23): The Kaap River does not have any significant dams and irrigators rely on run-of-river as well as small farm dams to meet their water requirements. The domestic water requirements of Barberton are met mostly from the Lomati Dam, located in the neighbouring Lomati catchment. Water is also transferred from the Shiyalongubo Dam (also located in the Lomati catchment) to irrigators in the Louws Creek area (lower Kaap). There are significant areas of forestry on the mountain ranges surrounding the Kaap River catchment.

Lower Crocodile (X24): The lower Crocodile catchment is characterised by extensive irrigation, supplied from the Crocodile with flows supplemented with releases from the Kwena Dam. The rainfall in this area is however too low for forestry. A large part of this catchment is located within the Kruger National Park and is undeveloped. Domestic use is very limited but there is a significant industrial use associated with the sugar mill located near Malelane.

Upper and Middle Sabie (X31): There are two significant dams in the Sabie catchment, the Da Gama Dam, which supplies irrigators, and the much larger Inyaka Dam which was built primarily to supply domestic users in the Sand River and support the ecological water requirements of the lower Sabie. Domestic use in the Sabie catchment has grown rapidly over the past few years and there are now significant abstractions from the Sabie Rive for domestic use. In addition to the irrigators supplied from the Da Gama Dam, there are large areas of irrigation in the upper Sabie which rely on run-of-river abstractions and numerous farm dams. The upper Sabie is well known for its extensive commercial afforestation with resulting streamflow reduction.

Sand River (X32): The Sand River, a major tributary of the Sabie River, is significantly drier than the neighbouring Sabie River and with insignificant water resources development; irrigation is limited to two run-of-river schemes. The catchment is however home to a large semi-rural population with large water requirements which are now largely met by transfer from the Inyaka Dam in the Sabie River catchment. There is limited forestry development on the eastern escarpment of the Sand River catchment.

Lower Sabie (X33): The lower reaches of the Sabie River lie within the Kruger National Park and are undeveloped. However, the ecological sustainability of the Sabie River is dependent on sound management of the catchment, river and dam upstream of the Kruger National Park.

X40: The X40 catchments are very dry and lie entirely within the Kruger National Park. These catchments are undeveloped.

STATUS QUO OF GROUNDWATER RESOURCES

Groundwater classification is used to define the present status of the groundwater resource and to identify ways to manage the groundwater resource in a sustainable manner. Groundwater classification aims in this regard to maintain a balance between the protection of a groundwater resource (including dependent ecosystems) and its use to meet economic and social demands.

The delineation of Groundwater Units of Analysis (GUA) is based on hydrogeological criteria and might not necessarily correlate to quaternary surface water catchments or surface water units of analysis. A total of nineteen GUAs were delineated based on the following criteria:

- Surface water units of analysis as part of this project.
- The four main Inkomati WMA sub-catchments were considered, namely the Komati, Crocodile, River/Sand and the undeveloped X4 sub-catchment in the KNP.
- The quaternary drainage areas were considered as the basis of delineation.
  - Quaternary drainage areas with similar hydrogeological characteristics were grouped into one GUA. The dolomites were a far as possible grouped into separate GUA, while including the quaternary drainage areas contributing to its run-off.
  - Hydrogeological criteria (including geology, geomorphology and topography).

From the available ~ 4900 geo-sites only ~2500 sites contain information on either water level or yield. From these geo-sites only ~1000 sites have a coordinate accuracy of less than 1 km. The results are summarised as follows:

- Komati sub-catchment
  - Average water levels range from 7 to 25 m below surface; with the deepest water levels found in the Nelspruit Suite basement (GUA1-6) and Karoo (basalt) (GUA1-7) aquifers.
  - Highest borehole yields are associated with the Barberton basement aquifer (GUA1-5), while yields below the population (Inkomati WMA) average are found in GUA1-2 to GUA1-4. It must be noted that a limited number of boreholes with yield data were available for these GUAs and might distort the assessment.
  - The deepest average borehole depth is found in the Nelspruit Suite basement- (GUA1-6) and the Karoo- (basalt) (GUA1-7) aquifers. Drilling depths below the population (Inkomati WMA) average are found in GUA1-2, GUA1-4 and GUA1-5.
- Crocodile sub-catchment
  - Average water levels range from 13 to 24 m below surface, while the deepest water levels are found in the Pretoria Group- (GUA2-1) and the Basement (GUA2-5) aquifers respectively.
  - Highest borehole yields are associated with the Malmani dolomites (GUA2-3), while yields above the population (Inkomati WMA) average are also found in GUA2-1 to GUA2-5. The lowest borehole yields are associated with the basement complex (GUA2-4) aquifer.
  - Average borehole depths range from 43 to 74 m below surface.
- Sabie-Sand sub-catchment
  - Average water levels range from 8 to 19 m below surface, which is considerably shallower than in the Komati- and Crocodile sub-catchments.
  - Borehole yields are unfortunately also generally lower compared to the Komati- and Crocodile sub-catchment. The Basement (GUA3-3 and GUA3-4) aquifers have a higher average yield in comparison to the Karoo (GUA3-5) aquifers.
  - Average borehole depths range from 50 to 90 m below surface. Despite shallower water levels compared to the Komati- and Crocodile sub-catchments, the drilling depths are on average deeper than the these sub-catchments.
- X4 sub-catchment
  - Average water levels are 15 m below surface with an average borehole yield of 1.5 l/s, which is lower than the total population (Inkomati WMA) average.

STATUS QUO OF THE ECONOMY

The environmentally sustainable development and management of water resources of the Komati River, Crocodile River and Sabie-Sand River systems is a serious and complex issue if one takes into account the vast potential for economic development within the catchment which requires water to ensure that the development does take place and can also be sustained. It is technically challenging and often entails difficult trade-offs between social, economic and political considerations.

The Kaap River, Crocodile River and the Sabie-Sand River catchments face a number of water resource challenges. Greatest of these challenges is sharing scarce water resources between various competing needs. Already, a large part of the catchment is threatened by water scarcity or an already over allocation of water – and yet there are new needs for water that must still be met.

The economic significance of water uses in the Inkomati WMA is dominated by primary sectors such as irrigated agriculture and commercial forestry, subsequently by secondary industries in particular saw and sugar mills as well as a pulp and paper processing plants. Tertiary flow of the economy represents the tourism sector. The WMA covers the very important economic hubs of Mbombela Local Municipality (Nelspruit) and Nkomazi Local Municipality which together represent more than 61% of the industrial output of the Inkomati Catchment.

It is also a very important agricultural region hosting large sugar cane production areas throughout the WMA with the accompanying sugar mills. A large variety of other agricultural products are produced varying from vegetable, citrus and macadamia production in the catchment.

The Inkomati Catchment area includes some of the most popular tourist and holiday areas in the country varying from a holiday destinations along the Panorama Route, including Sabie and Hazyview. The Kruger National Park forms part of the Crocodile and Sand River Catchments, and still one of the most popular tourist destinations for local and international tourists. The catchment has a large number of holiday resorts and game farms which further enhances the importance of tourism in the catchment.

Fourteen Economic Regions were identified across the catchment, 4 economic zones in the Komati River Catchment, 7 economic zones in the Crocodile Catchment and 3 economic zones in the Sabie-Sand catchment. In all the regions the agricultural related industry is prominent. Irrigation agriculture with commercial forestry is present in all three the catchments, while the majority of industries are located in the Crocodile Catchment.

STATUS QUO OF WATER QUALITY

General land use practices that pose water quality problems within the study area include the following:

- Non-point source pollution from agriculture (pesticides, fertilizers).
- Non-point source pollution from residential areas (urban and rural townships) e.g. stormwater run-off, washing in rivers.
- Point source pollution from urban infrastructure (e.g. non-compliant wastewater treatment works, saw mills and paper and pulp mills in the X3 Sabie catchment, sugar mills and processing facilities in the X2 Crocodile catchment).
- Microbiological counts and nutrient concentrations are problematic in many catchments, as indicated by high algal growth.
- The presence of alien invasive plants, removal of vegetation and overgrazing within the riparian zone of rivers, which results in erosion and sedimentation.
- Dams are scattered throughout the catchments, which impact on the movement of sediment, and temperature and oxygen levels.

- Mining and manufacturing water quality issues were reported in a 2012 study on the Crocodile catchment (Palmer *et al*., 2012), i.e. chemicals from metal processing, such as iron and manganese; acid mine drainage; water seepage and improper closure of mine dumps.

The following Water Quality (WQ) hotspots have been identified and summarised below.

Secondary catchment X1 - Komati River:

1. Gladdespruit (X11K-01194): Impacts are related to a reduction in low-flows due to forestry, water quality problems due to acid mine drainage from old gold mines, sulphates and raw sewage, erosion and sedimentation, alien invasives and trout dams.
2. Komati River (X13J-01130): Sewage effluent and extensive settlements resulting in elevated nutrients.
3. Teespruit (X12E-01287): Lower reaches only due to sewage effluent resulting in elevated nutrients.
4. Boesmanspruit (X11B-01272): Four open-cast mines in the Boesmanspruit catchment have impacted on water quality in the area.
5. Seekoeispruit (X12D-01235): Number of WWTWs results in elevated nutrients and increased salination around Badplaas.
6. Lomati River (X14E-01151, X14G-01128, X14H-01066): Stretch includes Driekoppies Dam and impacts on temperature and oxygen; also elevated nutrients from irrigation return flows.
7. Middle Komati River (X13G-01282, X13H-01281, X13H-01277, X13H-01280): Irrigation return flows.
8. Lower Komati River (X13K-01114, X13J-012210, X13J-01210, X13J-01149): Irrigation return flows.
9. Lower Komati River (X13K-01114, X13J-012210, X13J-01210, X13J-01149): Irrigation return flows.
10. Lower Komati River (X13K-01038, X13L-01027, X13L-00995): Extensive agricultural activities and irrigation return flows, exacerbated by low flows.

Secondary catchment X2 - Crocodile River

1. Crocodile River (X22K-00981): Extensive urban impacts from the Kanyamazane and Kabokweni area, including High Risk Waste Water Treatment Works (WWTW) at Kabokweni which drains into the Crocodile River.
2. Crocodile River (X24C-01033): Impacts are from extensive settlements on the left bank and irrigation on the right bank.
3. Crocodile River (X24D-00994): Urban impacts, including extensive irrigation effluent impacting on water quality due to the Critical Risk WWTW at Malelane and the High Risk WWTW at Mhlatikop.
4. Crocodile River (X24H-00880): Irrigation effluent and upstream impacts.
5. Crocodile River (X24H-00934): Extensive irrigation effluent impacting on water quality and a Critical Risk WWTW at Komatipoort.
6. Crocodile River (X24F-00953):Extensive irrigation effluent impacting on water quality and a Critical Risk WWTW at Hectorspruit.
7. Gutshwa River (X24B-00903): Extensive urban and rural impacts from the Kabokweni and Malekutu towns.
8. Elands River (X21F-01046; around Machadodorp only): Urban impacts, including the Critical Risk WWTW at Machadodorp and ferro-chrome processing.
9. Noord-Kaap (X23B-01052): Mining and water treatment impacts present.
10. Kaap River (X23G-01057): Mining activities and forestry in the upper catchment.

11. Elands River (X21K-01035): Impacts from Sappi Ngodwana directly into the Elands, and from impacts on the lower end of the Ngodwana Dam.
12. Crocodile River (X22J-00993): Urban impacts from Nelspruit. Diffuse source releases from Papas Quarry at the confluence with the Gladdespruit, is a source of increased manganese concentrations in the Crocodile River.
13. Crocodile River (X22J-00958): Urban impacts from Nelspruit.
14. Crocodile River (X22K-01018): Upstream impacts from Nelspruit, Kanyamazane and Kabokweni areas.
15. Wit River (X22H-00836): Urban impacts from White River and Kabokweni and agricultural impacts.

Secondary catchments X3 and X4 - Sabie and Sand River catchments:

1. A tributary into the Sabie River (X31K-00752): Effluent discharge from the Manghwazi WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system.
2. Sabie River (X31D-00755): Hazyview WWTW. In addition, vegetation removal is high and irrigation is extensive within this catchment, with moderate irrigation effluent impacting on water quality.
3. Ndlobesuthu (X32E-00639): Urban run-off, effluent discharge and vegetation removal represent predominant and critical impacts. Sedimentation and erosion is serious. Indirect impacts are probably high turbidity and nutrient levels, the latter indicated by elevated algal growth.
4. A tributary - Klein Sand River/Acornhoek (into Marite River: X31E-00647): Effluent discharge from the Acornhoek WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system. According to the DWA State of Rivers report, conditions are poor in the Klein Sand River, due to clearing of riparian vegetation and resultant erosion, coupled with alien plant infestation (DWAF, 2002).
5. Marite River (X31E-00647): Urban run-off and effluent from urban areas are the predominant water quality related impacts, along with extensive afforestation, vegetation removal and erosion, which most likely results in high turbidity levels and nutrient concentrations.
6. Marite River (X31G-00728): High algal growth is evident probably due to high nutrient inputs from irrigation run-off and agriculture. Erosion, alien vegetation, vegetation removal are also evident, with small impacts relating to urban run-off/effluent, sedimentation, and overgrazing. Indirect impacts are probably high turbidity and nutrient levels. According to the Inkomati Reserve Study (DWA, 2009g), increased suspended solids loads, elevated nutrients and toxics, as well as temperature and oxygen fluctuations at low flows occur. This is due to extensive citrus cultivation in the area and clearing for subsistence farming. The diatom *A. minutissimum* indicates anthropogenic disturbances and the presence of diffuse pollutants (upstream citrus farming) (EWR 5). According to the PES Fact Sheets irrigation run-off is moderate, which may result in pesticide and fertilizers discharging into the river.
7. Noord-Sand (X31J-00774):High algal growth is evident probably due to urban and irrigation run-off/effluent. Extensive vegetation removal and moderate afforestation probably results in high turbidity levels. Moderate impacts associated with erosion, alien vegetation, overgrazing and irrigation effluent are also evident. Indirect impacts are probably high turbidity and nutrient levels.
8. Noord-Sand (X31J-00835): Urban run-off and effluent from urban areas are the predominant impacts, with moderate levels of algal growth being the likely result of effluent discharges. Alien vegetation, overgrazing and irrigation effluent are also evident. Indirect impacts are probably high turbidity and nutrient levels.

9. Bejani (X31K-00713): Urban run-off, effluent discharge (i.e. Mkhuhlu WWTW) and vegetation removal represent serious impacts. Sedimentation and algal growth is high, with moderate erosion impacts. Indirect impacts are probably high turbidity and nutrient levels, especially since algal levels are high, as well as hazardous microbiological organisms.
10. A tributary that flows into Inyaka Dam, proximate to Marite River (X31G-00728): Effluent discharge from the Maviljan WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system.
11. Tlulandziteka (X32A-00583): The Reserve study of 2010 indicated a C category for this river, with elevated nutrients, turbidity and toxics present. Impacts on temperature and oxygen were also seen due to fluctuating flows.

STATUS QUO OF ECOSYSTEM SERVICES

The present-day status in terms of Ecosystem Services, based on the economic and social importance assessed from a literature review as well as mapping information,is described. The objective of describing communities and their well-being is to provide the baseline against which to estimate changes in social wellbeing for each of the scenarios that will be evaluated. 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 IUA, and to qualitatively estimate the value generated by that use. This will provide the baseline against which the scenarios can be compared.

The population estimate for the WMA is approximately 2 350 000 people or about 4.5% of the total South African population. It is estimated, based on the 2011 Census (Census, 2011) that approximately 67% of the population are living in the rural areas. Many of the settlements in the WMA that are classified as rural are being upgraded through the provision of services, and it might now be more appropriate to classify much of the population in these settlements as urban rather than rural. The term “peri urban” or “closer settlement”, is sometimes used.

Five different land use forms that reflect types of EcoSystem Services that might be associated with the usage have been identified. The land use based zones are:

- Recreation and Game Parks: Here the usage is largely recreational linked to the aesthetic appeal. The KNP and adjacent game parks make up the bulk of these zones.
- Commercial Agriculture and Forestry 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/tribal 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. Bushbuckridge is a typical example.
- High Density Formal Urban: These are the SQs heavily influenced by the formal towns such as Nelspruit, Hazyview, Sabie, and Malelane and the surrounding suburbs and satellite townships. 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.

The most important Ecosystem Services 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 including usage of plants for medicinal purposes.
- 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 KNP and other associated features.
- Dis-benefits associated with malaria, bilharzia, black fly and livestock disease.

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 conservation areas such as the Kruger National Park or the high dependence on resources associated with poor and vulnerable communities located within the SQ.

Sub Quaternary reaches with high Ecosystem Services dependence

SQ number	River	Summary of Status Quo and linked Ecosystem Services Importance
X13B-01347		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X13B-01348		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X14C-01212	Phophonyane	Upper reaches (upper 50%) comprised solely of commercial agriculture (sugar cane) with no presence of human habitation. River extends past the Piggs peak area so elevated tourism/recreational value. Lower reaches (lower 50%) extends into the Komati township which has extensive rural homestead and informal agriculture along the river.
X14C-01203	Phophonyane	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river.
X14D-01174	Lomati	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river.
X14E-01172	Mlilambi	The upper reaches of the river section is located in Swaziland, and an area comprised of scattered rural homesteads, informal agricultural plots and open terrain. The lower reaches of the river extends into an area of higher population density (linked to the Hlohlo township) and extensive informal subsistence farm plots.
X13B-01270	Umlambongwenya	Upper reaches of the river section extends through plantation forestry, and a large farm dam. The river then passes the rural village of Ndzingeni (which contains both households and industrial features). The lower half of the river section extends through a mosaic of rural homesteads with informal agriculture, open terrain.
X13C-01364	Mbuyane	The river section headwaters are located in Malolotja Nature Reserve in Swaziland. Much of the river extent is, however, a mosaic of rural homesteads, informal agriculture and open terrain.
X13D-01323	Komati	Much of the river extent is a mosaic of rural homesteads, informal agriculture and open terrain. Formal small-holdings noted. .
X13E-01389	Nyonyane	River section extends largely through a mosaic of open terrain and formal smallholdings (small-scale agriculture). Rural homesteads noted but not extensive
X13E-01346	Komati	Upper reaches of the river section comprised of open terrain. Mid-reaches extend north of a large rural settlement of Bhalekane and extensive informal agricultural fields. Commercial agriculture also present on the lower reaches.
X13F-01252	Mzimnene	Upper portions of the river section comprised of plantation forestry. Upper and mid-section of the river extend through a mosaic of open terrain, and rural homestead with extensive informal agriculture. Lower reaches extend into moderate density township (Bhalekane) with commercial agriculture on the river banks

SQ number	River	Summary of Status Quo and linked Ecosystem Services Importance
X13G-01261	Mphofu	Upper reaches of the river extends through a mosaic of plantation forestry and natural forests. Lower reaches extend through rural settlement (low density homesteads) with extensive informal agricultural plots.
X13G-01216	Mbulatana	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high.
X13G-01259	Mphofu	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high.
X13G-01282	Komati	River section is flanked on both banks by extensive commercial agriculture. Beyond the agricultural fields, is extensive rural settlement (low-density homestead) which flanks the river on certain sections.
X13H-01197	Mhlangatane	River section extends through a mosaic of low-density, rural homesteads with extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river.
X13H-01226		River section extends through a mosaic of low-density, rural homesteads with extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river.
X13H-01299		Upper reaches of the river section extends through rural settlements (rural homesteads) and extensive informal agricultural fields. Mid-reaches of the river section extend into open terrain/natural terrain with no human presence before discharging into the Sand River Reservoir. Lower reaches extend below the dam wall and cross commercial agricultural land.
X13H-01281	Komati	Small section of river which extends through commercial agricultural land, with rural homesteads found on the north bank.
X13J-01214	Mgobode	River section extends through open terrain and informal agricultural plots, of which the plots are linked to the MgodobeTownship located further down the river. The mid-reaches of the river extend through open terrain. The lower reaches of the river extend through the Madadeni Township, with some informal agricultural plots noted.
X13J-01141	Mzinti	River section is extends through extensive informal agricultural plots on it upper reaches, which are linked to the large Magogeni township located further down the river. The river extends through two additional large townships (Skoonplaas and Boschfontein). The lower reaches of the river include open terrain and an additional township (Mzinti).
X13K-01068	Nkwakwa	River section extends through a mosaic of open terrain, rural townships and limited informal agricultural plots. Lower-reaches of the river extend through commercial agriculture.
X14E-01151	Lomati	The river section is located in Swaziland and extends through extensive commercial agriculture (sugar cane). The river extends into the Hlohlo township before discharging into the Driekoppies Dam in South Africa.
X24A-00826	Nsikazi	Upper reaches of the river section extends through Legogote Township and Manzini. Mid-reaches are comprised of open terrain and passes the Makoko Township.
X24C-00978	Nsikazi	Upper reaches of the river section passes the Ehlanzeni township, and then extends through open/natural terrain, associated with a nature reserve. Lower reaches of the river passes the Matsulu township.
X31K-00713	Bejani	River extends through open terrain. Marongwana township located on the north bank on the upper reaches of the river. Much of the mid and lower-reaches extend through extensive rural townships.
X31M-00673	Musutlu	River extends through open terrain. Three large townships located on the banks of the river.
X32E-00629	Nwarhele	Upper section low population density some forestry then very dense settlement of Shatale and Dwarsloop.
X32E-00639	Ndlobesuthu	Short river section with very dense settlement of Marijane and Dwarsloop.

ECOLOGICAL STATUS QUO: WETLANDS

Quaternary catchments within the X1, X2, X3 and X4 secondary catchments were assessed for potential wetland importance by combining the frequency of different wetland types (NFEPA classification of types) and the total extent of all wetland types (area) within each quaternary, and scoring the result 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

FEPAs (the final wetland FEPAs selected by review) as well as Ramsar sites was also considered for the scoring. Only wetlands classified as “natural” were used for the analysis.

Seventeen SQs were highlighted as having potentially high wetland importance, 28 contained wetland NFEPAs and together 40 were highlighted for PES scoring.

ECOLOGICAL STATUS QUO: RIVERS AND RIVER LINKED WETLANDS

Data from the PESEIS project was used as the baseline for the status quo assessment of 237 river reaches covering the study area. 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 it is indicated whether these are flow (e.g. abstraction) or non-flow (e.g. riparian vegetation removal or land use practices) related.

X1: Inkomati sub-catchment: The Komati River in South Africa and Swaziland is extensively modified through flow regulation and inundation (large number of dams and weirs). In the lower Komati downstream of Swaziland there are basically no sections of river left that have not been inundated. Other notable impacts in the Komati catchment include forestry, some mining in the upper areas, sections with extensive alien vegetation, overgrazing and sedimentation.

There are 10 SQ reaches in a B PES (outside of Swaziland). Most of these reaches are upstream of Swaziland. The reasons for the relatively good state are due to inaccessibility related to the mountainous terrain. The upper Komati (upstream from Swaziland) is primarily in a C (and B/C) PES with the most significant impacts being irrigation, agriculture, mining, flow regulation, inundation, forestry and alien vegetation.Downstream of Swaziland and the eastern sections of Swaziland is dominated by D rivers, with seven SQ reaches in an unacceptable D/E and E PES. The reasons for these are inundation, irrigation to the rivers edge and return flows, barriers, sedimentation and flow regulation.

X2: Crocodile sub-catchment: The Crocodile Catchment is heavily utilised and possibly over-allocated. In terms of flow regulation, the Elands River is probably the least impacted. Impacts in the main Crocodile River are dominated by Kwena Dam operation and flow regulation of the downstream river for irrigation. Specific impacts are associated with increased (above natural) flows during the dry season, daily fluctuations due to the pumping and abstraction regime and abstraction of flows to such a degree that the river stops flowing at localised stretches. Irrigation return flows and urban runoff impact on water quality. In tributaries such as the Elands, Kaap and Nels rivers, extensive forestry take place. The lower Crocodile River and its tributaries from the Nsikazi River are bordered by or fall within the KNP.

Upstream of the Kaap River confluence, the PES is dominated by a C EC. Downstream of the Kaap River confluence, the Crocodile River is in a D with most of the tributaries being in an excellent state as they are mostly located within the KNP.

Twenty one SQ reaches are in an A, B or B/C PES. Of these, fifteen fall within the KNP from source to confluence with the Crocodile River or borders the KNP.

There is one SQ with PES lower than a D (PES D/E: X22H-00836). This SQ represents the WitRiver with extensive upstream flow modification (abstraction for irrigation), agricultural fields, farm dams and inundation as well as water quality problems with associated algal growth. The two most downstream Crocodile River SQ reaches have instream components that result in an E PES for instream components. The reason for this is due to the extensive sugarcane irrigation on the right bank with cessation of flow at localised areas and water quality problems particularly related to irrigation return flows and temperature fluctuations related to flow modification (abstraction).

X3: Sabie sub-catchment: A large section of the eastern part of this catchment falls within the Greater Kruger National Park All the SQs in the Greater KNP are either in a B or A PES apart from one SQ in the Sabie River which is in a C due to the presence of dams and weirs. There are three SQs in the Sabie River which borders the KNP and are in a C PES.

The Sabie River Catchment outside of the KNP is dominated by forestry and irrigation for agriculture (orchards). Some water quality deterioration is associated with Sabie town effluents. Outside of the KNP, the majority of the SQs are in a C with 5 SQs in a D EC. There are 6 SQs which are in a B or B/C PES.

The Sand River outside of the Greater KNP is dominated by forestry in the upper areas and subsistence agriculture with extensive erosion, overgrazing and human settlements on the lower lying areas. The PES is mostly a C with three D PES SQ reaches. It must be noted though that many of the rivers with their sources in the Drakensberg have A to B sections followed by a much lower PES in the lower section of an SQ (as low as E PES).

X4: Nwanedzi and Nwaswitsontso: The Nwanedzi/Nwaswitsontsorivers are seasonal systems that mostly originate in the Kruger National Park and drain separately through the Lebombo Mountains towards the Inkomati River in Mozambique. The Nwaswitsontso River is the only river originating outside the Park and the first 5 km of 97 km falls outside the KNP and adjacent Reserve areas. The occurrence of dams, overgrazing, erosion and agriculture renders this SQ-reach (X40C-00513) an EC of a B. The rest of the Nwaswitsontso River tributaries (X40C and X40D) are mostly unmodified and in an A category.

The Nwanedzi river system consists of the Nwanedzi and Sweni tributaries (X40A and X40B), and the majority of these seasonal streams are unmodified. The only adverse impacts in the two tributaries are tourist roads, river crossings and small dams. The lower section of the Nwanedzi River are rated a B category due to dams and abstraction for a tourist camp.

The Sweni River system (X40B) runs mainly through a wilderness area with very little notable impacts and is in an A PES. Impacts on this river include overgrazing by game, water abstraction for tourist facilities and erosion.

INTEGRATED UNITS OF ANALYSIS (IUA)

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 33 IUAs were delineated in the Inkomati WMA:

X1 KOMATI RIVER	
IUA X1_1	Catchment upstream of Nooitgedacht Dam.
IUA X1_2	Komati River between Nooitgedacht and Vygeboom Dam.
IUA X1_3	All tributaries between Nooitgedacht and Vygeboom Dam excluding the main Komati River
IUA X1_4	Gladdespruit catchment.
IUA X1_5	Komati River downstream of Vygeboom Dam to Swaziland.
IUA X1_6	All tributaries downstream of Vygeboom Dam in X1_6 excluding the Gladdespruit.
IUA X1_7	Lomati catchment upstream of Swaziland.
IUA X1_8	Lomati catchment downstream of Driekoppies Dam.
IUA X1_9	Komati catchment downstream of Swaziland to the Lomati River confluence.
IUA X1_10	Komati catchment downstream of the Lomati River.
X2 CROCODILE RIVER	
IUA X2_1	Crocodile sub-catchment upstream of Kwena Dam.
IUA X2_2	Crocodile River downstream of the Kwena Dam to the Elands River.
IUA X2_3	Elands catchment upstream of the Weltevredespruit excluded.
IUA X2_4	Elands River downstream of X2_3 to the Ngodwana confluence, including the Weltevredenspruit, the Ngodwana River upstream of the Ngodwana Dam and the Lupelele River.
IUA X2_5	Elands River downstream of the Ngodwana River.
IUA X2_6	Crocodile River to the Nels River confluence.
IUA X2_7	Houtbos and Visspruit Rivers.
IUA X2_8	Nels, Wit, and Gladdespruit rivers.
IUA X2_9	Crocodile River to the Kaap confluence including the Blinkwater tributary.
IUA X2_10	Kaap catchment.
IUA X2_11	Crocodile River from the Kaap confluence to the Komati River.
IUA X2_12	Nsikasi River.
IUA X2_13	Northern tributaries of the Crocodile River located in the KNP.
SABIE-SAND RIVER	
IUA X3_1	Sabie catchment upstream of the Klein Sabie included confluence.
IUA X3_2	Sabie River downstream of X3-1 to the Marite confluence including the Goudstroom, MacMac, Motitsi and Marite upstream of Inyaka Dam.
IUA X3_3	Marite and Sabie River downstream of Inyaka Dam to the Sand confluence.
IUA X3_4	Sabaan, Noord-Sand, Bejani, Saringwa, Musutlu rivers.
IUA X3_5	Sabie River downstream of the Sand confluence to the RSA border.
IUA X3_6	Southern and northern tributaries of the Sabie in the KNP downstream of the Sand confluence including the Phabeni.
IUA X3_7	Mutlumuvi catchment.
IUA X3_8	Sand catchment to the Khokhovela included confluence.
IUA X3_9	Sand catchment downstream of the Khokovela confluence.
IUA X4: NWANEDZI AND NWASWITSONTSO RIVERS: The whole X4 will be one IUA. The rivers are largely in the KNP and will not be affected by any scenario.	

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).

The rivers where hotspots dominate are mostly on the main stems of the rivers. This can largely be attributed to the cumulative impact of water use and deteriorating water quality relating to industrial and urban development as well as mining. Seventeen hotspots were identified in the Komati catchment; eleven hotspots were identified in the Crocodile catchment while fourteen hotspots occurred in the Sabie-Sand catchment (X3).

BIOPHYSICAL NODES

Each SQ unit is a surrogate for a desktop RU and must be represented by a desktop biophysical node. As there are 238 SQs, this implies that there 238 biophysical nodes. There are 21 EWR sites, i.e. key biophysical nodes. The key biophysical sites replaced 21 of the desktop biophysical nodes and therefore there are 217 desktop biophysical nodes and 21 key biophysical nodes.

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TERMINOLOGY AND ACRONYMS

AMD	Acid Mine Drainage
BHN	Basic Human Need
CD: RDM	Chief Directorate: Resource Directed Measures
D:RQS	Directorate: Resource Quality Services
DM	District Municipality
DSS	Decision Support System
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
EWR	Ecological Water Requirement
EZ	Economic Zone
FEPA	Freshwater Ecosystem Priority Area
GDP	Gross Domestic Product
GIS	Geographic Information System
GRA II	Groundwater Resource Assessment Phase II
GRDM	Groundwater Resource Directed Measures
GUA	Groundwater Units of Analysis
GVA	Gross Value Added
I/O	Input/Output
ICMA	Inkomati Catchment Management Agency
IEI	Integrated Environmental Importance
IFC	International Finance Corporation
IIMA	Interim IncoMaputo Agreement
ISP	Internal Strategic Perspective
IUAs	Integrated Unit of Analysis
IUCN	International Union for Conservation of Nature
IWAAS	Inkomati Water Availability Assessment Study
KNP	Kruger National Park
KOBWA	Komati Basin Water Authority
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MC	Management Classes
NFEPA	National Freshwater Ecosystem Priority Areas
NGA	National Groundwater Archive
NWA	National Water act
NWRCS	National Water Resource Classification System
PES	Present Ecological State
PSP	Professional Service Provider
REC	Recommended Ecological Category
Quat	Quaternary catchment
RQOs	Resource Quality Objectives
RU	Resource Unit
SAM	Social Accounting Matrix
SCI	Socio Cultural Importance
SIC	Standard Industrial Classification

SQ	Sub Quaternary
TDS	Total Dissolved Salt
TPTC	Tripartite Permanent Technical Committee
UGEP	Utilisable Groundwater Exploitation Potential
URS	User Requirements Specifications
WARMS	Water Use Authorisation and Registration Management System
WIM	Water Impact Model
WMA	Water Management Area
WMS	Water Management System
WQ	Water Quality
WRCS	Water Resources Classification System
WReMP	Water Resources Modelling Platform
WRUI	Water Resource Use Importance
WWTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the InkomatiWater Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Management Classes (MC) of the significant water resources in WMA 5 will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011a). The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2013 for the provision of professional services to undertake the determination of water resource classes and associated resource quality objectives in the Inkomati WMA. IWR Water Resourceswas appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 STUDY AREA OVERVIEW

The study area is the Inkomati Water Management Area (WMA) which islocated in the north east of South Africa. The WMA consists of three main rivers; the Komati in the South, the Sabie in the North and the Crocodile River in centre. All three of these rivers flow into Mozambique to form the Inkomati River which flows into the Indian Ocean just north of the city of Maputo (Figure 1.1). A part of Swaziland falls within the Komati catchment and while the Classification process will not apply to Swaziland, the water resources and water use within Swaziland will be taken into account when classifying the resources upstream and downstream of Swaziland.

The main urban area in the Inkomati study area is Nelspruit and surrounding towns such as Kanyamazane and White River. The sprawling urban and semi-urban area is centrally located near the Crocodile River. Other significant towns are Barberton, Hazeyview, Sabie, Graskop, Acornhoek, Carolina and Badplaas. Within the WMA there are also large areas of rural or semi-urban development with large populations of largely unemployed inhabitants. The Bushbuckridge area is a good example of this type of development.

Rainfall in the WMA is seasonal with relatively high summer rainfall and zero or minimal rainfall during winter months. Rainfall varies from over 1 000 mm/annum in the high lying area in the west to as low as 500 mm/annum in the east.

Intensive irrigation farming is practiced throughout the WMA but especially in the lower reaches of the Komati and Crocodile Rivers. Sugarcane is the dominant crop but citrus, tropical fruit and nuts are also found. Irrigation is by far the largest water use sector in the WMA.

Forestry is practiced extensively in the high rainfall areas on the upper plateau. Indirect water use by forestry through streamflow reduction is also the second highest user of water in the WMA.

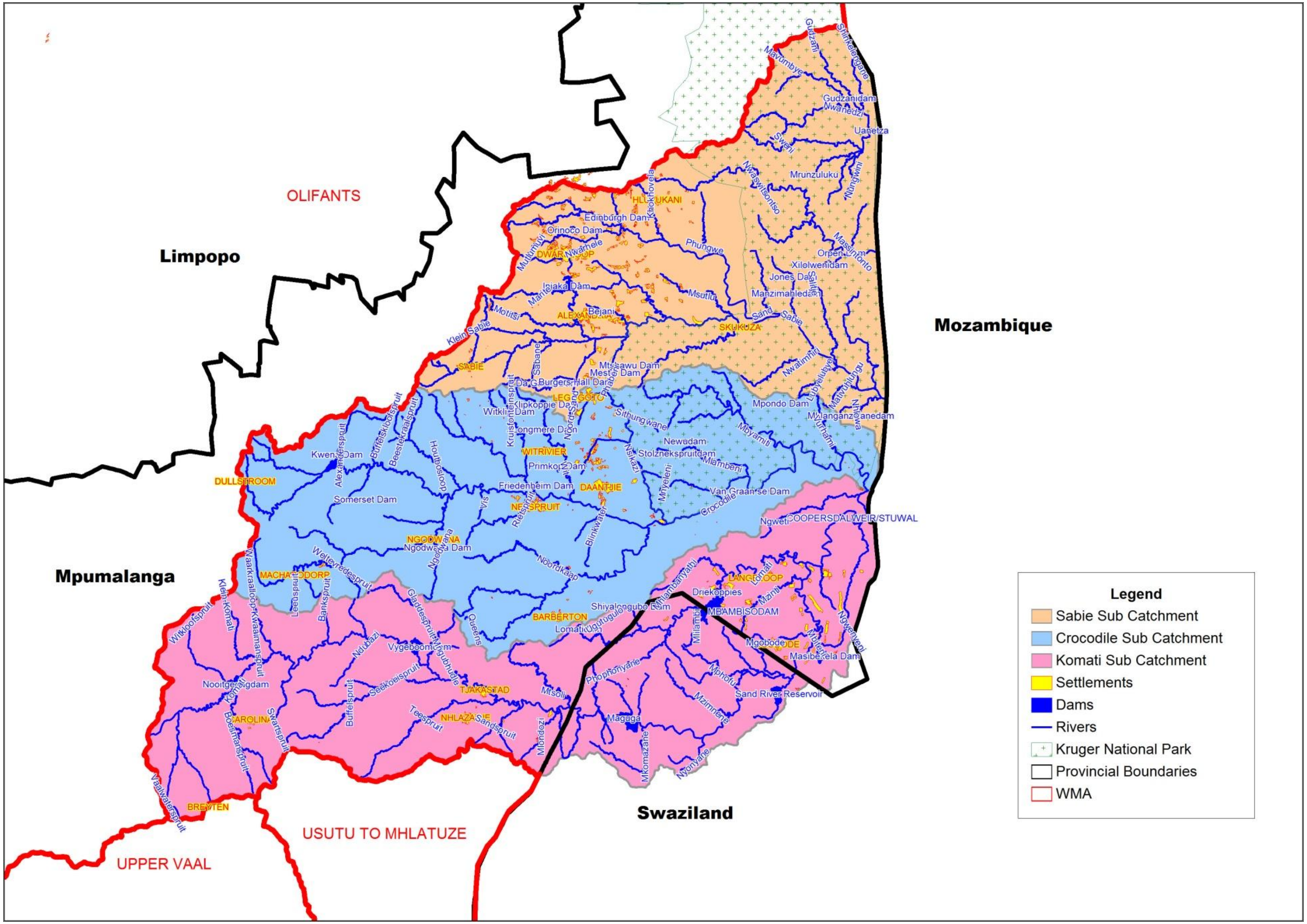

Figure 1.1 The Inkomati WMA

1.3 TASKD1: DESCRIBE STATUS QUO, DELINEATE IUAS AND RESOURCE UNITS AND IDENTIFY BIOPHYSICAL NODES

The objective of this task is to describe and document the status quo of the study area in terms of water use, economy, river and wetland ecology, water quality and Ecosystem Services. This information will be used to define the Integrated Unit of Analysis (IUAs). Once the IUAs have been defined, Resource Units (RUs) and biophysical nodes must be identified for different levels of Ecological Water Requirement (EWR) assessment and the setting of Resource Quality Objectives (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 thecommunity well-being.

1.5 REPORT OUTLINE

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 for WMA 5.
- **Section 9**provides information on the delineated Integrated Units of Analysis (IUAs).
- **Section 10** outlines the general approach to identifying Hotspots in WMA 11 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**.
- Appendix A to C provides additional information for groundwater, biophysical nodes and wetlands. Appendix D provides an outline of comments provided by the Client.

2 STATUS QUO ASSESSMENT: SURFACE WATER RESOURCES

2.1 INTRODUCTION

This Chapter of this Status Quo report covers water resources aspects. The water resources situation of the Inkomati WMA is well documented in several recent reports. This chapter therefore summarised readily available information in terms of natural and present day runoff, water use, streamflow reduction, yields of major dams and an overall water balance which is expressed in terms of assurance of supply.

2.2 APPROACH

There are several different yield models available within the Inkomati WMA, but the three that are in regular use are the Water Resources Yield Model, the Rationing Model and the Water Resources Modelling Platform (WReMP). The Water Resources Yield Model is used occasionally by DWA and their PSPs to assess water use licences; the Rationing Model is used occasionally by the Komati Basin Authority to assess the need for restrictions in the Komati Basin, while the WReMP is used on a weekly basis as a Decision Support System to advise on releases from dams and to advise on when to impose restrictions on users.

The reality in the Inkomati WMA (as documented in ICMA[1] Catchment Management Strategy and the Mbombela Reconciliation Strategy) is that the water requirements in the WMA exceed the water resource (if expressed as firm yield). What this implies is that restrictions will need to be imposed on users periodically. Since WReMP is modelling the catchment in this manner it is the logical tool to use to describe the water resources and to model scenarios for this Classification study.

2.3 DESCRIPTION OF WATER RESOURCES

2.3.1 The study area

The study area comprises the Komati, Crocodile East and Sabie-Sandrivers, as shown in Figure 1.1.These three major tributaries of the international Incomati River Basin are operated largely independently of each other and are therefore described in this section as separate entities.

2.3.2 KomatiRiver

Location

The Komati River is most southern tributary of the Incomati River, which rises in South Africa and flows into Swaziland, then re-enters South Africa where it is joined by the Crocodile River at the border with Mozambique, before flowing into Mozambique as the Incomati River. The Kruger National Park (KNP) is partially located in the Sabie and Crocodile catchments.

Rainfall and runoff

Rainfall in the Komati River catchment is highest on the western escarpment with rainfall in excess of 1 600 mm/annum recorded in places, as shown in Figure 2.1 (DWA, 2009a). The eastern parts of the Komati River catchment are drier, with rainfall of less than 400 mm/annum. The average rainfall in the Komati River catchment is high compared to the average for South Africa, which is 486 mm/annum.

1Inkomati Catchment Management Agency.

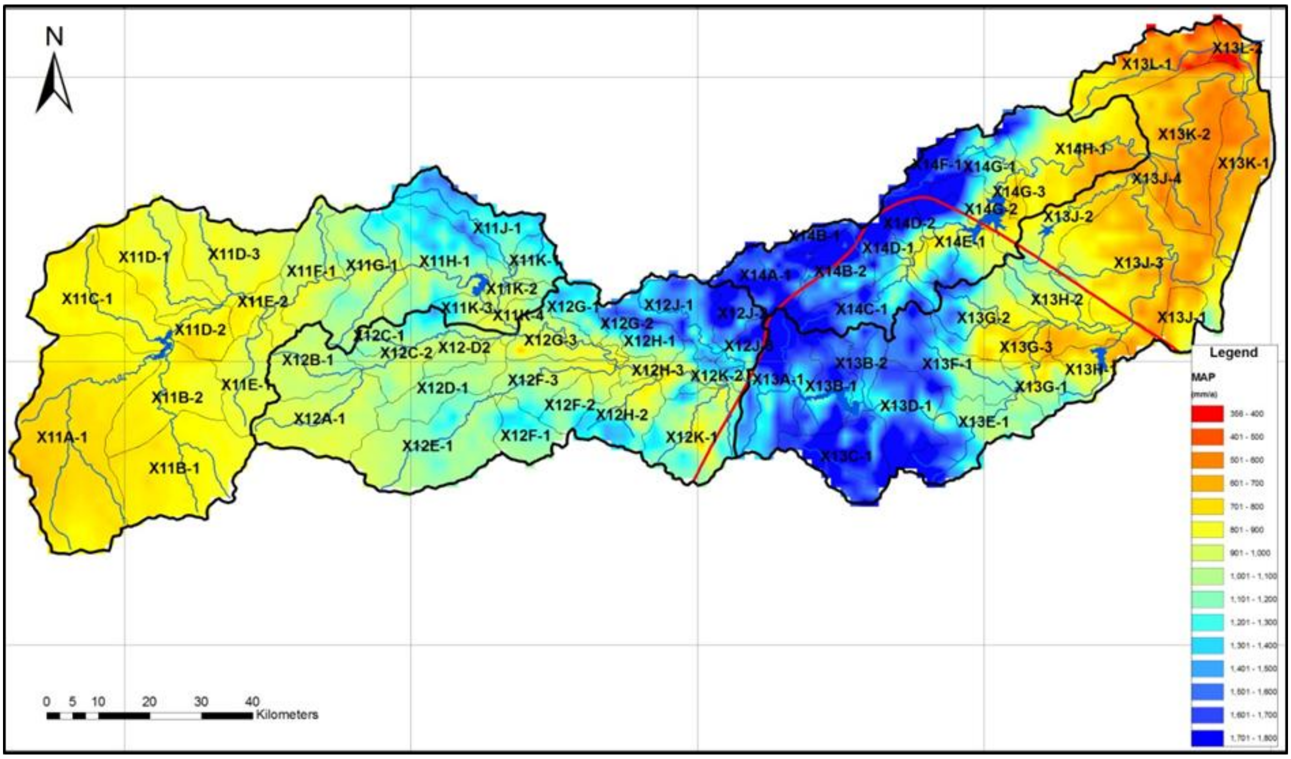

Figure 2.1 Komati River catchment (DWA, 2009a)

According to the Inkomati Water Availability Assessment Study (IWAAS)(DWA, 2009a), the Komati River has a Mean Annual Runoff (MAR) of 1 357 million m^3/annum. However, not all of this water is available for use. Approximately half of this runoff passes into Mozambique as floods while South Africa is obliged in term of international agreements to allow a minimum flow of 35 million m^3/annum into the Incomati River which flows into Mozambique (DWA, 2009a).

Water use

The water allocation and use situation of the Komati River (Table 2.1) is complicated, since it is shared with another state (Swaziland) which has different water legislation to that of South Africa. There are however international agreements in place which define the water allocations and assurance of supply for the two basin states.It is important to note, however, that these *international*allocations are not immediately achievable and assume the development of new and as yet unspecified dams.

Table 2.1 Water allocation and use within the Komati River catchment, including Swaziland (from TPTC, 2002)

Sector	Allocation/use (million m^3/annum)	Actual use (million m^3/annum)
Domestic	21	21
Strategic	106	106
Industrial	11	11
Irrigation	620	~ 500
Total	758	638

The Interim IncoMaputo Agreement (IIMA) (TPTC, 2002) allocates 205 million m^3/annum to ‘high assurance’ use, of which approximately 106 million m^3/annum is transferred to the Olifants River catchment for power generation. The remainder is for domestic and industrial use. While there is unallocated water in the Komati catchment in terms of the IIMA, this water has not been allocated under South African or Swaziland’s respective water laws.The intention is that this additional allocation will be made if and when new dams are constructed within the catchment.Table 2.2 summarises the volumes of water currently utilised and the assurance of supply at which the various user sectors can be supplied.

Table 2.2 Water supply and water use situation within the Komati River catchment

User Sector	Allocation/use (million m^3/annum)	Assurance of supply
Domestic	21	98%
Strategic	106	99.5%
Industrial	11	99%
Irrigation	620	80%

Irrigation

The Komati River is highly utilised by the irrigation sector. Irrigation water use has expanded to the point where the assurance of supply is only about 80%, which is probably close to the limit of economic sustainability. Any new water use within the catchment will lead to a decrease of assurance of supply to irrigators, with resulting economic hardship. It should be noted that Swaziland has yet to take up about 20 million m^3/annum of their irrigation allocation. When they do, it will reduce the assurance of supply to the South African irrigation sector to about 70%.

Stream Flow Reduction Activities

Forestry reduces streamflowby about 117 million m^3/annum, which is taken into account when determining the current assurance of supply. Water to the forestry sector is assumed to be provided at 100% assurance, since “restrictions” would entail cutting down trees before they reach maturity (DWA, 2009a).

Ecological Reserve

The current operating rules for the major dams in the catchment allow for releases to downstream users. These releases meet the ecological Reserve requirements of the Komati and Lomati rivers upstream of their confluence. The minimum cross-border flows required in terms of the IIMA agreement are sufficient for the ecological requirements of the lower reaches of the Komati (below the confluence with the Lomati River). Nevertheless, development on any tributary would need to comply with the ecological requirements of that tributary (Nepid Consultants, 2009).

Dams

The details of the major dams on the Komati River are summarised in Table 2.3 (DWAF, 2009a)

Table 2.3 Major dams on the Komati River (DWA, 2009a)

Dam	MAR (million m^3/a)	Full supply capacity		Full supply area (km^2)
		Million m^3	% MAR	
Maguga	766.2	332.0	43	10.4
Driekoppies	267	251.0	94	18.7
Vygeboom	239.6	83.3	35	6.7
Nooitgedacht	59.2	78.8	133	7.6
Shiyalongubo	12.7	2.3	18	0.4
Lomati	10.6	5.1	48	0.57
Sand River	4.1	49.0	1 200	7.0
Masibikela	2.8	9.1	325	3.0
Mbambiso	2	10.0	500	1.7

2.3.3 Crocodile River

Location

The Crocodile River is located between the Komati and Sabie rivers.The Crocodile River joins the Komati River just before the border with Mozambique to form the Incomati River.

Rainfall and runoff

Rainfall in the Crocodile River catchment is highest on the western escarpment, with rainfall in excess of 1 600 mm/annum recorded in places. The eastern parts of the Crocodile River catchment are drier, with rainfall less than 400 mm/annum in places, as shown inFigure 2.2.

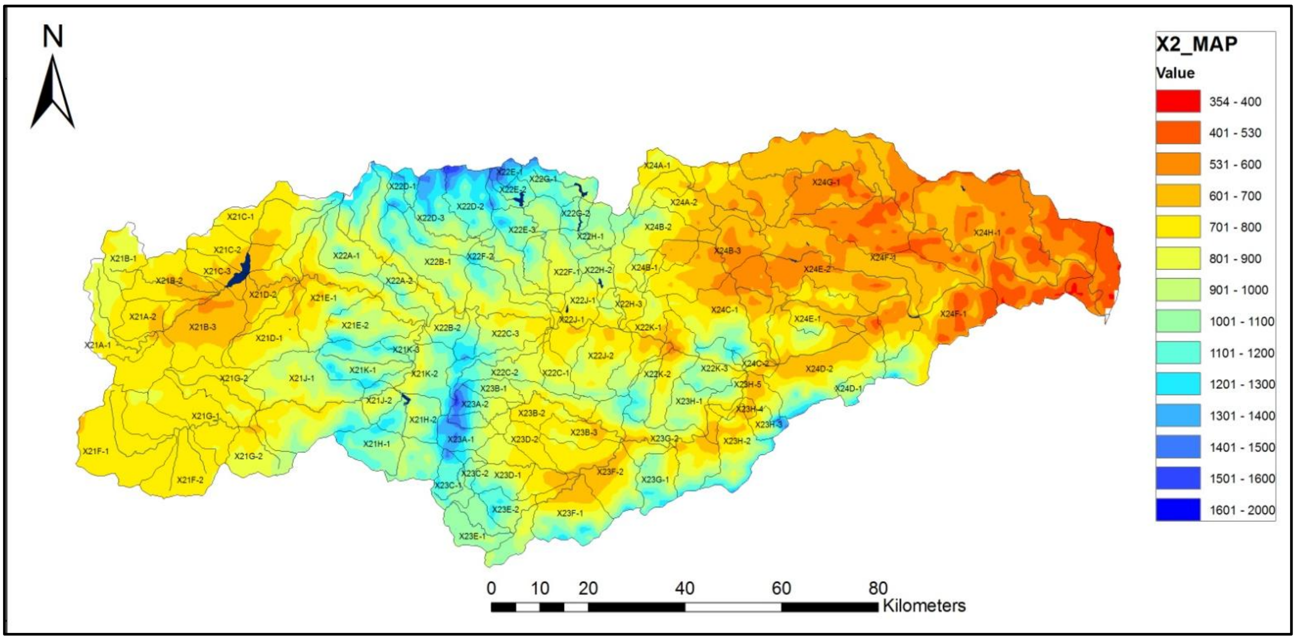

Figure 2.2 Crocodile River catchment (DWA, 2009b)

Water allocation, supply and use

The water allocations made to the various water user sectors within the Crocodile River catchment are summarised in Table 2.4. The urban sector is currently using more than their allocation, while the irrigation sector is using less than their full allocation at a lower assurance than that of domestic use. The fact that irrigators can only be supplied about 400 of their 480 million m^3/annum allocation is a good indicator of the stressed nature of this catchment.

Table 2.4 Allocations and water use within the Crocodile River catchment (DWA, 2009b)

Sector	Allocation/use (million m^3/annum)	Actual use (million m^3/annum)
Domestic	45	52
Industrial	22	22
Irrigation	480	~ 400
Total	539	465

According to the IWAAS (DWAF, 2009b), the Crocodile River has anMAR of 1140million m^3/annum, although not all of this is available for use. Approximately half of this runoff passes into Mozambique as floods, while South Africa is obliged in terms of international agreements to allow a minimum flow of 28 million m^3/annum (TPTC, 2002).

The Crocodile River is highly utilised by the irrigation sector. Irrigation water use has expanded to the point where the assurance of supply is only about 70% (DWA, 2010a), which is probably close to the limit of economic sustainability. Any new water use within the catchment will lead to a decrease of assurance of supply to irrigators, with resulting economic hardship.Further, without appropriate control, irrigators could continue to abstract their rightful allocation: This will reduce the water available to meet both the ecological flow requirements and the international obligations.

Table 2.5summarises the volumes of water currently allocated, and the assurance at which the user sectors can be supplied.

Table 2.5 Water resources and assurance of supply (DWA, 2010a)

User Sector	Allocation/use (million m^3/annum)	Assurance of supply
Domestic	52	98%
Industrial	22	99%
Irrigation	480	70%

Stream flow Reduction Activities

Forestry reduces streamflowin the Crocodile River by about 150 million m^3/annum(DWA, 2009b),which is taken into account when determining the current assurance of supply. Water to the forestry sector is assumed to be provided at 100% assurance, since “restrictions” would entail cutting down trees before they reach maturity.

Ecological Reserve

In terms of the ecological Reserve, the decision has been made to maintain the current ecological state by maintaining the flow regime. The implication of this is that no new water licences can be issued without further development of the water resources.

Dams

The details of the major dams on the Crocodile River are summarised in Table 2.6 (DWAF, 2009b)

Table 2.6 Major dams on the Crocodile River (DWA, 2009b)

Dam	MAR (million m^3/a)	Full supply capacity		Full supply area (km^2)
		Million m^3	% MAR	
Kwena	127.8	159.0	124	12.5
Ngodwana	63.5	10.4	16	0.9
Longmere	29.4	4.5	14	0.9
Klipkopjes	20.9	12.3	58	3.8
Witklip	19.2	12.6	64	1.9
Primkop	13.7	1.9	15	0.4

2.3.4 Sabie-Sand River

Location

The Sabie River catchment lies in the north of the Inkomati WMA, entering Mozambique after flowing through the Kruger National Park.Once in Mozambique, the Sabie joins the Komati River, which at this point is referred to as the Inkomati River (Figure 1.1).The Sabie River catchment is considered the most pristine of the six river catchments that cross over from South Africa to Mozambique.

The Sand River is a main tributary of the Sabie River and is somewhat drier than the Sabie River.

Rainfall and runoff

In the Lowveld region of the catchment the Mean Annual Precipitation (MAP) is about 600 mm on average. Towards the Drakensberg mountains in the upper Middleveld region the rainfall increases rapidly with altitude, with the MAP reaching 2 000 mm in the west (DWA, 2013a).The rainy season generally lasts from about November to March, with the maximum rainfall usually occurring in January (Figure 2.3).

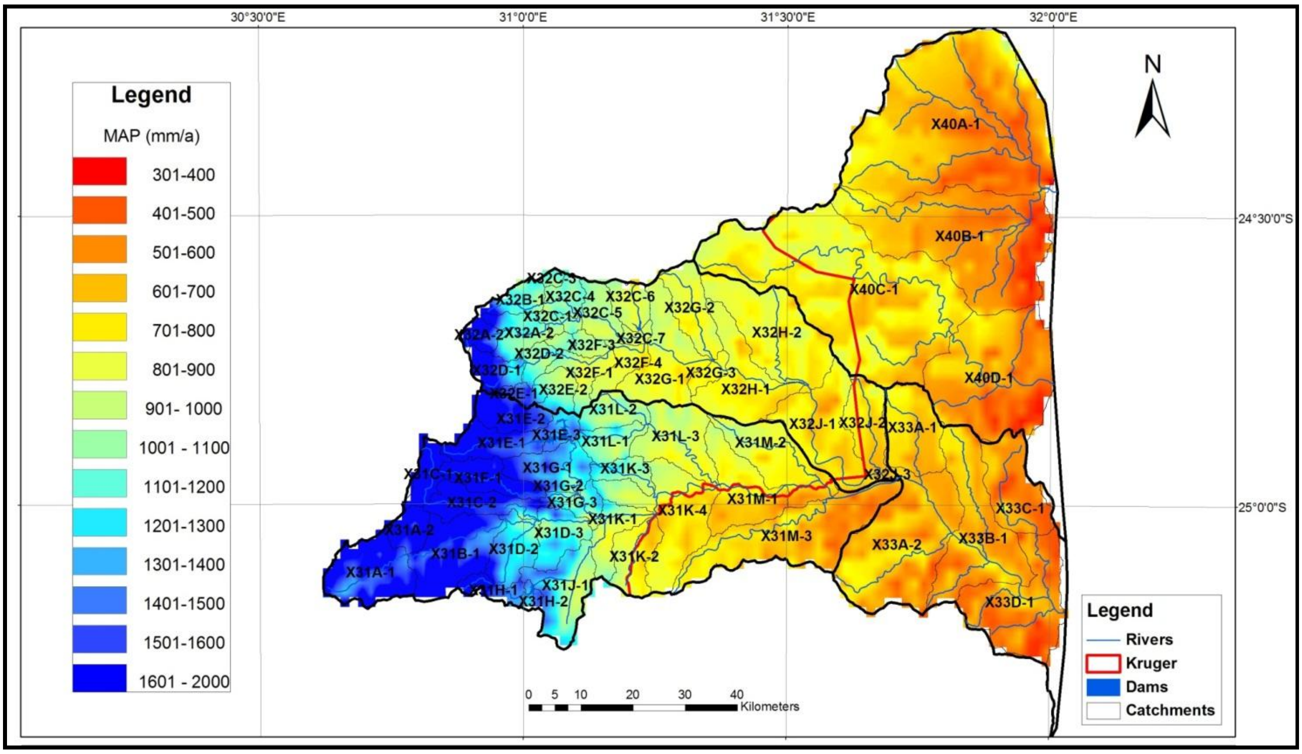

Figure 2.3 Rainfall in the Sabie catchment (DWA, 2009d)

The natural MAR of the Sabie River catchment is675 million m^3/annum (DWA, 2009d).

Water allocation, supply and use

The IWAAS study (DWAF, 2009d), concluded that Sabie River had surplus water available even after the implementation of the Reserve.However, the more recent Water Requirements and Availability Reconciliation Strategy for the Mbombela Municipal Area Study (DWA, 2013b), concludes that while the available water resource of the Sabie River is not yet fully utilised, it has been fully allocated.Outcomes from that study include the finding that once the transfer of water from the Inyaka Dam to the Sand River has been fully implemented, the Sabie River will be in balance and fully utilised.The only option to make more water available for use is to downgrade the ecological management class of the river, the evaluation of which forms part of this study.

The high ecological flow requirements of the KNP, coupled with the need to support rural development and improved service delivery to the rural sector, brought about the construction of the Inyaka Dam, completed in 2000. Detailed operating rules to meet the ecological Reserve as well as other water requirements within these catchments were developed by the then Department of Water Affairs and Forestry (DWAF). However, these operating rules were never implemented, probably because the Sabie catchment has not been unduly stressed at that time (DWA, 2013a).

However, the imminent completion of the final phase of the treatment plant at Bushbuckridge (which treats water from the Inyaka Dam) will maximise demand in the system. This, coupled with the threat of legal action from the Sabie-Sand Game Reserve if the ecological Reserve is not implemented in the Sand River catchment may lead to the system as a whole becoming water stressed shortly. Improved operation of the system will be necessary if all the water requirements, including the Reserve, are to be met (DWA, 2013a).

Domestic water supply

The Sabie River is the main water supply for Nsikazi North and Hoxani.The current water use in Nsikazi North is estimated to be 10.7 million m^3/a, 8.2 of which is supplied from the Sabie River.

The Sabie River also supplies Hazyview, mostly via an irrigation canal which supplies the Sabie Irrigation Board. Current use approximately is 1.4 million m^3/a.The target assurance of supply for domestic water use is 98% (DWA,2013b).

Irrigation

There is an estimated 85 million m^3/a of irrigation use in the Sabie-Sand catchment, most of which is located along the Sabie River upstream of the confluence with the Marite River. The irrigation sector in this area is well organised and very seldom if ever experience water restrictions. There is currently only and estimated 9 million m^3/a of irrigation in the Sand River which is supported by a system of canals which divert water from the upper reaches of the Sand River and its tributaries. The irrigation in this area is struggling due to land claims and the lack of farming skills. Several farms in the area recently went insolvent and the water use is currently less than it used to be.

Stream Flow Reduction Activities

Forestry reduces streamflowin the Sabie-Sand catchment by about 95 million m^3/annum. This water use is taken into account within the water resources models when determined the yield of dams and the assurance of supply to water users.Water to the forestry sector is assumed to be provided at 100% assurance, since “restrictions” would entail cutting down trees before they reach maturity.

Ecological Reserve

The ecological Reserve has been determined through a comprehensive study (DWA, 2010a). A recently concluded study, *Establishment of a Real Time Operating Decision Support System for the Sabie-Sand River System* (DWA, 2013a)describes the development and implementation of a real-time Decision Support System (DSS) for the operationalisation of the Reserve on the Sabie-Sand system.In the Sabie River this entails making releases from the Inyaka Dam when required while in the Sand River a passive system of proportional flow diversion is used.

Dams

The dams on the Sabie River command just over one quarter of the natural runoffof the catchment andoffer support to users along the Sabie River during periods of low flow(DWA, 2013b). The most significant is the Inyaka Dam, completed in the year 2000. Due to the high rainfall and related high runoff from the Sabie River, the relatively high baseflows can support users for most of the year.Consequently, releases from the Inyaka Dam are required only during the winter months to supplement the water requirements of the users located on the middle and lower Sabie Rivers.

An allocation of 25 million m^3/annum has been made from Inyaka dam for transfer to the Sand River catchment, leaving no additional water available for allocation(DWA, 2013b).The major dams in the Sabie catchment are summarised in Table 2.7(DWA, 2009c).

Table 2.7 Details of major dams in the Sabie River catchment (DWA, 2009c)

Dam	MAR (million m^3/a)	Full supply capacity		Full supply area (km^2)
		Million m^3	% MAR	
Inyaka	104.5	123.0	118	8.1
Maritsane	39.7	2.1	5	0.5
Da Gama	17.8	13.6	76	1.3
Edinburgh	3.9	2.4	62	0.6
Kasteel	3.2	1.4	42	0.2
Orinoco	2.7	1.6	60	0.2

2.4 STATUS QUO ASSESSMENT

2.4.1 Decision Support System

An evaluation of available models was carried out and it was concluded that the most up to date and appropriate models, or decision support systems, are those maintained by the ICMA. These consist of monthly time-step operational models which take into account the low assurance of supply of users by recommending water restrictions timeously so as to prevent the failure of the bulk water supply system. These systems operate as three separate stand-alone systems, one for the Crocodile, one for the Sabie and a third for the Komati. The Crocodile and Sabie models are web-based while the Komati model is still undergoing trial runs to compare it with the Komati Basin Water Authority (KOBWA) Rationing Model. The KOBWA rationing model is an appropriate model but has been set up to model water allocations in terms of international agreements and does not model that actual use in the catchment. It therefore tends to be somewhat conservative.

2.4.2 Water Resources

The Inkomati WMA was divided into 34 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 2.4to Figure 2.6). The significant resources of the proposed water resource zones are summarised in Table 2.8.

Table 2.8 Inkomati catchment water resource zones

Water Resource Zone	Description	Major impoundments	Quaternary catchments
Kom1	The area upstream of the Nooitgedacht Dam.	Nooitgedacht	X11A – X11D
Kom2	The area between Nooitgedacht and Vygeboom Dam.	Vygeboom	X11E – X11H
Kom3	The Gladdespruit catchment.	None	X11J
Kom4	Major undeveloped tributaries south of the Komati (Teespruit, Seekoeisrpuit, Buffelsspruit, Mtosoli and Mlondizi).	None	X12A – X12J
Kom5	The main stem of the Komati River between the Vygeboom dam and the Swaziland border.	None	X11K-3, X11K-4, X12G-4, X12H-3, X12K-2
Kom6	Lomati River upstream of Swaziland.	Shiyalongubo, Lomati	X14A, X14B
Kom7	Lomati downstream of Swaziland.	Driekoppies Dam	X14F, G and H
Kom8	Komati River downstream of Swaziland.	Mbambiso, Masibikela	X13J
Kom9	Lower Komati River downstream of confluence with the Lomati river.	None	X13K, X13L

Water Resource Zone	Description	Major impoundments	Quaternary catchments
Croc1	Upstream of the Kwena Dam.	Kwena Dam	X21A,B and C
Croc2	Eland River catchment up to Ngodwana.	None	X21F to X21J
Croc3	Ngodwana River.	Ngodwana Dam	X21H
Croc4	Crocodile downstream of the Kwena Dam to the confluence with the Elands Rivers.	None	X21E
Croc5	Elands River downstream of Ngodwana.	None	X21K
Croc6	Houtbos and Nels River.	None	X22A, X22B-1, X22D, X22F-2
Croc7	Small tributaries south of the Crocodile.	None	X22C-1, X22C-2,southern portion of X22J-1,J-2,K-1,K2
Croc8	Main stem of the crocodile River from Montrose falls to Crocodile gorge.	None	X22B-2, X22C-3, northern portion of X22J-1,J-2,K-1,K2, X22K-3
Croc9	Kaap River.	None	X23
Croc10	Sand and White River.	Witklip, Klipkopjes, Longmere, Primkop	X22E,G,H,F-1
Croc11	Nsikasi River.	None	X24A-1,B-1,B-2, C-4, part of X24A-2,B-3 and C-1
Croc12	Main stem of the Crocodile River downstream of Crocodile Gorge.	Van Graan se dam	X24D-1, part of X24D-2, E-1,E2, F-1,H-1,H-2
Croc13	Northern tributaries of the Crocodile River located in the Kruger National Park.	None	X24G-1, part of X24A-2,B-3,C-1,D-2,E-1,E-2,F-1,H-1,H-2
Sabie 1	Upper Sabie River.	None	X31A,B,C and X31D-1
Sabie 2	Sabaan River and upper Sabie irrigation.	None	X31D-2,D-3
Sabie 3	Upstream of Inyaka Dam.	Inyaka, Maritsana	X31E
Sabie 4	Motitis and Marite Rivers.	None	X31F and G
Sabie 5	Upstream of Da Gama Dam.	Da Gama Dam	X31H
Sabie 6	White Water and Noord Sand Rivers.	None	X31J
Sabie 7	Tributaries north of the Sabie.	None	X31L, X31K-3, part of X31K-3, K-4, M-1, M-2
Sabie 8	Tributaries south of the Sabie.	None	X31K-2,M-1,M4, part of X31K-4, M-1, M-2
Sabie 9	Main stem of the Sabie River downstream of the Marite River	None	part of X31K-1, K-4, M-1, M-2
Sand1	The Sand River.	Kasteel, Acornhoek, Edenburgh, Orinoco	X32
SabieSand	The Sabie River after the confluence with the Sand.	None	X33
X40	The X40 catchment.	None	X40

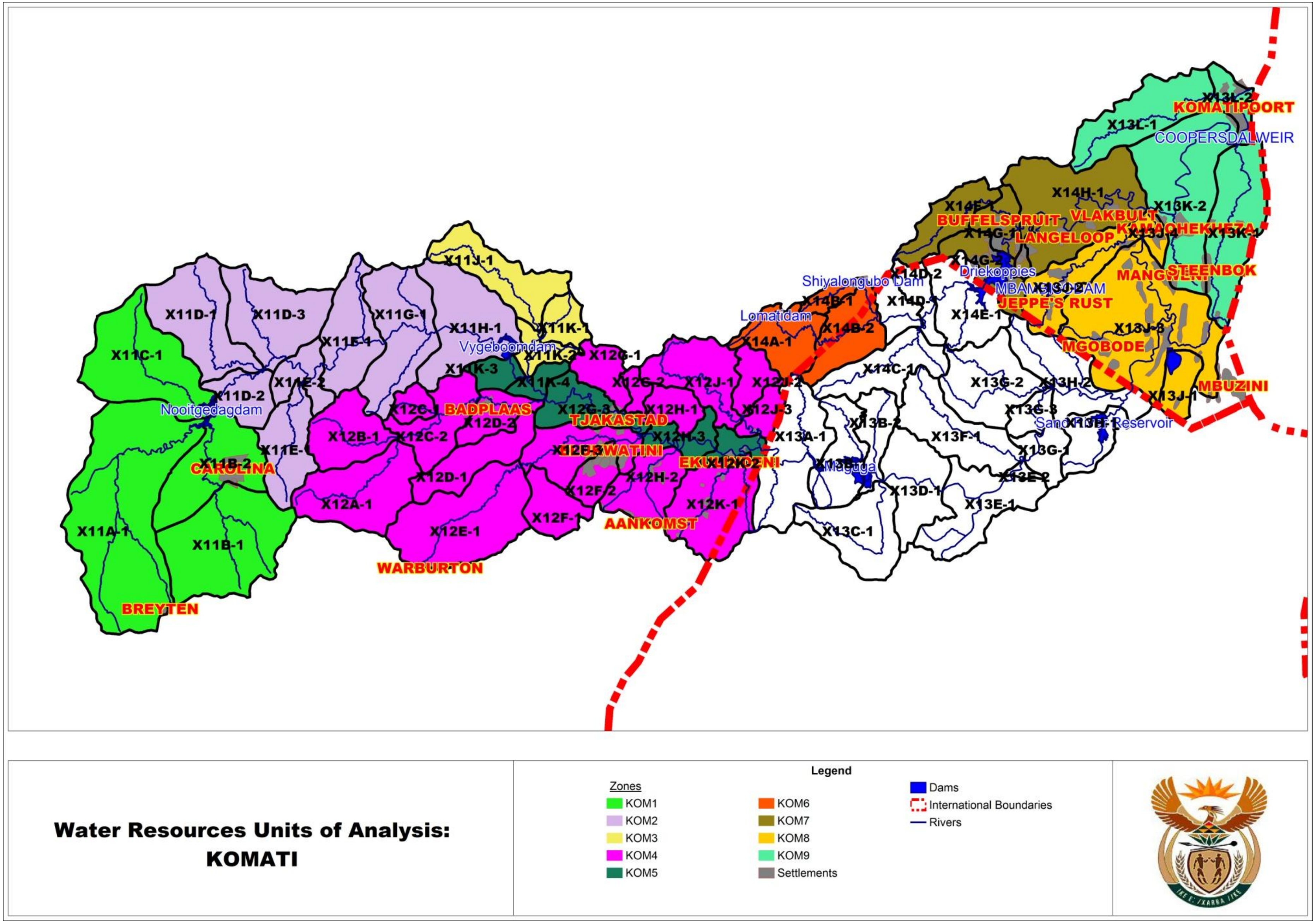

Figure 2.4 Water Resources zones: Komati catchment

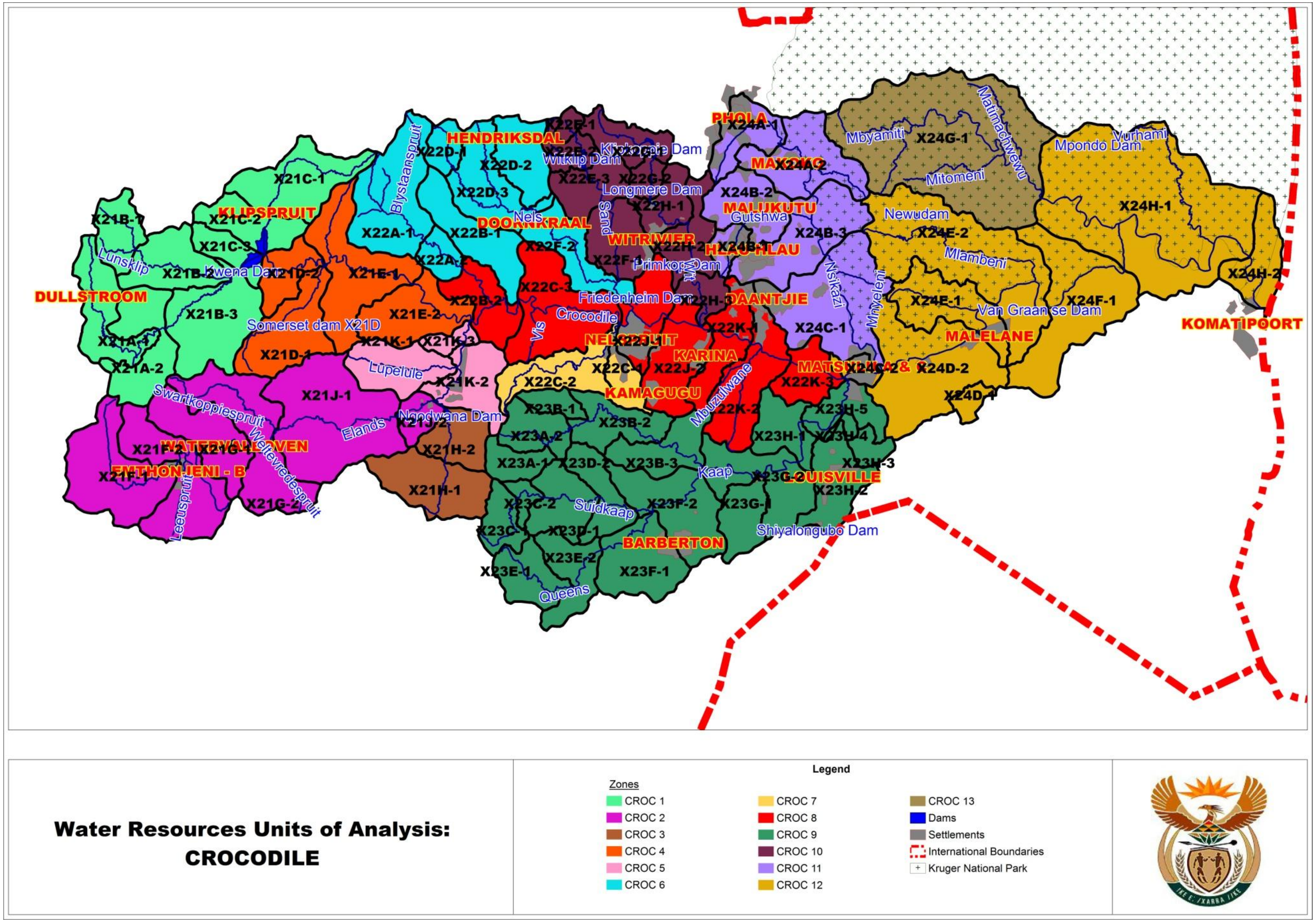

Figure 2.5 Water Resources zones: Crocodilecatchment

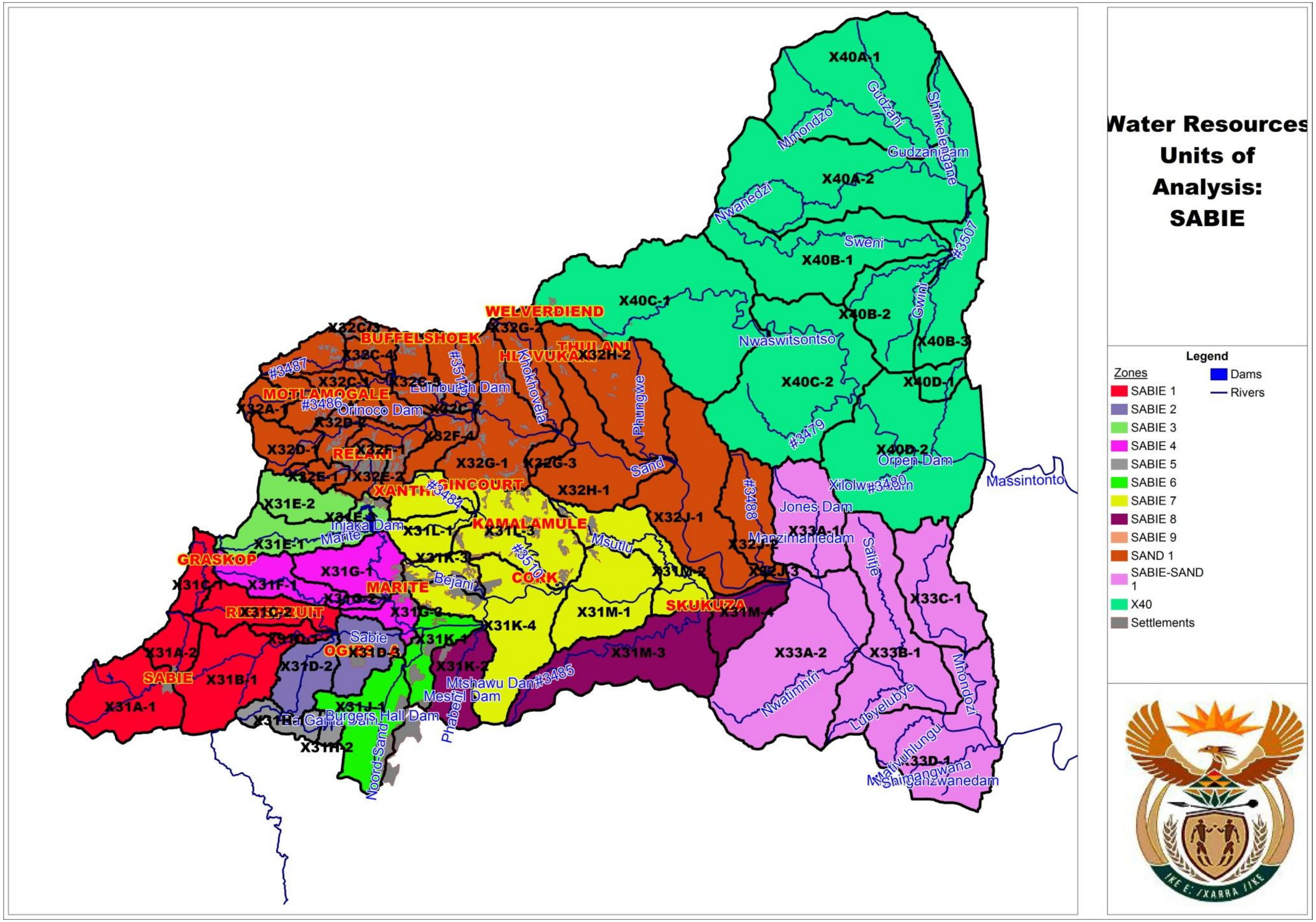

Figure 2.6 Water Resources zones: Sabie catchment

3 STATUS QUO: GROUNDWATER RESOURCES

3.1 BACKGROUND

Groundwater classification is used to define the present status of the groundwater resource and to identify ways to manage the groundwater resource in a sustainable manner. Groundwater classification aims in this regard to maintain a balance between the protection of a groundwater resource (including dependent ecosystems) and its use to meet economic and social demands.

The outcome of the classification process will be the setting of the Management Class (MC), Reserve and Resources Quality Objectives (RQOs) by the Minister or delegated authority for every significant water resources (watercourse, surface water, estuary or aquifer) under consideration. This will be binding for all authorities or institutions when exercising any power, or performing any duty under the National Water act (NWA).The MC represents the desired characteristics of groundwater in that area and outlines the attributes required by the custodian (Department of Water Affairs) of the resource as well as society (DWA, 2013c).

3.2 LITERATURE AND DATA

The following reports and datasets were consulted for the determination of the status quo and the classification of groundwater resourcesin the Inkomati WMA:

- Inkomati WMA: Overview of Water Resources Availability and Utilisation (DWAF, 2003).
- Inkomati WMA: Internal Strategic Perspective (DWAF, 2004a).
- Komati catchment Ecological Water Requirement study; Groundwater Scoping Report (DWAF, 2005a).
- Inkomati Groundwater Reserve Determination (AGES, 2007).
- Desktop Geohydrological Assessment of the Sudwala/Pilgrim’s Rest Dolomites (WGC, 2008).
- Comprehensive Groundwater Reserve Determination study for the Inkomati WMA (AGES, 2010).
- Inkomati Water Availability Assessment (DWA, 2009a-e).

Data Collation:

- 1:250 000 geological maps (Council for Geoscience).
- 1:500 000 Nelspruit and Phalaborwa geological maps (Council for Geoscience).
- Groundwater Resources Information (Groundwater Resource Assessment Phase II - GRA II) Project (DWAF, 2004b) – quaternary scale.
  - Recharge; baseflow; groundwater/harvest potential.
- Groundwater Use (GRAII andWater Use Authorisation and Registration Management System(WARMS), 2013).
- Inkomati Water Availability Assessment (as part of this project).
- Vegter (1995) groundwater map set (borehole yield prospect).
- Regional groundwater quality and water level data from the National Groundwater Archive (NGA – DWA)
- Groundwater Regions (Vegter, 2000).

3.3 DESCRIPTION OF GROUNDWATER RESOURCES

3.3.1 Geology

The understanding of the geological setting and its influence on the groundwater occurrence is one of the first steps in identifying potential aquifersand significant groundwater resources. It also forms the basis for the delineation of aquifers.

The Inkomati WMA is predominantly (>60%) underlain by igneous and metamorphic crystalline basement rocks comprising of the Northern Basement Rocks (i.e. Nelspruit Suite) and the Barberton Supergroup (Figure 3.1). These basement rocks form weathered and fractured aquifers with complex hydrogeology and perceived low exploitation potential of groundwater due to historically low drilling success rates or high frequency of low yielding boreholes. However, scientifically sited boreholes using appropriate groundwater exploration and interpretation methods showed to yield considerable amounts of groundwater (Sami *et al*., 2002). The remainder of the Inkomati WMA comprise of the following major geological groups:

- Karoo Supergroup
  - The Ecca Group is represented by the Dwyka and Vryheid formations in the south-western parts (near Carolina) of the Inkomati WMA. These formations consist mainly of shales, sandstones and coal beds. Dolerite sills intrude these formations.
  - The eastern edge of the Inkomati WMA is represented by the basalts of the Lebombo Group.
- Transvaal Supergroup
  - The Pretoria Group overlies the crystalline igneous and metamorphic Basement rocksunconformably and is characterised by shales, mudrock and quartzites. The Malmani dolomite Subgroup occurs at the base of the Pretoria Group. The weathering resistant Transvaal Supergroup forms the “Great Escarpment”.

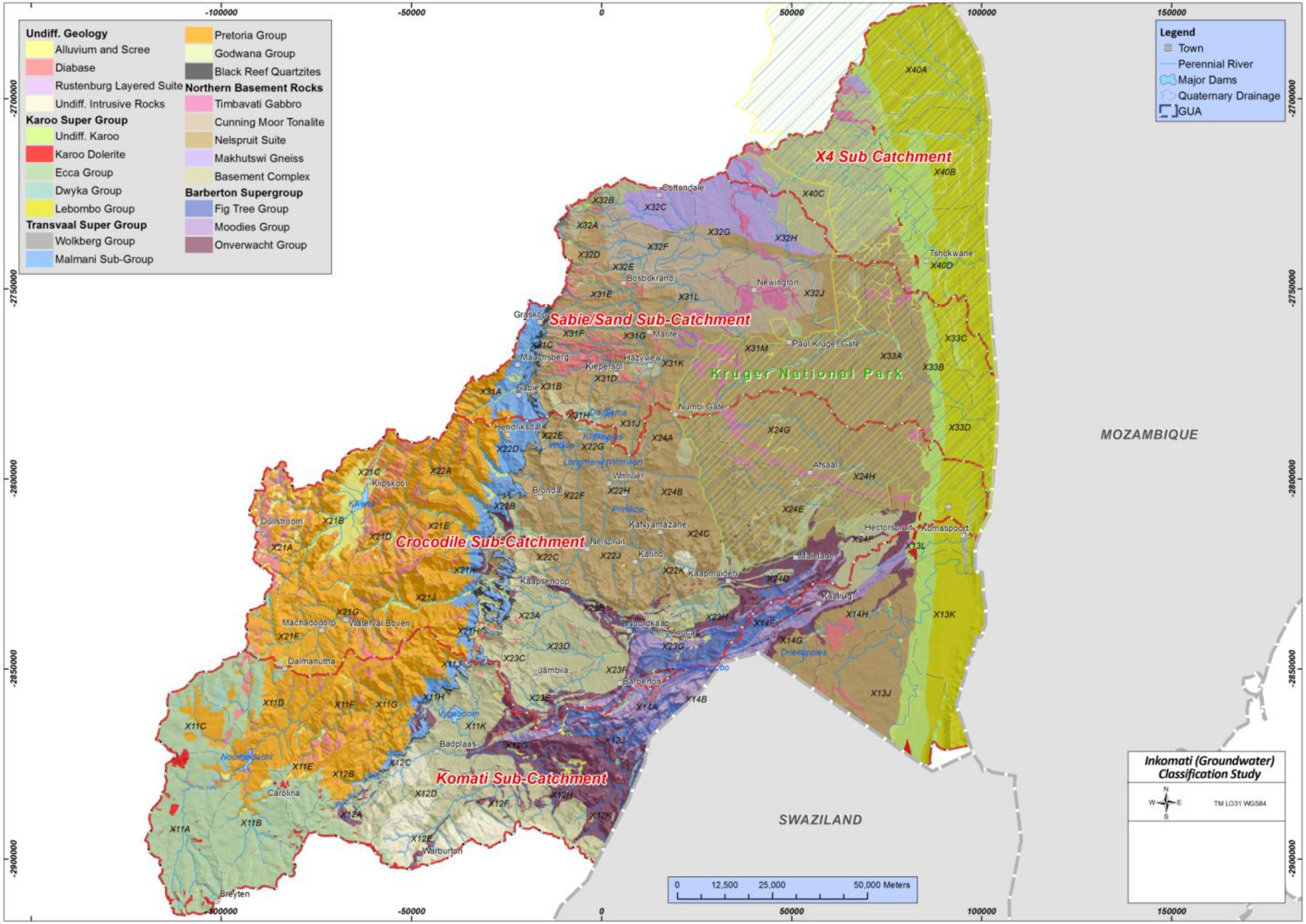

Figure3.1 Simplified geology of the Inkomati WMA (showing the four secondary drainage regions)

3.3.2 Groundwater regions and aquifers

The Inkomati WMA aquifers comprise of five groundwater regions as defined by Vegter (2000) and are predominantly characterised by their geological settings (Figure 3.2):

1. **Eastern Highveld** – Comprise of the rocks belonging to the Karoo Supergroup.
2. **Eastern Bankeveld –** Comprise of the gently westerly dipping mainly sedimentary rocks of the Transvaal Supergroup including the Malmani dolomites.
3. **North-eastern Middelveld** – Comprise of the rugged mountainous region of the more basic igneous and metamorphic Barberton Supergroup.
4. **Lowveld** – Comprise of the Northern Basement rocks (granites and gneisses), most notably the Nelspruit Suite.
5. **Northern Lebombo** – Comprise of the Lebombo Group, including basalts and rhyolite-dacite. These rocks are tilted in a general easterly or seaward direction.

Within each of these regions a number of aquifer types can be differentiated (**Ошибка! Источник ссылки не найден.**):

- Intergranular (weathered) and Fractured Aquifers
    - The weathered/fractured aquifer type is characterised by an almost continuous regolith overlying the fresh (un-weathered) bedrock. The overlying regolith,i.e. unconsolidated material derived from prolonged in-situ decomposition of the bedrock, has a thickness from negligible to a couple of tens of meters. The regolith usually has a high porosity and a low permeability due to clay-rich material (Acworth, 1987). When saturated, this layer constitutes the reservoir of the aquifer. The situation allows for circumstances where the intergranular regolith serves primarily as a storage function while the water is transmitted mainly through the underlying fractured bedrock.
    - By far the greatest portion of the Inkomati WMA is underlain by Intergranular and Fractured aquifers associated with the igneous and metamorphic Basement rocks as well as the sedimentary rocks of the Transvaal- and Karoo Supergroup.
    - It must be emphasised that in the case of a very thin or absent weathered zone or if the water level occurs in the underlying bedrock, it can be characterised as a fractured aquifer only. This may be the case for the topographical higher lying areas along the escarpment and in the mountainous Barberton terrain.
- Fractured Aquifers
    - The fractured aquifer type is characterised by an intact and relatively un-weathered matrix with a complex arrangement of interconnected fracture systems.
    - Fractured aquifers may occur throughout the Inkomati WMA on a local scale, but based on the published hydrogeological maps it is mostly limited to the quartzites and dolerite sills of the Transvaal- and Karoo Supergroup (Figure 3.2).
- Intergranular (alluvial) aquifers.
    - Intergranular (alluvial) aquifers overlie or replace the weathered overburden and are found along watercourses, valleys and wide open plains. Tey comprise of sand deposits of unconsolidated clayey silts and forms primary aquifers of high yielding potential, but are typically limited in extent. The spatial extent varies according to the topography and climate (especially run-off).
    - It is an important local, major aquifer and exists in equilibrium with surface water, adjacent groundwater systems and ecosystems along the rivers.Towards the eastern and central regions (along the 'great escarpment') a close inter-dependence exists between groundwater and surface water.

3.3.3 Borehole yield and aquifer rating

The published Hydrogeological Map Series by DWA indicate median borehole yields (excluding dry boreholes) in l/s from <0.1 to >5l/s for various aquifer types. These borehole yields can be classified into four categories of aquifer rating as follows (DWA, 2013d):

Borehole Yield Class (l/s)	Aquifer Rating
<0.1 to 0.5	Insignificant
>0.5 to 2.0	Minor
>2.0 to 5.0	Moderate
>5.0	Significant

The above aquifer rating for the Inkomati WMA is presented inFigure 3.2, which shows that insignificant to minor aquifers are present in large parts of the WMA.Moderate intergranular aquifer zones are associated with river courses, valleys or open plains and although not specifically mapped, they do occur locally throughout the Inkomati WMA. The Malmani dolomite formations cutting across the Inkomati WMA forms a moderate Karst aquifer. The dolomitic rocks of the Inkomati WMA have been described as “Escarpment Dolomite”, distinctly different in terms of weathering and morphology from the dolomites in e.g. the Gauteng area(Martini and Kavalieris, 1976).Although dolomitic formations can be regarded as a significant aquifer, according to the Inkomati Internal Strategic Perspective (ISP) the Escarpment dolomite is not the generally high-yielding aquifer that dolomite is elsewhere in the country due to the prevailing and past geomorphic conditions in this region (DWAF, 2004b). However, scientifically sited boreholes could yield considerable larger amounts of groundwater and merits further investigations.Other moderate aquifers are associated with the intergranular and fractured aquifer type occurring as higher yielding areas within the minor classification. These regions may be attributed to more locally well-developed weathering and fractured zones, while the development of these aquifers was based on detailed exploration methods.

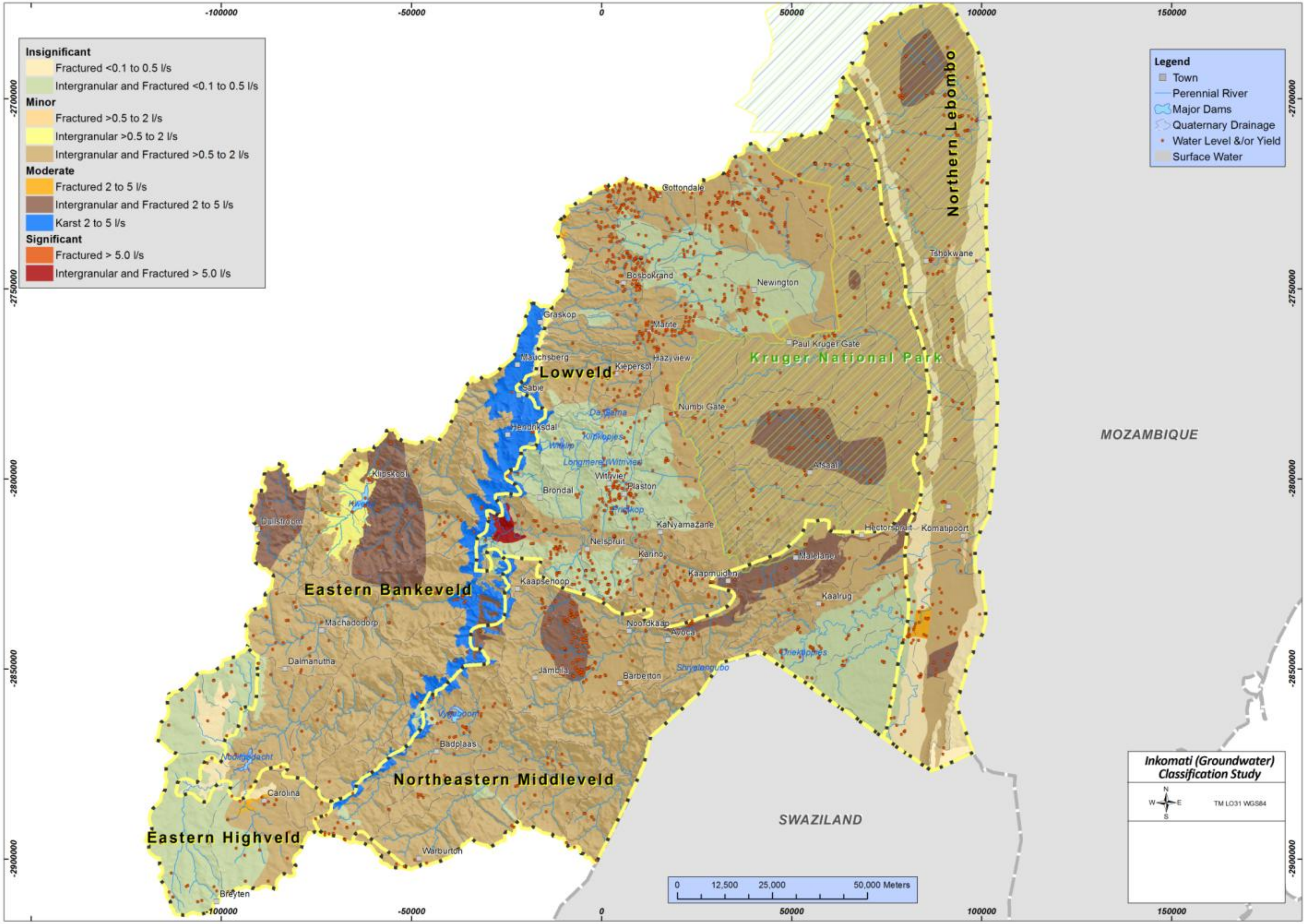

Figure 3.2 Groundwater regions and aquifer yields for the Inkomati WMA

3.3.4 Delineation of Groundwater Units of Analysis

The first step for determining the different classes of water resources is the delineation of (Groundwater) Units of Analysis (GUA) and describing the status quo of the water resources. The delineation of groundwater units are based on hydrogeological criteria and might not necessarily correlate to quaternary surface water catchmentsor surface water units of analysis.

However, it must be kept in mind during the delineation of groundwater units of analysis, that a Class, Reserve and RQOs have to be set for each unit; linkages with other components have to be considered; and that each unit will have to be managed.As a result, the delineation is largely based on management considerations while attention is given to hydrogeological criteria. Although previous groundwater reserve studies for the Inkomati WMA (AGES 2007; 2010) identified groundwater target areas (based on quaternary drainages), no groundwater units were delineated. As a result, the current delineation of Groundwater Units of Analysis for the Inkomati WMA was based on the following criteria:

- Surface water units of analysis as part of this project.
- The four main Inkomati WMA sub-catchments were considered, namely the Komati, Crocodile, River/Sand and the undeveloped X4 sub-catchment in the KNP.
- The quaternary drainage areas were considered as the basis of delineation.
    - Quaternary drainage areas with similar hydrogeological characteristics were grouped into one GUA. The dolomites were a far as possible grouped into separate GUA, while including the quaternary drainage areas contributing to its run-off.
- Hydrogeological criteria (including geology, geomorphology and topography).

A total of nineteen GUAs were delineated as described in Table 3.1and illustrated inFigure 3.3.

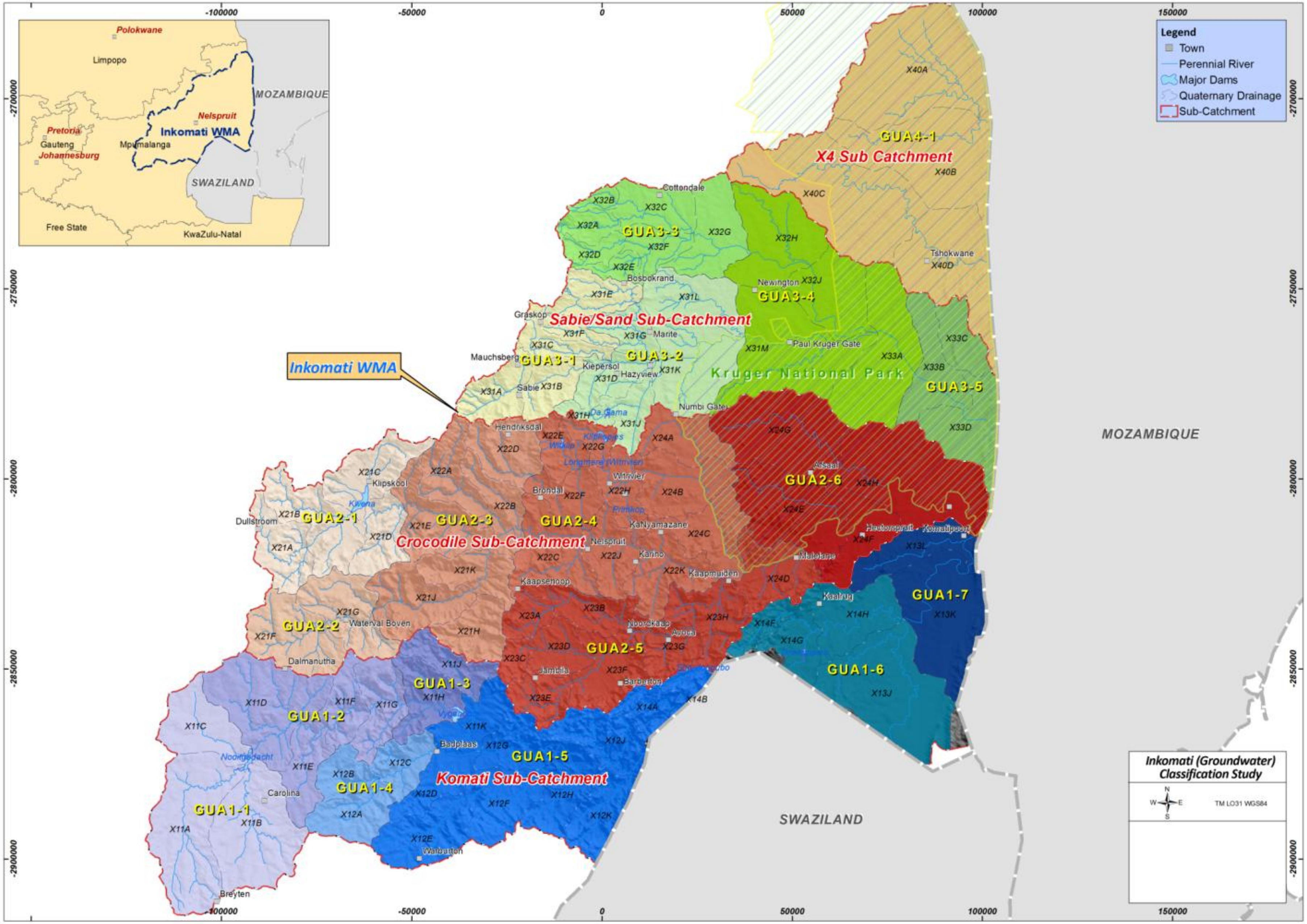

Figure 3.3 Delineated groundwater units of analysis for the Inkomati WMA

Table 3.1 Description of delineated groundwater units of analysis for the Inkomati WMA

GUAs	Area (km^2)	No of quats[1]	Predominant geology (Rock Type)	Aquifer rating
Komati sub-catchment				
GUA1-1	1.588	3	Karoo Supergroup (Vryheid Formation) sandstone, shale and coal seams.Intrusive Dykes.	Insignificant to Minor
GUA1-2	1.278	4	Pretoria Group (Lydenburg Shale) Shale, mudrock and quartzites Malmani Sub-Group Dolomites.	Minor
GUA1-3	451	2	Pretoria Group (Lydenburg Shale) Shale, mudrock and quartzites Malmani Sub-Group Dolomites.	Minor to Moderate (dolomites)
GUA1-4	585	3	Karoo Supergroup (Vryheid Formation) sandstone, shale and coal seams. Intrusive Dykes. Pretoria Group (Lydenburg Shale) Shale, mudrock and quartzites Basement Complex.	Minor to Moderate (dolomites)
GUA1-5	2.511	10	Basement Complex (Granite, Gneiss). Onverwacht Group (Ultramafic, and mafic lavas). Fig Tree Group (Pyroclastic rocks, greywacke).	Minor
GUA1-6	1.471	4	Basement Complex (Nelspruit Suite) Porphyrytic granite. Moodies Group (Sandstone, quartzite, shale, conglomerate). Karoo Supergroup (Basalts, diamictite, mudrock and Sandstone).	Minor
GUA1-7	908	2	Karoo Supergroup (Basalts, diamictite, mudrock and Sandstone)	Insignificant to Minor
Crocodile sub-catchment				
GUA2-1	1.174	4	Pretoria Group (Shale, siltstone and quartzites). Diabase (Intrusive). Alluvium and Scree.	Minor to Moderate (alluvial aquifers)
GUA2-2	744	2	Pretoria Group (Shale, siltstone and quartzites). Alluvium.	Minor to Moderate (alluvial aquifers)
GUA2-3	1.926	7	Malmani Sub-Group Dolomites. Pretoria Group (Shale, siltstone and quartzites). Diabase (Intrusive). Alluvium.	Minor to Moderate (dolomites/alluvium)
GUA2-4	2.483	10	Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites).	Insignificant to Minor
GUA2-5	1.942	9	Kaap Valley Tonalite (Horneblende, biotite tonalite). Moodies Group (Subgreywacke, quartzite, shale, conglomerate). Fig Tree Group (Greywacke and shale).	Minor to Moderate (intergranular aquifers)
GUA2-6	2.177	4	Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites). Moodies Group (Subgreywacke, quartzite, shale, conglomerate). Fig Tree Group (Greywacke and shale).	Minor to Moderate (intergranular aquifers)
Sabie-Sand sub-catchment				
GUA3-1	887	5	Malmani Sub-Group Dolomites. Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites). Pretoria Group (Shale, siltstone and quartzites). Diabase (Intrusive).	Minor to Moderate (dolomites)
GUA3-2	1.367	6	Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites). Timbavati gabbro. Cunning Moor Tonalite.	Minor to Moderate (intergranular aquifers)
GUA3-3	1.072	7	Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites). Makhutswi Gneiss. Cunning Moor Tonalite.	Insignificant to Minor
GUA3-4	2.153	4	Basement Complex (Nelspruit Suite) Porphyrytic granite and granodiorites). Cunning Moor Tonalite. Alluvium.	Minor to Moderate (intergranular aquifers/alluvium)
GUA3-5	844	3	Karoo Supergroup (Basalts, diamictite, mudrock and Sandstone).	Insignificant to Minor
X4 sub-catchment				

GUAs	Area (km^2)	No of quats[1]	Predominant geology (Rock Type)	Aquifer rating
GUA4-1	3.197	4	Basement Complex (Gneiss). Karoo Supergroup (Basalts, diamictite, mudrock and Sandstone). Alluvium.	Insignificant to Moderate (alluvium)

1 Quaternary catchments

3.3.5 Status quo

Water level, borehole depth and yields

A summary of the water level, borehole depth and yields obtained from the NGA for each GUA is shown in Table 3.2.

Table 3.2 Water level and borehole statics for the Inkomati WMA per GUA

GUA	Predominant Aquifer	Parameter	Water Level (mbs)[1]	Yield (l/s)	Borehole Depth
Komati sub-catchment					
GUA1-1	Karoo rocks	N	10	n.a.	3
		Mean	13.5	n.a.	68
GUA1-2	Malmani Dolomites, Pretoria Group	N	5	6	6
		Mean	7.2	1.2	37
GUA1-3	Malmani Dolomites, Pretoria Group	N	3	4	5
		Mean	14.0	1.4	76
GUA1-4	Karoo, Basement Complex	N	13	5	13
		Mean	13.8	0.4	37
GUA1-5	Barberton Basement	N	56	27	59
		Mean	13.0	3.1	49
GUA1-6	Nelspruit Suite Basement	N	44	8	40
		Mean	24.8	1.7	93
GUA1-7	Karoo rocks	N	8	10	10
		Mean	23.6	2.2	79
Crocodile sub-catchment					
GUA2-1	Pretoria Group Alluvium and Scree	N	11	7	12
		Mean	24.1	2.3	63
GUA2-2	Pretoria Group Alluvium	N	8	8	8
		Mean	16.2	1.6	74
GUA2-3	Malmani Sub- Dolomites Pretoria Group Alluvium	N	29	17	24
		Mean	18.3	2.7	63
GUA2-4	Basement Complex	N	116	100	115
		Mean	23.8	0.8	73
GUA2-5	Barberton Basement	N	59	91	110
		Mean	20.3	2.2	43
GUA2-6	Basement Complex	N	71	83	83
		Mean	13.0	1.7	54
Sabie-Sand sub-catchment					
GUA3-1	Malmani Dolomites, Basement Complex, Pretoria Group	N	11	1	11
		Mean	18.7	2.6	90
GUA3-2	Basement Complex	N	97	13	95
		Mean	12.6	1.1	64
GUA3-3	Basement Complex	N	223	10	209
		Mean	16.0	1.7	69
GUA3-4	Basement Complex	N	98	44	97

GUA	Predominant Aquifer	Parameter	Water Level (mbs)[1]	Yield (l/s)	Borehole Depth
		Mean	16.9	1.9	60
GUA3-5	Karoo rocks	N	31	40	40
		Mean	8.2	1.5	50
X4 sub-catchment					
GUA4-1	Basement Complex Karoo rocks	N	174	176	182
		Mean	15.4	1.5	52
Inkomati WMA					
Total		N	1069	651	1123
		Mean	16.7	1.7	61

1 Metres below surface.
Lowest value in sub-catchment
Highest Value in sub-catchment
n.a. - Not available

From the available ~ 4900 geo-sites only ~2500 sites contain information on either water level or yield. From these geo-sites only ~1000 sites have a coordinate accuracy of less than 1km. The results from Table 3.2can be summarised as follows:

- Komati sub-catchment
  - Average water levels range from 7 to 25 m below surface; with the deepest water levels found in the Nelspruit Suite basement (GUA1-6) and Karoo (basalt) (GUA1-7) aquifers.
  - Highest borehole yields are associated with the Barberton basement aquifer (GUA1-5), while yields below the population (Inkomati WMA) average are found in GUA1-2 to GUA1-4. It must be noted that a limited number of boreholes with yield data were available for these GUAs and might distort the assessment.
  - The deepest average borehole depth is found in the Nelspruit Suite basement- (GUA1-6) and the Karoo- (basalt) (GUA1-7) aquifers. Drilling depths below the population (Inkomati WMA) average are found in GUA1-2, GUA1-4 and GUA1-5.
- Crocodilesub-catchment
  - Average water levels range from 13 to 24 m below surface, while the deepest water levels are found in the Pretoria Group- (GUA2-1) and the Basement (GUA2-5) aquifers respectively.
  - Highest borehole yields are associated with the Malmani dolomites (GUA2-3), while yields above the population (Inkomati WMA) average are also found in GUA2-1 to GUA2-5. The lowest borehole yields are associated with the basement complex (GUA2-4) aquifer.
  - Average borehole depths range from 43 to 74 m below surface.
- Sabie-Sand sub-catchment
  - Average water levels range from 8 to 19 m below surface, which is considerably shallower than in the Komati- and Crocodile sub-catchments.
  - Borehole yields are unfortunately also generally lower compared to the Komati- and Crocodile sub-catchment. The Basement (GUA3-3 and GUA3-4) aquifers have a higher average yield in comparison to the Karoo (GUA3-5) aquifers.
  - Average borehole depths range from 50 to 90 m below surface. Despite shallower water levels compared to the Komati- and Crocodile sub-catchments, the drilling depths are on average deeper than the these sub-catchments.
  - X4sub-catchment
  - Average water levels are 15 m below surface with an average borehole yield of 1.5 l/s, which is lower than the total population (Inkomati WMA) average.

Groundwater Resources

Groundwater resources were assessed on a national scale during the Groundwater Resource Assessment Phase II project (GRA II, DWAF, 2004b) and the data are used in Groundwater Resource Directed Measures (GRDM) datasets at quaternary catchment scale.The results from the following datasets were populated for each GUA and are summarised in Table 3.3 to Table 3.6:

- Groundwater contribution to river baseflow.
- Recharge.
- Harvest potential.
- Utilisable Groundwater Exploitation Potential (UGEP).

Table 3.3 Summary of groundwater resources for the Komati sub-catchment (in Mm^3/a)

GUAs	Quat	Area (Km^2)	Baseflow	Recharge (Wet)	Recharge (Dry)	Harvest potential	UGEP (Wet)	UGEP (Dry)
GUA1-1	X11A	672	7.21	30.79	22.67	13.67	8.63	5.67
	X11B	597	6.96	30.33	22.54	12.49	9.24	6.16
	X11C	319	3.68	17.57	13.04	6.45	5.49	3.68
	Total	**1587**	**17.84**	**78.68**	**58.25**	**32.60**	**23.36**	**15.51**
GUA1-2	X11D	590	23.59	32.17	24.11	8.59	3.52	0.00
	X11E	241	9.97	14.31	10.77	3.57	2.01	0.48
	X11F	183	7.54	13.06	10.00	2.03	2.44	1.08
	X11G	264	17.25	29.39	22.87	3.03	5.55	2.59
	Total	**1278**	**58.35**	**88.93**	**67.74**	**17.22**	**13.52**	**4.15**
GUA1-3	X11H	265	17.17	34.11	27.14	7.46	7.08	4.11
	X11J	186	11.98	27.20	22.18	5.03	6.52	4.41
	Total	**451**	**29.14**	**61.32**	**49.32**	**12.49**	**13.60**	**8.52**
GUA1-4	X12A	244	13.94	18.74	14.29	9.74	2.51	0.85
	X12B	155	12.05	12.65	9.72	2.81	2.01	0.71
	X12C	186	8.03	17.32	13.53	7.66	2.87	1.37
	Total	**585**	**34.02**	**48.71**	**37.54**	**20.21**	**7.39**	**2.93**
GUA1-5	X11K	211	10.00	24.93	19.54	7.69	4.01	2.02
	X12D	223	7.54	17.29	13.40	9.48	3.67	2.18
	X12E	333	11.50	25.80	20.20	14.05	5.30	3.23
	X12F	313	10.85	26.89	21.00	13.04	6.36	4.08
	X12G	239	3.42	21.70	17.02	4.53	6.94	5.18
	X12H	286	9.41	29.19	23.06	7.14	7.87	5.49
	X12J	296	5.77	43.10	35.89	4.74	13.68	11.02
	X12K	286	9.37	31.18	24.43	5.21	7.22	5.01
	X14A	141	0.00	26.69	22.51	2.18	8.07	6.56
	X14B	185	0.00	34.76	29.22	1.50	5.51	4.49
	Total	**2511**	**67.85**	**281.52**	**226.28**	**69.55**	**68.62**	**49.26**
GUA1-6	X13J	828	0.00	34.49	25.18	10.75	13.47	10.39
	X14F	117	4.62	22.17	18.60	1.82	6.83	5.57
	X14G	204	6.15	12.70	9.97	3.20	2.03	1.06
	X14H	360	3.19	14.87	11.21	5.31	4.73	3.37
	Total	**1509**	**13.96**	**84.24**	**64.96**	**21.09**	**27.07**	**20.40**
GUA1-7	X13K	621	6.86	13.79	9.64	8.96	5.67	4.49
	X13L	286	2.83	7.08	5.01	3.56	3.12	2.38
	Total	**907**	**9.69**	**20.87**	**14.65**	**12.53**	**8.79**	**6.86**

Table 3.4 Summary of groundwater resources for the Crocodilesub-catchment (in Mm^3/a)

GUAs	Quat	Area (Km^2)	Baseflow	Recharge (Wet)	Recharge (Dry)	Harvest Potential	UGEP (Wet)	UGEP (Dry)
GUA2-1	X21A	265	2.69	17.49	13.21	3.01	6.39	4.59
	X21B	378	4.01	22.02	16.35	4.22	8.07	5.52
	X21C	311	3.21	20.57	15.50	3.49	7.83	5.52
	X21D	219	2.04	13.36	9.98	2.48	5.47	3.90
	Total	**1173**	**11.95**	**73.44**	**55.03**	**13.20**	**27.76**	**19.53**
GUA2-2	X21F	397	3.17	22.55	16.96	4.43	7.71	5.46
	X21G	347	4.24	22.43	17.08	3.90	8.94	6.51
	Total	**744**	**7.41**	**44.99**	**34.04**	**8.33**	**16.65**	**11.97**
GUA2-3	X21E	345	3.59	44.27	34.29	4.59	18.06	13.72
	X21H	229	5.70	34.86	28.55	7.33	12.99	10.21
	X21J	355	6.45	41.18	32.49	4.45	15.62	11.74
	X21K	245	4.16	36.75	29.99	5.76	14.39	11.43
	X22A	251	4.28	40.14	32.38	3.28	16.64	13.06
	X22B	227	4.36	34.68	27.72	4.61	12.11	9.49
	X22D	274	3.84	43.22	36.02	6.40	15.43	12.39
	Total	**1926**	**32.39**	**275.10**	**221.45**	**36.42**	**105.25**	**82.03**
GUA2-4	X22C	366	7.51	28.48	22.57	7.30	9.38	7.55
	X22E	153	3.90	21.76	18.08	2.51	6.92	5.70
	X22F	212	2.05	15.67	12.48	3.38	5.14	4.19
	X22G	107	3.02	14.74	12.22	1.73	4.83	3.94
	X22H	200	2.09	13.76	10.90	3.23	4.07	3.31
	X22J	240	2.56	15.30	11.72	3.84	4.63	3.66
	X22K	335	3.55	24.17	18.75	5.30	8.02	6.39
	X24A	249	2.52	10.57	7.88	3.82	4.08	2.96
	X24B	335	2.46	15.01	11.19	5.30	5.13	3.89
	X24C	286	1.35	14.73	10.99	4.51	5.20	3.82
	Total	**2483**	**31.02**	**174.20**	**136.77**	**40.92**	**57.40**	**45.41**
GUA2-5	X23A	127	1.71	20.73	17.07	5.53	6.82	5.47
	X23B	229	3.18	15.74	12.23	5.62	5.44	4.10
	X23C	81	3.34	13.09	10.84	3.51	4.39	3.55
	X23D	182	2.43	18.15	13.97	7.88	6.07	4.56
	X23E	180	3.18	18.52	15.10	5.72	6.01	4.70
	X23F	310	1.63	25.96	19.73	8.86	9.13	6.73
	X23G	225	2.24	19.31	15.05	3.58	6.56	4.98
	X23H	306	1.92	25.47	19.68	4.96	9.63	7.40
	X24D	302	2.08	19.29	14.66	4.70	7.03	5.22
	Total	**1942**	**21.71**	**176.27**	**138.34**	**50.36**	**61.08**	**46.71**
GUA2-6	X24E	526	0.00	18.10	13.14	6.41	7.64	5.55
	X24F	262	0.00	8.86	6.48	3.34	3.72	2.75
	X24G	620	0.00	15.44	11.06	7.48	6.73	4.81
	X24H	770	0.00	15.80	11.14	8.39	5.79	4.10
	Total	**2178**	**0.00**	**58.20**	**41.82**	**25.62**	**23.87**	**17.21**

Table 3.5 Summary of groundwater resources for the Sabie-Sandsub-catchment (in Mm^3/a)

GUAs	Quat. No.	Area (Km^2)	Baseflow	Recharge (Wet)	Recharge (Dry)	Harvest Potential	UGEP (Wet)	UGEP (Dry)
GUA3-1	X31A	230	2.14	65.72	55.36	5.32	28.82	24.11
	X31B	195	1.81	55.26	46.48	3.63	23.95	20.22
	X31C	154	1.44	45.93	38.87	3.04	20.77	17.56
	X31E	214	1.92	55.83	46.76	3.38	21.72	18.15
	X31F	94	1.88	25.93	22.00	1.48	10.72	9.09
	Total	**887**	**9.19**	**248.67**	**209.47**	**16.86**	**105.98**	**89.13**
GUA3-2	X31D	192	0.77	20.82	16.55	3.06	9.44	7.63
	X31G	169	1.65	17.70	14.20	2.66	8.36	6.78
	X31H	60	0.60	10.11	8.40	0.96	4.51	3.78
	X31J	154	1.57	14.49	11.35	2.43	6.31	5.04
	X31K	488	0.00	16.27	11.99	6.57	7.96	6.01
	X31L	304	0.00	10.02	7.53	3.94	4.96	3.96
	Total	**1367**	**4.59**	**89.40**	**70.03**	**19.62**	**41.53**	**33.20**
GUA3-3	X32A	112	0.00	13.11	10.62	1.84	5.68	4.60
	X32B	55	1.07	5.89	4.63	0.90	2.27	1.76
	X32C	233	0.52	7.36	5.54	3.48	3.63	2.86
	X32D	100	1.47	13.16	10.68	1.60	5.29	4.29
	X32E	78	0.95	7.08	5.56	1.30	3.56	2.83
	X32F	157	0.76	5.00	3.72	2.49	2.76	2.20
	X32G	336	0.99	8.02	5.87	4.08	4.70	3.76
	Total	**1072**	**5.77**	**59.61**	**46.63**	**15.69**	**27.90**	**22.31**
GUA3-4	X31M	709	0.00	13.74	9.80	8.52	6.21	4.45
	X32H	488	0.00	9.84	7.14	5.86	4.59	3.39
	X32J	355	0.00	6.35	4.54	4.13	2.64	1.88
	X33A	600	0.00	11.19	7.88	5.97	4.38	3.08
	Total	**2153**	**0.00**	**41.13**	**29.37**	**24.48**	**17.82**	**12.81**
GUA3-5	X33B	310	0.00	4.47	3.13	2.77	1.64	1.15
	X33C	183	0.00	1.64	1.14	1.62	0.46	0.32
	X33D	350	0.00	4.84	3.24	3.14	1.24	0.84
	Total	**843**	**0.00**	**10.95**	**7.51**	**7.53**	**3.34**	**2.31**

Table 3.6 Summary of groundwater resources for the X4sub-catchment (in Mm^3/a)

GUAs	Quat. No.	Area (Km^2)	Baseflow	Recharge (Wet)	Recharge (Dry)	Harvest Potential	UGEP (Wet)	UGEP (Dry)
GUA4-1	X40A	924	0.00	12.59	8.76	8.11	4.60	3.20
	X40B	743	0.00	9.38	6.32	6.51	3.22	2.21
	X40C	941	0.00	16.58	11.93	10.26	6.85	4.92
	X40D	589	0.00	6.01	4.09	5.10	1.71	1.17
	All	**3197**	**0.00**	**44.56**	**31.09**	**29.98**	**16.38**	**11.50**

Baseflow

Figure 3.4illustrates the probability of groundwater contributions to baseflow in a river.The ‘Great Escarpment’ is an important recharge area and groundwater provides significant baseflow to the head waters of surface drainages. The lower reaches of the Inkomati WMA lack on the other hand groundwater baseflow and many major rivers have a low probability of being groundwater-fed.The aquifers of the Barberton lithologies and the Pretoria Group show generally higher baseflow values than the Karoo Supergroup aquifers.There is little or no contribution of the Lebombo Group to the baseflow component of rivers.

Groundwater Recharge

The distribution of groundwater recharge based on the GRA II dataset is presented inFigure 3.5. Mean annual groundwater recharge varies from 100 to 150 mm in the higher rainfall areas along the central escarpment regions to 10 to 25 mm in the low rainfall and lower lying easternmost portionof the WMA.The average annual groundwater recharge for the entire WMA based on the GRA II dataset is estimated to be morethan 1500 Mm^3/a, equating to recharge percentages between 5 and 10% of the mean annual precipitation forthe area. However, recharge may be significant lower in areas covered with basement rocks, where the contribution of rainfall to the groundwater recharge is estimated as less than 3%.

The comprehensive groundwater reserve determination for the Inkomati WMA (AGES, 2010) determined a lower groundwater recharge volume of around 1300 Mm^3/a for the WMA. However, the groundwater recharge was calculated in this assessment as a percentage of rainfall that is assumed to reach the aquifer on a monthly basis and the standard deviation for a 95% assurance level was used to obtain a range within which the monthly rainfall-recharge is sampled (AGES, 2010). In the absence of more detailed groundwater recharge studies, the latter values are used in the setting of a management class.

Groundwater Availability (GRA II)

The volume of water that may be abstracted from a groundwater resource may be limited by anthropogenic, ecological and/or legislative considerations andthe definition of the so called **Utilisable Groundwater Exploitation Potential (UGEP)** is ultimately a management decision that will reduce the total volume of groundwater available for development. It is likely that, with an adequate and even distribution of production boreholes in accessible portions of most catchments or aquifer systems, these volumes of groundwater may be annually abstracted on a sustainable basis.

The **Groundwater Harvest Potential** is aimed at providing preliminary estimates on a national scale of the annual maximum volume of groundwater that can be practically abstracted (taking technical constraints into account) from a unit area on a sustainable basis. The spatial distribution of the Inkomati WMA groundwater harvest potential is shown in Figure 3.6. It must be emphasised that the volumes of groundwater estimated under the various exploitation scenarios are for planning purposes only. While they give an indication of the general availability and distribution of groundwater resources, detailed studies are still required to identify, develop and exploit site specific groundwater abstraction schemes.

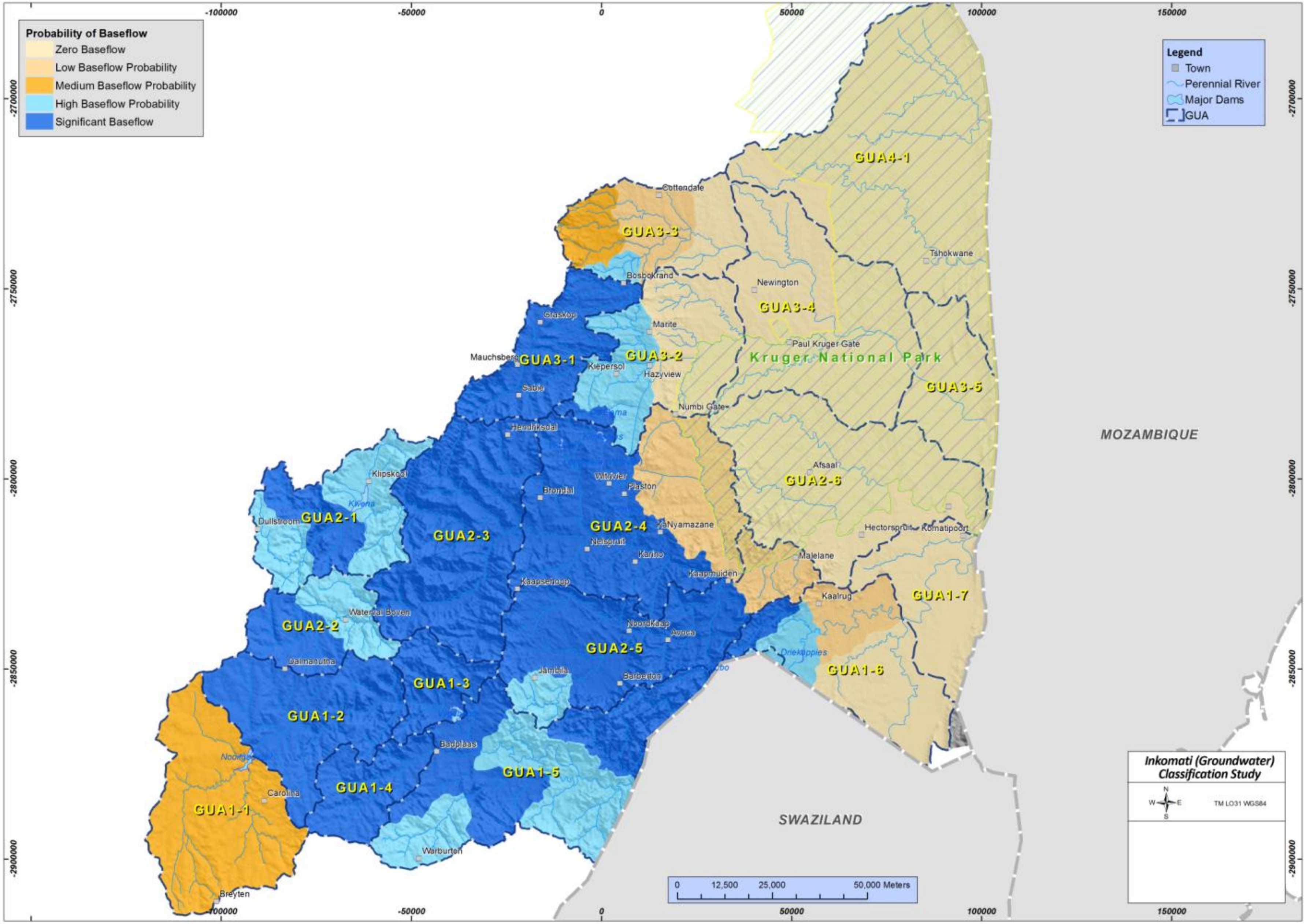

Figure 3.4 Groundwater contribution to baseflow probability

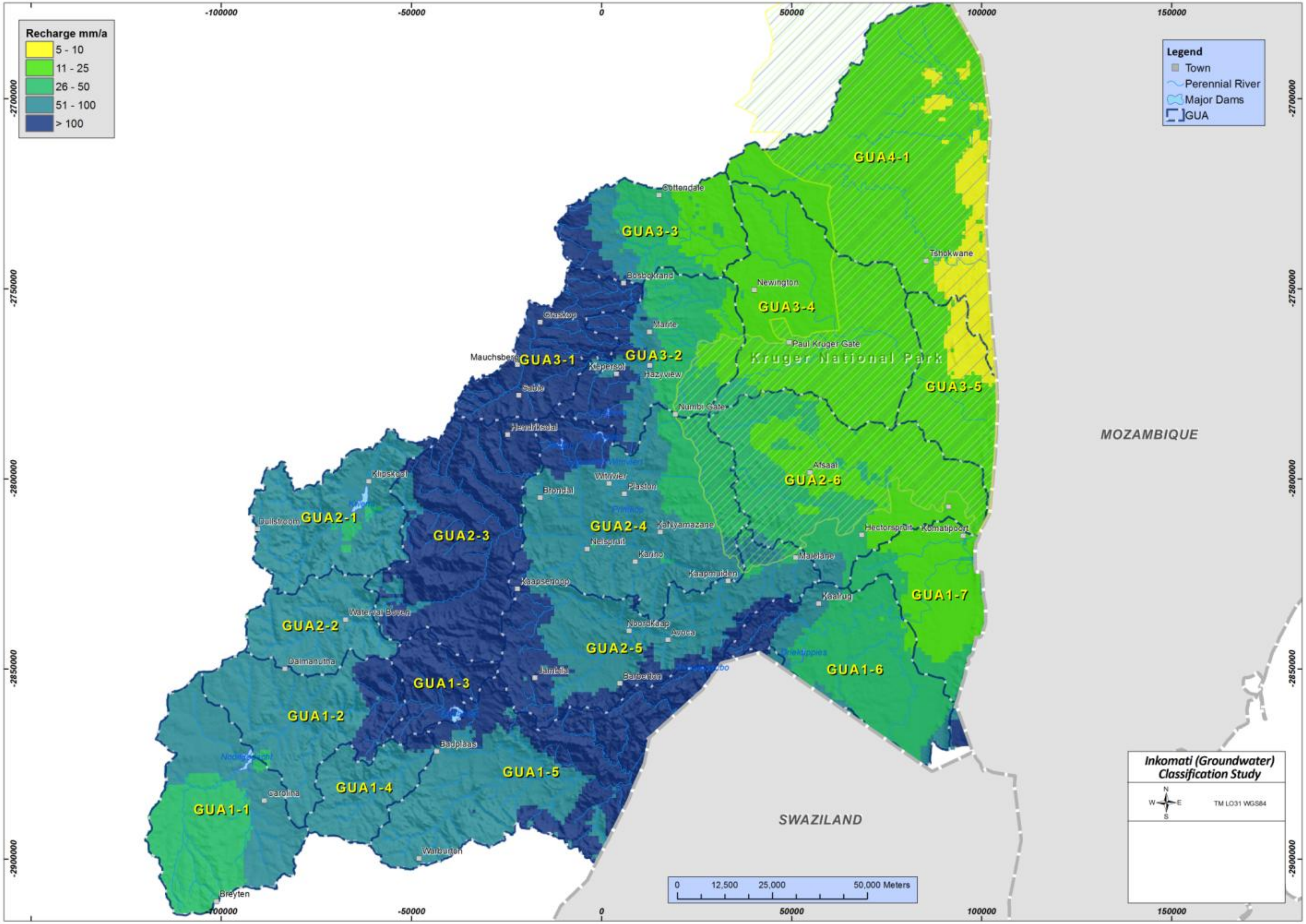

Figure 3.5 Recharge distribution map based on values obtained from the GRA II dataset

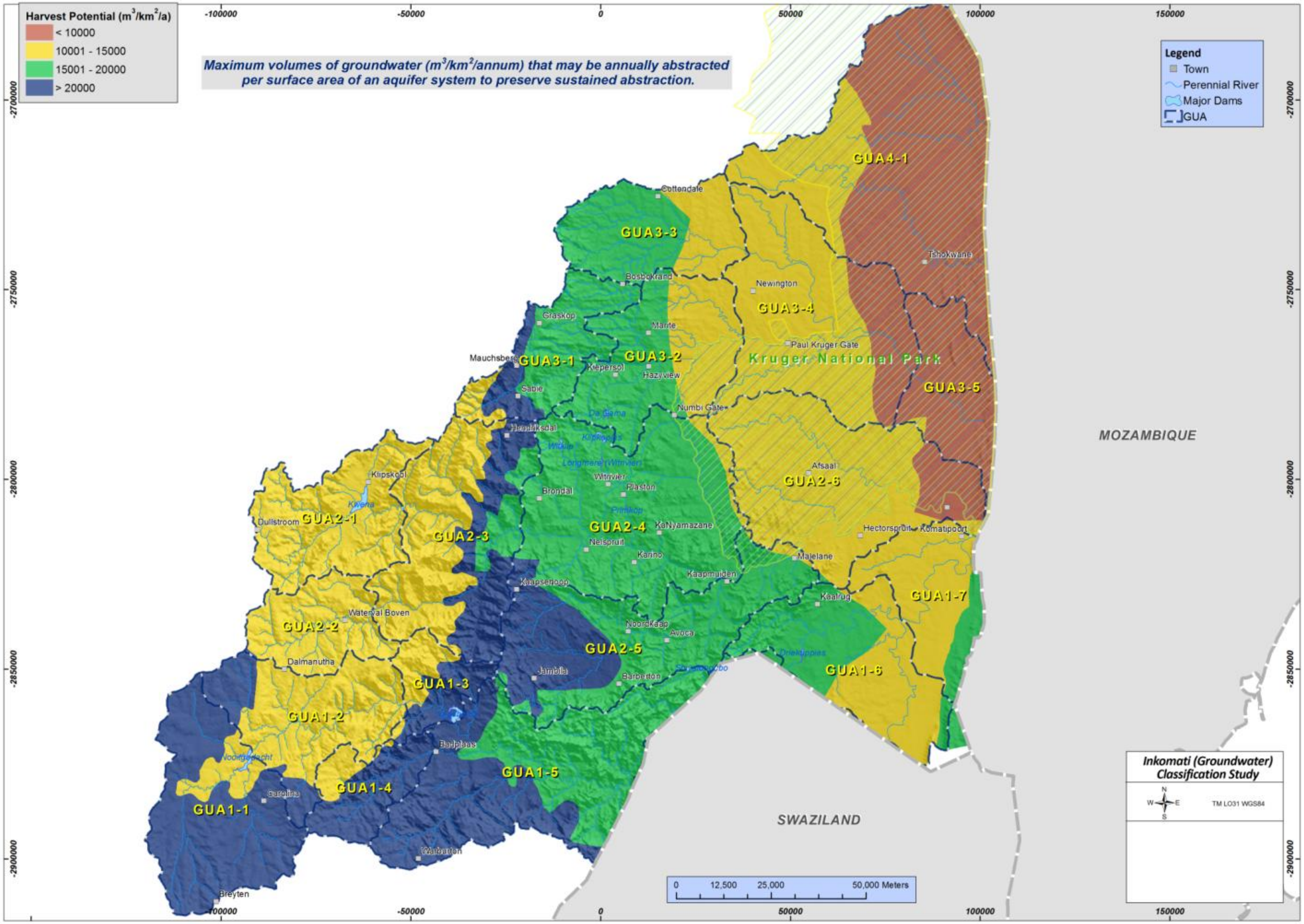

Figure 3.6 Groundwater harvest potential map of the Inkomati WMA

Groundwater Use

Most of the groundwater use in the Inkomati WMA is for rural domesticsupplies, as well as for game and livestock watering in its drier parts.However groundwater abstraction for irrigation purposes should not be underestimated.

According to the Inkomati WMA ISP groundwater use amounts to 27.5 Million m^3/a based on the WARMS database (2004), while estimated use based on the GRA II dataset amount to only 13.3 Million m^3/a (DWAF 2004b). The latter use figure can be broken down into 68% for rural water supply, 12% for the mining industry and 12% for agricultural use. Based on the results of the Comprehensive Groundwater Reserve Determination for the Inkomati WMA by AGES (2010), a significantly higher groundwater use figure was estimated. The study was based on the distribution of NGA boreholes and associating them with a specific use (agriculture irrigation, forestry, mining or domestic water supply). It was further assumed in the assessment by AGES (2010) that of the 70440 ha of farm land are under irrigation, with groundwater resources accounting for 10% or 70.4 Mm^3/a of farm irrigation. Similarly groundwater use was assumed to be relevant for 1% of the forestry surface area and amounted to 3.9 Mm^3/a. The total groundwater use for the Inkomati WMA was subsequently estimated to 114.9 Mm^3/a and includes the Basic Human Need (BHN) community water allocation of 18.9 Mm^3/a.

In view of several far reaching assumptions in the specialist Groundwater Reserve studies by AGES (2010), the current study approach took also cognisance of the GRA II and WARMS 2013 datasets to achieve a more balanced estimate of groundwater use. It must be emphasized that the ‘WARMS’dataset is based on actual current reporting of groundwater use and arguably provides the best available water use dataset on a WMA scale to establish the groundwater stress index required for the classification process. A summary of the various groundwater use datasets per GUA is shown inTable 3.7.

Table 3.7 Summary of the groundwater use estimates for each of the Inkomati GUAs (in m^3/a)

Sub-catchment	GUAs	WARMS	GRA II	AGES (2010)*	Revised GW use[#]
Komati sub-catchment	GUA1-1	2,712,265	406,200	1,242,432	2,712,265
	GUA1-2	524,105	49,600	2,316,184	871,203
	GUA1-3	452,656	12,700	1,036,012	701,304
	GUA1-4	129,198	12,500	435,940	195,570
	GUA1-5	1,272,365	30,000	2,500,108	1,858,673
	GUA1-6	7,351,154	1,992,300	1,450,516	8,064,320
	GUA1-7	3,080,995	381,700	6,244,388	3,539,513
Crocodile sub-catchment	GUA2-1	781,994	1,634,600	2,606,128	2,013,346
	GUA2-2	987,474	195,100	363,448	987,474
	GUA2-3	169,708	111,100	1,782,836	1,215,650
	GUA2-4	4,679,017	1,168,000	9,950,008	8,305,594
	GUA2-5	3,387,769	1,464,200	6,925,312	4,890,928
	GUA2-6	748,485	25,600	4,535,156	2,036,529
Sabie-Sandsub-catchment	GUA3-1	2,744,067	855,700	583,416	3,002,219
	GUA3-2	2,274,679	1,785,000	5,854,292	4,301,823
	GUA3-3	3,845,298	2,633,900	3,934,948	5,818,181
	GUA3-4	297,077	410,200	1,702,020	1,370,892
	GUA3-5			110,376	55,188
X4 sub-catchment	GUA4-1	17,719	103,400	1,505,844	376,461

Sub-catchment	GUAs	WARMS	GRA II	AGES (2010)*	Revised GW use#
Total		35,456,025	13,271,800	55,079,364	52,317,133

* The estimated Irrigation use by AGES (2010) was regarded as an overestimate and was reduced by 50%.
# The final revised groundwater use estimate is based on a combination of the AGES (2010) reported volumes and the WARMS.

Groundwater quality

Approximately 800 groundwater quality samples (latest analysis per station) were collated from the NGA and WMS datasets.Major elements and selected metals were compared to the water quality guidelines as specified by DWAF (1996) (Appendix A – Section 14.1).

The general groundwater mineralisation in the Inkomati WMA is based on average Electrical Conductivities between 10 mS/m and 235 mS/m low to acceptable. A deterioration of the groundwater quality (salinity) in the WMA from west to east, following essentially the average annual rainfall, is obvious. While the higher rainfall areas in the west have usually a Total Dissolved Salt (TDS) content of less than 300 mg/l, the TDS content in the more arid areas in the east (i.e. GUA 1-7; GUA3-4 and GUA3-5)risesto more than 1000 mg/l (Appendix A – Section 14.1) or poor water quality.

Several samples show major ion concentrations (i.e. Mg, Na, Cl, and F) and subsequently electric conductivities elevated to Class II drinking water qualities. This can mostly be related to evaporative concentration of elements in discharge areas or low recharge values, while the occurrence of fluoride is primarily controlled by geology. Therefore, there are no preventative measures under the given spatial limits of water supply to avoid exceedance of applicable drinking water limits in certain regions except treatment.

Historical mining activities have resulted in the presence of abandoned adits, shafts, mine reside deposits and other infrastructure scattered across the area, although the impact of these on groundwater quality is thought to be rather local in nature. Current mining activities, including the reprocessing of old waste dumps, present a possible threat to local groundwater resources if applicable environmental legislation is not enforced. Other potential threats to groundwater quality include sub-standard sewage treatment plants and agricultural activities. In general, the risk of regional pollution of aquifers is far lower compared to urbanized areas like Gauteng, but it should be emphasised that the sustainability of rural water supply (without sophisticated treatment) depends on unpolluted water resources, which are difficult to remediate once contaminated.The water quality in the rural settlements ranges already from good to poor. Due to the growing population, the increase in the use ofseptic tanks, pit and bucket latrines, poses a direct risk to the groundwater quality in terms ofnitrate and bacterial or viral concentrations.

4 STATUS QUO: ECONOMICS

4.1 INTRODUCTION

The environmentally sustainable development and management of water resources of the Komati River, Crocodile River and Sabie-Sand River systems is a serious and complex issue if one takes into account the vast potential for economic development within the catchment which requires water to ensure that development does take place and can be sustained.It is technically challenging and often entails difficult trade-offs between social, economic and political considerations.

The Crocodile River and the Sabie-Sand River catchments face a number of water resource challenges. Greatest of these challenges is sharing scarce water resources between various competing needs. Already, a large part of the catchment is threatened by water scarcity or an already over allocation of water – and yet there are new needs for water that must still be met.

This section provides the economic baseline of the current water allocation status in the Komati, Crocodile and the Sabie-Sand sub-catchments and is intended to provide the basis to evaluate the implication.

4.2 APPROACH

The economic baseline provides the current impacts of water usage in the respective sub-systems on variables such as Gross Domestic Product (GDP)/Gross Value Added (GVA), production, employment, and household income.

Economic impacts refer to the effects on the level of economic activity in a given area, as result of some form of external intervention in the economy. The intervention can be in the form of new investment in for example, social developments, policy interventions, housing, business development, etc. All of these will imply changes in the economy and will need to be identified and captured in an impact simulation model identifying impacts regionally and nationally in terms of, inter-alia:

- Increased production.
- Employment creation.
- Increased revenue.
- Sectoral impacts.
- Poverty alleviation.

4.2.1 Macro-economic models

A macro-economic model is an analytical tool designed to describe the operation of the economy of a country or a region. These models are usually designed to examine the dynamics of aggregate quantities such as the total amount of goods and services produced, total income earned, the level of employment of productive resources, and the level of prices.

For the purpose of this project a Social Accounting Matrix (SAM) model will be used. A SAM represents flows of all economic transactions that take place within an economy (regional or national). It is at the core, a matrix representation of the National Accounts for a given country, but can be extended to include non-national accounting flows, and created for whole regions or area. SAMs refer to a single year providing a static picture of the economy.

The model is a computerised model that is adapted to a water evaluation impact model to achieve the objectives of this project.As a first step the macro economy of the **Komati, Crocodile, and Sabie-Sand catchments was established and then subdivided into its sub-catchments**. Production and employment data was used for the catchments and its sub-catchments. A Macro Economic Impact Model was constructed for the catchment and the identified sub-catchments. The model is water driven and gives the direct and indirect/induced results for the following sectors: **Irrigation agriculture, commercial forestry, mining and industry**.

The following impacts are estimated by the Macro Economic Impact Model:

- GDP/GVA.
- Production.
- Household Income.
- Employment Creation.

4.2.2 Water Impact Model

The Water Impact Model (WIM) is the application of the SAM with regards to water usage in the Inkomati catchment. The WIM includes a number of primary elements, these include:

- SAM.
- Economic data.
- Water allocation and usage information.
- Production.
- Economicmultipliers.

A change in the economy can be effectively simulated by the Input/Output (I/O) technique to identify and quantify the various impacts of such a change in regional and national context. For the purpose of this project the utilisation of the SAM as an application of the I/O technique is used. The SAM provides a particular transactional snapshot of the economy and can be manipulated through the application of multipliers to relate investments in terms of monetary and employment impacts. The National computerised SAM, the Mpumalanga SAM and regional knowledge will be set up and calibrated in accordance with the principles underlying the following User Requirements Specifications (URS):

- Spatial allocation options.
- Economic growth and multiplier analysis.
- Scenario simulation.
- Sensitivity analysis.

The multipliers which were used in this study to determine the economic impacts for the WIM were as follows:

- **Economic growth** (the impact on GDP and the impact on business output).
- **Employment creation** (the impact on labour requirements).
- **Household Income** (the impact on household income).

These multipliers are expressed in direct impacts, indirect impacts and induced impacts.

- **Direct impact:**Refers to effects occurring directly in the sector.
- **Indirect impact:**Refers to those effects occurring in the different economic sectors that link backward to the sector in question due to the supply of intermediate inputs

- **Induced impact:**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.

4.2.3 Macro-economic impacts

There are a number of economic impacts that needs to be defined, these include; impact on GDP/GVA, impact on business output (production), impact on employment and the impact on household income.

4.2.3.1 Impact on GDP/GVA

These impacts describe the positive effects of water usage in various economic activities on the GDP/GVA of the local area. In line with the described multipliers, the total impacts on GDP/GVA can further be categorised into direct, indirect and induced effects.

4.2.3.2 Impacts on business output (production)

These impacts describe the effects of water usage in various economic activities on the performance of business output or production.

4.2.3.3 Impact on employment

These impacts describe the employment created in the local area as a result of water usage in various economic activities, such as irrigation agriculture, water use in the mining sector, etc.

4.2.3.4 Impact on household income

Besides the GDP and employment impacts, water use will also have an effect on the income earned by households in the study area. The income is calculated and compared to the total household income generated by the specific economic activity.

4.3 DESCRIPTION OF ECONOMICS

This sub-section will examine the Komati, Crocodile and Sabie-Sand catchments in more detail. The catchments will be divided into economic regions of influence and the current land use and main industries will be described.

4.3.1 Economicregions/zones

The Komati, Crocodile and Sabie-Sand River sub-catchments were divided into Economic Zones(EZs) as follows:

Komati sub-catchment

- EZ 1: Komati-West.
- EZ 2: Komati (Nkomati).
- EZ 3: Lomati (RSA).
- EZ 4: Lower Komati.

Crocodile sub-catchment

- EZ 1: Upper Crocodile.
- EZ 2: Lower Kwena.
- EZ 3: Elands.
- EZ 4: White.
- EZ 5: Middle Crocodile.

- EZ 6: Kaap River.
- EZ 7: Lower Crocodile.

Sabie-Sandsub-catchment

- EZ 1: Sabie River.
- EZ 2: Maritsane/Inyaka.
- EZ 3: Sand River.

4.3.2 Land use

The following are the main economic sectors in the catchment:

- Irrigation Agriculture.
- Commercial forestry.
- Mining.
- Industry (manufacturing).
- Eco-tourism.

Eco-Tourism/Tourism plays an important role in the catchment. The difficulty in determining the impact of tourism on the economy is that tourism is not classified as a specific economic sector according to the Standard Industrial Classification (SIC) used by Statistics South Africa. The tourism sector forms part of a number of economic sectors including, Trade and Accommodation, Finance and Business, Transport and Communication and Community and Personal Services. It is therefore very difficult to determine the actual contribution of tourism on the economy.

This sub-section examines the current dominant land uses in each of the three sub-catchments that make up the Inkomati Catchment Management Area.

Komati sub-catchment: Main economic sectors

The main economic drivers of the Komati sub-catchment are irrigation, forestry, mining and industry.

Agriculture Irrigation

The following main crops have been identified:

- Citrus
- Banana
- Avocado
- Macadamia
- Vegetable
- Sugarcane
- Maize

The amount of water available and allocated to the various irrigated crops as well as the allocated hectares play a major role towards the significance of irrigation agriculture in these sub-systems. The more hectares, coupled with adequate or high water volumes available for irrigation, the higher will be the impact of any crop in terms of contribution to the GDP, business output, employment and to household income.

The inputs towards the irrigation sector consist of Computer Based Budgets which were developed by the Department of Agriculture based on 2011/12 production budgets for various crops. The computer based budgets were updated and adapted for the different production areas in terms of yield, production prices and input costs.

Commercial Forestry

Commercial plantation forestry is an important economic activity in specific zones, with a number of the zones having sizeable hectares of both gum and pine tree plantations. Plantation forestry is concentrated in the rural areas where unemployment is high and alternative economic activities and employment opportunities are scarce.

The economic impact from commercial forestry was calculated using the area under plantations together with the annual average volume growth per hectare.

Mining

The mining activities investigated are all located in the Komati West zone. Underground mining operations in general decant large quantities of water from both surface and underground water sources. At the same time these samemining operations also discharge large quantities of water back into the water system. This is underground seepage water which fills the mines and which is then pumped from the mines to the surface and discharged in the existing surface water systems.

The only mining activities identified and quantified are a large Nickel mine in Komati West and a number of small coal mining operations in the upper reaches of the Komati River (Komati West.)

An estimation of their annual turnovers was made together with the estimated labour force, which was then used as inputs in the WIM.

Industry (Manufacturing)

The two main industries in the Komati is a sugar mill in Komatipoort and sawmills for the commercial forestry operations.

The respective turnover for the sugar mill is based on the published cane crushing tonnage and the factory door price for raw sugar. The mill was contacted to obtain the permanent labour force at the mill, as well as the estimated water use.

The actual data for the operating sawmills where not readily available, and the estimated turnover was based on the throughput of saw logs, the prices as provided by Forestry South Africa and the main forestry companies, and the water use based on general figures used by the industry.

Crocodile sub-catchment: Main economic sectors

The main economic drivers of the Crocodile sub-catchment are irrigation, forestry, mining and industry.

Agriculture Irrigation

The following main crops have been identified:

- Citrus
- Banana
- Avocado
- Vegetable
- Macadamia
- Sugarcane

- Maize
- Brassicas

The amount of water available and allocated to the various irrigated crops as well as the allocated hectares play a major role towards the significance of irrigation agriculture in these sub-systems. The more hectares, coupled with adequate or high water volumes available for irrigation, the higher will be the impact of any crop in terms of contribution to the GDP, business output, employment and to income household income.

The inputs towards the irrigation sector consist of Computer Based Budgets which were developed by the Department of Agriculture based on 2011/12 production budgets for various crops. The computer based budgets were updated and adapted for the different production areas in terms of yield, production prices and input costs.

Commercial Forestry
Commercial plantation forestry is an important economic activity in the majority of the zones, with a number of the zones having sizeable hectares of both gum and pine tree plantations. Plantation forestry is concentrated in the rural areas where unemployment is high and alternative economic activities and employment opportunities are scarce.

The economic impact from commercial forestry was calculated using the area under plantations together with the annual average volume growth per hectare.

Mining
Mining operations in general decant large quantities of water from both surface and underground water sources. At the same time these same mining operations also discharge large quantities of water back into the water system. This is underground seepage water which fills the mines and which is then pumped from the mines to the surface and discharged in the existing surface water systems.

Mining activities are mainly dominated by manganese production in various forms (magnetite, manganese-dioxide, manganese-metal, manganese sulphate and manganese-oxide) with gold production in two of the zones. At least four of the seven economic zones have some mining activities. Talc production and aggregate sand quarrying is also present in the area.

There are four gold mines operating in the area, one in the Machadodorp area (Elands River EZ), one in the Barberton area, one in the Kaapmuiden area (both in the Kaap River EZ) and the fourth, the Makonjwaan mine (presently an open pit mine), situated 76 km from Nelspruit on the road to Malelane (Middle Crocodile EZ). Three of these mines are underground mining operations.

Manganese mining entails surface works, opencast and underground operations. Manganese, in different forms, is produced by three mines located in the Malelane (Lower Crocodile EZ) and two in the Nelspruit (Middle Crocodile EZ) areas.

There are several other mining activities spread over the area such as crushers for the production of aggregate sand from open cast mines, clay, for the production of bricks, from open cast mining in the Malelane area and talc from underground mining in the Barberton area. All these mining activities make use of a dry process in the production of the various commodities and have therefore not been taken into account in this study.

Industry (Manufacturing)

The four main industries in the area outside of urban areas are paper and pulp production, sawmills, sugar milling and the ferrochrome smelter in Machadodorp. Pulp and paper production is located in the Elands EZ, with the Ngodwana Mill as one of the largest mills in the Southern Hemisphere.

Sawmills operate in all of the economic zones, varying considerably in size, depending on their location in terms of the Ngodwana mill. There is one TSB sugar mill in the area at Malelane (Lower Crocodile EZ). A soft drink bottling plant (Coca-Cola Company) is also present in Nelspruit. Both the paper and pulp and sugar industries are large water users.

The actual data for the operating sawmills where not readily available, and the estimated turnover was based on the throughput of saw logs, the prices as provided by Forestry South Africa and the main forestry companies, and the water use based on general figures used by the industry.

Sabie-Sandsub-catchment: Main economic sectors

The main economic drivers of the Sabie-Sand sub-catchment main economic drivers are irrigation, forestry, and industry.

Agriculture Irrigation

The following main crops have been identified:

- Citrus
- Banana
- Avocado
- Vegetable
- Maize/Wheat
- Brassicas

The amount of water available and allocated to the various irrigated crops as well as the allocated hectares play a major role towards the significance of irrigation agriculture in these sub-systems. The more hectares, coupled with adequate or high water volumes available for irrigation, the higher will be the impact of any crop in terms of contribution to the GDP, business output, employment and to income household income.

The inputs towards the irrigation sector consist of Computer Based Budgets which were developed by the Department of Agriculture based on 2011/12 production budgets for various crops. The computer based budgets were updated and adapted for the different production areas in terms of yield, production prices and input costs.

Commercial Forestry

The two irrigated forestry plantations in the Sabie-Sand sub-catchment are pine and gum.Plantation forestry is concentrated in the rural areas where unemployment is high and alternative economic activities and employment opportunities are scarce.

The economic impact from commercial forestry was calculated using the area under plantations together with the annual average volume growth per hectare.

Industry (Manufacturing)

The only industries present in the Sabie-Sand sub-catchment that provide employment is the saw mills.

4.4 STATUS QUO ASSESSMENT

This section examines the economic baseline for each of the sub-catchments and their economic regions. The economic baseline will be conducted on each of the Komati, Crocodile and Sabie-Sand sub-catchments and the economic regions within the sub-catchments.

4.4.1 Economicbaselinedata

Komati sub-catchment economic baseline data

The four zones of the Komati catchment have been defined and their activities used to calculate the economic baseline is illustrated in Table 4.1.

Table 4.1 The four zones of the Komati sub-catchment and the relevant activities

EZ 1: Komati West	EZ 2: Komati (Nkomati)	EZ 3: Lomati (RSA)	EZ 4: Lower Komati
Maize Production Commercial Forestry Sawmills Mining	Sugarcane	Sugarcane Citrus Banana Avocado Vegetable Commercial Forestry Sawmills	Sugarcane Citrus Banana Vegetable Commercial Forestry Sawmills Sugar Mill

Irrigation Agriculture

The irrigation data used is obtained from a number of sources. The total hectares sugarcane irrigated was obtained from the South African Cane Growers while the other commodity figures were checked with the various commodity growers associations (Table 4.2).

Table 4.2 Irrigation hectares for each commodity indicated per zone (hectares)

Commodity	EZ 1	EZ 2	EZ 3	EZ 4	Total
Sugarcane	0	8,850	8,000	12,000	28,850
Citrus	0	0	1,300	900	2,200
Banana	0	0	900	1,300	2,200
Avocado	0	0	300	0	300
Maize	4,000	0	0	0	4,000
Vegetable	0	0	400	100	500
Total	**4,000**	**8,850**	**10,900**	**14,300**	**38,050**

The computer based budgets developed by the Department of Agriculture was used to determine the cost structure of the various agriculture commodities. The cost structure of the various commodities as well as the estimated farm income is illustrated in Table 4.3.From the table it appears that at present the net farm income per hectare for the orchard crops is much larger than the figure for sugarcane or irrigated maize.

Table 4.3 Cost structure of agriculture commodities (based on 2011 prices)

(R/ha)	Sugarcane	Citrus	Avocado	Banana	Vegetable	Maize
Annual Income	24,500	71,100	71,250	80,350	76,900	22,100
Gross Operating Surplus	14,600	18,350	19,200	34,120	32,050	12,100

Fixed Cost	4,200	6,800	9,000	8,500	5,600	4,100
Net Farm Income	**7,200**	**10,000**	**11,100**	**25,150**	**24,350**	**6,100**

The cost structure is constantly changing due to commodity prices and cost increases, for the purpose of this project we assume a constant cost structure.

Commercial Forestry

The physical hectares per allocation zone were determined using the total area as provided by Forestry South Africa. Table 4.4illustrates the estimated hectares of plantations in Zone 1 and 4.

Table 4.4 Plantation hectares per economic zone

Plantation	EZ 1	EZ 3	Total Hectares
Gum	11,000	1,900	12,900
Pine	59,500	11,000	70,500
Total	**70,500**	**12,900**	**83,400**

Mining

There are a number of mining operations in the Komati sub-catchment.

- **Nickel and Chrome:** The Nkomati Mine at Badplaas has a nickel and chrome production of 318,000 tonnes, with a turnover of R2,017 million tonnes per annum and a work force of 800 permanent workers and 700 contractors (based on Komati Baseline study of 2010; DWA, 2010b).
- **Thermal Coal:**Thermal coal is mined at both the Arnot and Sumo Collieries at Rietkuil and Van Wyksvlei. Both these collieries are open cast mines in the vicinity of Middelburg. The Arnot Colliery delivers solely to Eskom while the Sumo Colliery exports the coal through Maputo (20 million tons/month), Durban (35 million tons/month) from Pan, Rietkuil and Sunbury sidings and 50 million tons of pea blend railed to Richards Bay Coal every two months. The production of these mines are 6,000 tonnes for Arnot and 2,424,000 tonnes for Sumo with a turnover of R450 million for Arnot and R1, 025 million for Sumo and a workforce of approximately 840 for Arnot and 300 for Sumo (based on Komati Baseline study of 2010; DWA, 2010b).
- **Other:** There are a few other smaller mining activities spread over the area such as stone crushers for the production of aggregate sand and clay mining for the production of bricks all in the vicinity of Carolina. These activities were not taken into consideration (based on Komati Baseline study of 2010; DWA, 2010b).

Industry

The two industries are saw mills and the Komati sugar mill in Komatipoort.

- **Komati sugar mill:**The Komati sugar mill produces raw sugar of which three-quarters is exported and the balance refined at Malelane, the 2011/2012 production of sugar is used to calculate the annual turnover of the sugar mill (Table 4.5).
- **Sawmills:** There are a number of sawmills in the Zone 1 and 3. The mills differ in size and capacity which makes accurate information difficult. Table 4.5 illustrates the annual turnover and employment per zone for the saw mill industry.

Table 4.5 Estimated annual turnover of the sugar mill in Komatipoort and sawmills in the Komati sub-catchment

Industry	Annual Turnover (Rand)
Komati sugar mill (Zone 4)	R650,000,000
Sawmill: Zone 1	R720,000,000
Sawmill: Zone 3	R200,000,000

Crocodile sub-catchment economic baseline data

The seven zones of the Komati catchment have been defined and their activities used to calculate the economic baseline is illustrated in Table 4.6.

Table 4.6 Economic activities in the 7 EZs of the Crocodile sub-catchment

EZ 1: Upper Crocodile	EZ 2: Lower Kwena	EZ 3: Elands	EZ 4: White	EZ 5: Middle Crocodile	EZ 6: Kaap	EZ 7: Lower Crocodile
Citrus Brassicas Maize Cucurbits Forestry Industry	Citrus Macadamia Brassicas Maize Cucurbits Forestry Industry	Citrus Brassicas Maize Cucurbits Forestry Industry	Citrus Sugarcane Brassicas Cucurbits Forestry Industry	Banana Citrus Avocado Macadamia Sugarcane Brassicas Cucurbits Forestry Mining Industry	Banana Citrus Avocado Macadamia Sugarcane Brassicas Maize Cucurbits Forestry Mining Industry	Citrus Sugarcane Brassicas Forestry Mining Industry

Irrigation Agriculture

The irrigation data used is obtained from a number of sources. The total hectares sugarcane irrigated is obtained from the South African Cane Growers while the other commodity figures were checked with the various commodity growers associations (Table 4.7).

Table 4.7 Irrigation hectares for each commodity indicated per zone (hectares)

Crop hectares	EZ 1: Upper Crocodile	EZ 2: Lower Kwena	EZ 3: Elands	EZ 4: White	EZ 5: Middle Crocodile	EZ 6: Kaap	EZ 7: Lower Crocodile
Banana	0	0	0	0	100	1,000	0
Citrus	10	500	300	1,000	5,000	1,250	5,000
Avocado	0	0	0	0	1,300	600	0
Macadamia	0	150	0	0	2,500	1,200	0
Sugarcane	0	0	0	400	4,000	4,500	16,000
Brassicas	10	100	300	2,000	400	100	30
Maize	500	350	500	0	0	300	0
Cucurbits	10	120	300	2,000	400	100	20
Total	**530**	**1,170**	**1,400**	**5,400**	**13,700**	**9,050**	**21,050**

Although agriculture is a dynamic industry and the area per crop varies from time to time and from zone to zone, for purposes of this exercise they were assumed to be constant. The most cultivated crops are sugar cane and citrus.

Water use is critical to determine the economic impact of irrigation agriculture in the Crocodile sub-catchment. Table 4.8illustrates the water use and hectares irrigated for each of the seven zones.

Table 4.8 Water use for Irrigation in the Crocodile sub-catchment

Zone	Water use (Mm^3)	Area (hectares)
Zone 1: Upper Crocodile	4.1	530
Zone 2: Lower Kwena	9.4	1,170
Zone 3: Elands	6.0	1,400
Zone 4: White	30.5	5,400
Zone 5: Middle Crocodile	112.0	13,700
Zone 6: Kaap	82.4	9,050
Zone 7: Lower Crocodile	245.9	21,050
Total	**490.3**	**52,300**

Commercial Forestry

The physical hectares per allocation zone were determined using the total area as provided by Forestry South Africa.

Table 4.9illustrates the estimated hectares of plantations for all seven of the zones. All the zones have pine and gum plantations. As indicated in the table below pine plantations, 152,283 hectares are by far more dominant than gum plantations 24,790 hectares. The Middle Crocodile dominates forestry plantation in this sub-catchment.

Table 4.9 Forestry hectares across the seven zones

Forestry hectares	EZ 1: Upper Crocodile	EZ 2: Lower Kwena	EZ 3: Elands	EZ 4: White	EZ 5: Middle Crocodile	EZ 6: Kaap	EZ 7: Lower Crocodile
Pine	4,000	11,000	25,000	27,000	51,000	32,000	150
Gum	600	2,000	4,000	5,500	9,000	5,000	25
Total	**4,600**	**13,000**	**29,000**	**32,500**	**60,000**	**37,000**	**175**

Mining

- **Gold mining:**There are four gold mines operating in the area, one in the Machadodorp area (Elands River EZ), one in the Barberton area, one in the Kaapmuiden area (both in the Kaap River EZ) and the fourth, the Makonjwaan mine, situated 75 km from Nelspruit on the road to Malelane (Middle Crocodile EZ). The first three mines are underground mining operations.
- **Manganese mining:**Manganese mining entails surface works, opencast and underground operations. Manganese, in different forms, is produced by three mines located in the Malelane area (Lower Crocodile EZ) and two in the Nelspruit (Middle Crocodile EZ) area.
- **Other:**There are other mining operations in the form of sand mining, clay mining and crushers that make use of dry processes and are thus not considered for the study. Most of these operations are in the Barberton and Malelane area.

Table 4.10 Mining turnover and water use in the Crocodile sub-catchment

Zone	Water use (Mm^3)	Turnover (R/million)
Zone 5: Middle Crocodile	1.05	1,010.50
Zone 6: Kaap	1.25	660.50
Zone 7: Lower Crocodile	0.10	43.40
Total	**2.40**	**1,714.40**

Industry

The main industries present in the catchment are paper and pulp milling, sugar milling, saw milling and a ferrochrome smelter. The ferrochrome smelter is located in Machadodorp. Most of these industries are heavy water users. Table 4.11 illustrates the industrial activities in the Crocodile sub-catchment per zone.

Table 4.11 Annual turnover and water usage for industry in the sub-catchment

Industry	Water use (Mm^3)	Annual turnover (Rand/million)
Zone 1: Upper Crocodile	0.1	20
Zone 2: Lower Kwena	0.3	62
Zone 3: Elands	7.5	4,900
Zone 4: White	0.8	150
Zone 5: Middle Crocodile	1.3	410
Zone 6: Kaap	0.6	100
Zone 7: Lower Crocodile	0.9	580
Total	**11.5**	**6,222**

Sabie-Sandsub-catchment economic baseline data

The three zones of the Sabie-Sand catchment have been defined and their activities used to calculate the economic baseline is illustrated in Table 4.12.

Table 4.12 Economic activities in the three zones

EZ 1: Sabie	EZ 2: Maritsane/Inyaka	EZ 3: Sand
Banana Citrus Avocado Macadamia Papaya Brassicas Maize Curcurbits Forestry Sawmill	Banana Citrus Avocado Macadamia Brassicas Maize Curcubits Forestry Sawmill	Banana Citrus Avocado Brassicas Forestry Sawmill

Irrigation Agriculture

The irrigation data used is obtained from a number of sources. The total hectares sugarcane irrigated is obtained from the South African Cane Growers while the other commodity figures were checked with the various commodity growers associations (Table 4.13).

Table 4.13 Irrigation hectares for each commodity indicated per zone (Hectares)

Crop hectares	EZ 1: Sabie	EZ 2: Maritsane/Inyaka	EZ 3: Sand
Banana	1,500	850	200
Citrus	1,000	1,000	150
Avocado	2,000	350	120
Macadamia	1,200	140	0
Papaya	1,000	0	0
Brassicas	250	50	1,200
Maize	600	45	0
Cucurbits	250	25	700
Total	**7,800**	**2,460**	**2,370**

The Sabie River is the most cultivated zone with 7,800 hectares under irrigation as well as the biggest water user. On the other hand, the Sand River is the least cultivated as well as the zone using the least water. A total of 12,630 crop hectares are irrigated in this sub-system as indicated in Table 4.14.

Table 4.14 Water Usage and Hectares Planted in the zones

Zone	Water use (Mm^3)	Area (hectares)
EZ 1: Sabie	84.9	7,800
EZ 2: Maritsane/Inyaka	46.3	2,460
EZ 3: Sand	13.8	2,370
Total	**145.0**	**12,630**

Commercial Forestry

The physical hectares per allocation zone were determined using the total area as provided by Forestry South Africa. As indicated in the table below, pine plantations of 66,000 hectares are by far the most dominant specie with gum plantations only at 11,500 hectares. The Sabie River zone dominates forestry plantation in this sub-catchment (Table 4.15).

Table 4.15 Forestry hectares across the three zones

Forestry hectares	EZ 1: Sabie	EZ 2: Maritsane/Inyaka	EZ 3: Sand
Pine	39,000	20,000	7,000
Gum	7,000	3,500	1,000
Total	**46,000**	**23,500**	**8,000**

Mining

There are no significant mining operations in the Sabie-Sand sub-catchment. The only operations are minor sand mining operations which makes use of dry processes.

Industry

Saw milling is the only real industrial activity in the sub-catchment. The economic output of the wood and paper processing sub-sector was used to determine the economic value of saw milling in the Sabie-Sandsub-catchment.

Table 4.16 Industry turnover and water use in the Sabie-Sandsub-catchment

Zone	Water Use (Mm^3)	Turnover (R/million)
EZ1: Sabie	1.0	530.0
EZ 2: Maritsane/Inyaka	0.4	280.0
EZ 3: Sand	0.2	90.0
Total	**1.6**	**900.0**

4.4.2 Economic baseline

As described in the previous section the direct GDP and employment are economic impacts within the project area, while some of the other multiplier impacts might occur outside of the project area. In presenting the results it was decided to present the total macroeconomic impact to assist in reflecting the total economic picture.The baseline results will be presented for each of the three sub-catchments; the Komati, the Crocodile and the Sabie-Sand.

Komati sub-catchment economic baseline

The data are presented for each of the four economic zones.

EZ 1: Komati West

Table 4.17illustrates the economic baseline for EZ 1 – Komati West. An important factor to take note of in EZ 1 (Komati West) is the Acid Mine Drainage (AMD). This will impose a future cost on the catchment when the mines close and the AMD needs to be treated. This cost needs to be factored into the net contribution of coal mining to the GDP. The amount of AMD is not known accurately at this stage but a study is being undertaken by the ICMA which should quantify the future AMD and suggest operating procedures for managing it.As an interim measure for the purpose of this Status Quo report, the future AMD has been estimated by comparing the productions of the Komati mines with the production of the mines in the Olifants catchment, where the AMD has been quantified. Based on this, a rough estimated of future AMD is estimated at 5.0 million m^3 per annum. This is a significant amount of water that will need to be treated. The current industry estimates for treating AMD (*pers. comm*., P Gunther, 2010) is approximately R12/m^3 which means a direct cost impact of R60 million a year to treat the AMD.

The dominant sector in EZ 1 is mining, directly contributing R2.24 billion to the GDP and approximately 4,450 jobs. Total GDP contribution is R4.3 billion taking into account the indirect and induced impacts of the sector on the economy.

Table 4.17 Economic baseline in EZ 1 – Komati West (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	97.8	285.7	3862.2	796.3	5042.0
	Indirect	99.0	225.2	3484.1	1249.6	5057.8
	Induced	35.8	138.9	1426.4	341.1	1942.2
	Total	**232.6**	**649.8**	**8772.6**	**2387.0**	**12042.0**
GDP (R'million)	Direct	51.8	181.1	2243.6	215.8	2692.4
	Indirect	41.2	93.7	1449.2	519.8	2103.8
	Induced	15.2	58.3	607.7	145.3	826.5
	Total	**108.2**	**333.0**	**4300.5**	**880.9**	**5622.6**
Employment (Number)	Direct	472.0	2804.0	4447.0	2034.0	9757.0
	Indirect	148.0	336.0	5202.0	1866.0	7552.0
	Induced	98.0	370.0	3917.0	963.0	5348.0
	Total	**718.0**	**3510.0**	**13566.0**	**4863.0**	**22657.0**
Income (R'million)	Direct	17.0	100.9	774.1	116.7	1008.7
	Indirect	17.9	40.7	630.3	226.1	915.0
	Induced	7.2	27.6	289.5	69.2	393.5
	Total	**42.1**	**169.2**	**1693.9**	**412.0**	**2317.2**

Source: Urban-Econ Impact Modelling, 2013.

EZ 2: Komati

Table 4.18illustrates the economic baseline for EZ2 – Komati. The only significant economic activity in EZ 2 is irrigation agriculture contributing around R265.3 million and 1,761 jobs.

Table 4.18 Economic baseline in EZ 2 – Komati (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	239.8				239.8
	Indirect	242.9				242.9

		Irrigation	Forestry	Mining	Industry	Total
	Induced	87.8				87.8
	Total	**570.5**	**0.0**	**0.0**	**0.0**	**570.5**
GDP (R'million)	Direct	127.0				127.0
	Indirect	101.0				101.0
	Induced	37.3				37.3
	Total	**265.3**	**0.0**	**0.0**	**0.0**	**265.3**
Employment (Number)	Direct	1158.0				1158.0
	Indirect	363.0				363.0
	Induced	240.0				240.0
	Total	**1761.0**	**0.0**	**0.0**	**0.0**	**1761.0**
Income (R'million)	Direct	41.7				41.7
	Indirect	43.9				43.9
	Induced	17.7				17.7
	Total	**103.3**	**0.0**	**0.0**	**0.0**	**103.3**

Source: Urban-Econ Impact Modelling, 2013.

EZ 3: Lomati

Table 4.19illustrates the economic baseline for EZ3 – Lomati. Irrigation agriculture is the dominant economic activity in EZ 3 contributing R505.2 million and 3,354 jobs.

Table 4.19 Economic baseline in EZ3 – Lomati (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	456.7	52.3		221.2	730.1
	Indirect	462.5	41.2		347.1	850.8
	Induced	167.2	25.4		94.8	287.4
	Total	**1086.3**	**118.9**	**0.0**	**663.1**	**1868.3**
GDP (R'million)	Direct	241.8	33.1		60.0	334.9
	Indirect	192.4	17.1		144.4	353.9
	Induced	71.0	10.7		40.4	122.1
	Total	**505.2**	**60.9**	**0.0**	**244.7**	**810.8**
Employment (Number)	Direct	2205.0	513.0		565.0	3283.0
	Indirect	691.0	62.0		518.0	1271.0
	Induced	458.0	68.0		260.0	786.0
	Total	**3354.0**	**643.0**	**0.0**	**1343.0**	**5340.0**
Income (R'million)	Direct	79.3	18.5		32.4	130.2
	Indirect	83.7	7.5		62.8	154.0
	Induced	33.8	5.0		19.2	58.0
	Total	**196.8**	**31.0**	**0.0**	**114.4**	**342.2**

Source: Urban-Econ Impact Modelling, 2013.

EZ 4: Lower Komati

Table 4.20 illustrates the economic baseline for Economic Zone 4 – Lower Komati. The dominant economic activity in EZ 4 is industry, specifically driven by the Komati sugar mill and sawmills in the area.

Table 4.20 Economic baseline in EZ 4 – Lower Komati (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	520.0			718.9	1238.9
	Indirect	526.6			1128.1	1654.7

		Irrigation	Forestry	Mining	Industry	Total
	Induced	190.4			308.0	498.3
	Total	**1237.0**	**0.0**	**0.0**	**2155.0**	**3391.9**
GDP (R'million)	Direct	275.3			194.8	470.2
	Indirect	219.1			469.2	688.3
	Induced	80.9			131.2	212.1
	Total	**575.3**	**0.0**	**0.0**	**795.3**	**1370.5**
Employment (Number)	Direct	2511.0			1837.0	4348.0
	Indirect	786.0			1683.0	2469.0
	Induced	521.0			845.0	1366.0
	Total	**3818.0**	**0.0**	**0.0**	**4365.0**	**8183.0**
Income (R'million)	Direct	90.3			105.4	195.7
	Indirect	95.3			204.1	299.4
	Induced	38.5			62.5	101.0
	Total	**224.1**	**0.0**	**0.0**	**372.0**	**596.1**

Source: Urban-Econ Impact Modelling, 2013.

Summary: Komati sub-catchment

Table 4.21provides a summary of the economic baseline for the entire Komati sub-catchment.

Table 4.21 Economic baseline summary – Komati sub-catchment (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	1314.2	338.0	3862.2	1736.4	7250.8
	Indirect	1331.1	266.4	3484.1	2724.8	7806.3
	Induced	481.1	164.3	1426.4	743.9	2815.7
	Total	**3126.4**	**768.7**	**8772.6**	**5205.1**	**17872.7**
GDP (R'million)	Direct	695.9	214.3	2243.6	470.6	3624.4
	Indirect	553.7	110.8	1449.2	1133.4	3247.0
	Induced	204.4	68.9	607.7	316.9	1197.9
	Total	**1453.9**	**394.0**	**4300.5**	**1920.9**	**8069.3**
Employment (Number)	Direct	6346.0	3317.0	4447.0	4436.0	18546.0
	Indirect	1988.0	398.0	5202.0	4067.0	11655.0
	Induced	1317.0	438.0	3917.0	2068.0	7740.0
	Total	**9651.0**	**4153.0**	**13566.0**	**10571.0**	**37941.0**
Income (R'million)	Direct	228.3	119.4	774.1	254.5	1376.3
	Indirect	240.8	48.2	630.3	493.0	1412.3
	Induced	97.2	32.6	289.5	150.9	570.2
	Total	**566.3**	**200.2**	**1693.9**	**898.4**	**3358.8**

Figure 4.1 illustrates the contribution of each of the main economic activities within the Komati sub-catchment in relation to the direct macro-economic impact. The Urban-Econ calculations were based on Economic Impact Modelling, 2013.

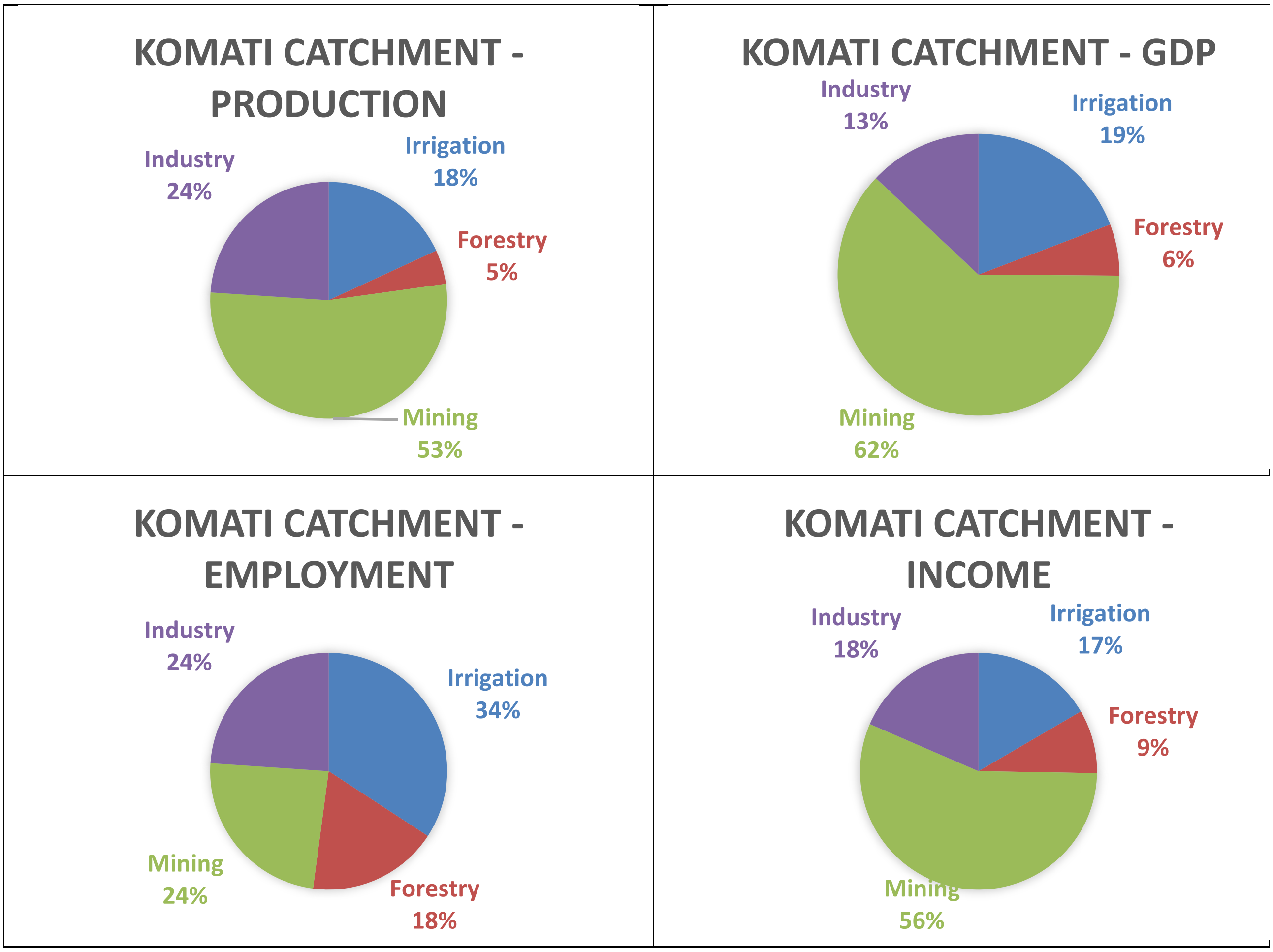

Figure 4.1 Direct impact contribution of the economic activities in the Komati sub-catchment (as % of the total)

In the **Komati sub-catchment**, the **mining sector contributes the most to GDP with approximately 62%** of total GDP in the catchment.**Irrigation agriculture contributes the most jobs in the catchment with 34%** of total jobs followed by mining (24%) and industry (24%).

Crocodile sub-catchment economic baseline

The data are presented for each of the seven economic zones.

EZ 1: Upper Crocodile

Table 4.22illustrates the economic baseline for EZ1 – Upper Crocodile.The dominant economic activity is industry, specifically the Ferrochrome Smelter in Machadodorp which contributes directly R22.1 million to production. Other economic activities include irrigation agriculture and forestry plantations.

Table 4.22 Economic baseline in EZ 1 – Upper Crocodile (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	14.7	11.8		22.1	48.7
	Indirect	16.6	9.3		34.7	60.7
	Induced	5.2	5.7		9.5	20.4
	Total	**36.6**	**26.9**	**0.0**	**66.3**	**129.7**
GDP (R'million)	Direct	7.0	7.5		6.0	20.5
	Indirect	6.9	3.9		14.4	25.2
	Induced	2.2	2.4		4.0	8.7
	Total	**16.1**	**13.8**	**0.0**	**24.5**	**54.4**

		Irrigation	Forestry	Mining	Industry	Total
Employment (Number)	Direct	71.0	116.0		57.0	244.0
	Indirect	25.0	14.0		52.0	91.0
	Induced	14.0	15.0		26.0	55.0
	Total	**110.0**	**145.0**	**0.0**	**135.0**	**390.0**
Income (R'million)	Direct	2.1	4.2		3.2	9.5
	Indirect	3.0	1.7		6.3	11.0
	Induced	1.1	1.1		1.9	4.1
	Total	**6.2**	**7.0**	**0.0**	**11.4**	**24.6**

Source: Urban-Econ Impact Modelling, 2013.

EZ 2: Lower Kwena

Table 4.23illustrates the economic baseline for EZ 2 – Lower Kwena. The dominant economic activity is irrigation agriculture with a direct contribution of R36.1 million to GDP and 367 jobs. Other significant activities are forestry plantations and industry.

Table 4.23 Economic baseline in EZ 2 – Lower Kwena (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	76.1	33.4		68.6	178.1
	Indirect	86.1	26.3		107.6	220.0
	Induced	27.0	16.3		29.4	72.7
	Total	**189.1**	**76.0**	**0.0**	**205.6**	**470.7**
GDP (R'million)	Direct	36.1	21.2		18.6	75.9
	Indirect	35.8	11.0		44.8	91.5
	Induced	11.5	6.8		12.5	30.8
	Total	**83.4**	**38.9**	**0.0**	**75.9**	**198.2**
Employment (Number)	Direct	367.0	328.0		175.0	870.0
	Indirect	129.0	39.0		161.0	329.0
	Induced	74.0	43.0		81.0	198.0
	Total	**570.0**	**410.0**	**0.0**	**417.0**	**1397.0**
Income (R'million)	Direct	10.6	11.8		10.0	32.4
	Indirect	15.6	4.8		19.5	39.9
	Induced	5.5	3.2		6.0	14.7
	Total	**31.7**	**19.8**	**0.0**	**35.5**	**87.0**

Source: Urban-Econ Impact Modelling, 2013.

EZ 3: Elands River

Table 4.24 illustrates the economic baseline for EZ3 – Elands. The dominant economic activity is industry, specifically the Ngodwana Paper Mill.

Table 4.24 Economic baseline in EZ 3 – Elands (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	86.8	74.5		4313.4	4474.8
	Indirect	98.2	58.7		6768.5	6925.5
	Induced	30.8	36.2		1847.8	1914.8
	Total	**215.9**	**169.4**	**0.0**	**12929.8**	**13315.1**
GDP (R'million)	Direct	41.2	47.2		1169.1	1257.5
	Indirect	40.9	24.4		2815.4	2880.7
	Induced	13.1	15.2		787.2	815.4
	Total	**95.2**	**86.8**	**0.0**	**4771.6**	**4953.6**

		Irrigation	Forestry	Mining	Industry	Total
Employment (Number)	Direct	419.0	731.0		11020.0	12170.0
	Indirect	147.0	88.0		10106.0	10341.0
	Induced	84.0	96.0		5073.0	5253.0
	Total	**650.0**	**915.0**	**0.0**	**26199.0**	**27764.0**
Income (R'million)	Direct	12.1	26.3		632.1	670.5
	Indirect	17.8	10.6		1224.5	1252.9
	Induced	6.2	7.2		374.9	388.3
	Total	**36.1**	**44.1**	**0.0**	**2231.5**	**2311.7**

Source: Urban-Econ Impact Modelling, 2013.

EZ 4: White River

Table 4.25illustrates the economic baseline for EZ4 – White River. The main economic activity is irrigation agriculture, with a direct impact of R203.9 million to GDP and 2,075 jobs.

Table 4.25 Economic baseline in EZ 4 – White River (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	429.7	83.5		165.9	679.1
	Indirect	486.1	65.8		260.3	812.2
	Induced	152.3	40.8		71.1	264.2
	Total	**1068.1**	**190.1**	**0.0**	**497.3**	**1755.5**
GDP (R'million)	Direct	203.9	52.9		45.0	301.8
	Indirect	202.2	27.4		108.3	337.8
	Induced	64.8	17.0		30.3	112.1
	Total	**470.8**	**97.3**	**0.0**	**183.5**	**751.7**
Employment (Number)	Direct	2075.0	820.0		424.0	3319.0
	Indirect	726.0	98.0		389.0	1213.0
	Induced	417.0	108.0		195.0	720.0
	Total	**3218.0**	**1026.0**	**0.0**	**1008.0**	**5252.0**
Income (R'million)	Direct	59.9	29.5		24.3	113.7
	Indirect	87.9	11.9		47.1	146.9
	Induced	30.8	8.1		14.4	53.3
	Total	**178.6**	**49.5**	**0.0**	**85.8**	**313.9**

Source: Urban-Econ Impact Modelling, 2013.

EZ 5: Middle Crocodile

Table 4.26illustrates the economic baseline for EZ5 – Middle Crocodile. The Middle Crocodile EZ has a significant impact on the economy in all the economic sectors. The mining sector contributes R648.9 million (direct) to the economy with 3,924 jobs (total). The irrigation sector contributes R398.3 million (direct) to the economy with 6,286 jobs (total).

Table 4.26 Economic baseline in EZ 5 – Middle Crocodile (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	839.4	154.2	1117.1	453.5	2564.1
	Indirect	949.5	121.5	1007.7	711.6	2790.3
	Induced	297.6	74.9	412.6	194.3	979.3
	Total	**2086.5**	**350.5**	**2537.3**	**1359.3**	**6333.6**
GDP (R'million)	Direct	398.3	97.7	648.9	122.9	1267.8
	Indirect	395.0	50.5	419.2	296.0	1160.6
	Induced	126.5	31.4	175.8	82.8	416.4

		Irrigation	Forestry	Mining	Industry	Total
	Total	**919.7**	**179.7**	**1243.9**	**501.6**	**2844.9**
Employment (Number)	Direct	4053.0	1513.0	1286.0	1159.0	8011.0
	Indirect	1418.0	181.0	1505.0	1062.0	4166.0
	Induced	815.0	199.0	1133.0	533.0	2680.0
	Total	**6286.0**	**1893.0**	**3924.0**	**2754.0**	**14857.0**
Income (R'million)	Direct	117.0	54.4	223.9	66.5	461.8
	Indirect	171.8	22.0	182.3	128.7	504.8
	Induced	60.2	14.9	83.7	39.4	198.2
	Total	**349.0**	**91.3**	**489.9**	**234.6**	**1164.8**

Source: Urban-Econ Impact Modelling, 2013.

EZ 6: Kaap River

Table 4.27illustrates the economic baseline for EZ6 – Kaap River. The Kaap River EZ has significant economic impacts in irrigation agriculture, mining and industry. Mining contributes R812.8 million (total) to the local economy whereas irrigation agriculture provides the most jobs at 3,422 (total).

Table 4.27 Economic baseline in EZ 6 – Kaap River (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	456.8	95.1	730.0	453.5	1735.3
	Indirect	516.7	74.9	658.5	711.6	1961.7
	Induced	161.9	46.2	269.6	194.3	672.0
	Total	**1135.4**	**216.2**	**1658.1**	**1359.3**	**4368.9**
GDP (R'million)	Direct	216.7	60.3	424.1	122.9	824.0
	Indirect	214.9	31.2	273.9	296.0	816.0
	Induced	68.8	19.4	114.9	83.0	286.1
	Total	**500.5**	**110.8**	**812.8**	**501.9**	**1926.0**
Employment (Number)	Direct	2206.0	933.0	841.0	1159.0	5139.0
	Indirect	772.0	112.0	983.0	1062.0	2929.0
	Induced	444.0	123.0	740.0	533.0	1840.0
	Total	**3422.0**	**1168.0**	**2564.0**	**2754.0**	**9908.0**
Income (R'million)	Direct	63.7	33.6	146.3	66.5	310.1
	Indirect	93.5	13.6	119.1	128.7	354.9
	Induced	32.8	9.2	54.7	39.4	136.1
	Total	**190.0**	**56.4**	**320.1**	**234.6**	**801.1**

Source: Urban-Econ Impact Modelling, 2013.

EZ 7: Lower Crocodile

Table 4.28illustrates the economic baseline for EZ7 – Lower Crocodile. The main economic activity is irrigation agriculture, contributing R910.6 million (total) to the local economy and 6,224 jobs (total). Industry contributes R709.6 million (total) to the local economy, mainly due to the TSB Sugar Mill in Malelane.

Table 4.28 Economic baseline in EZ 7 – Lower Crocodile (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	831.0	0.5	48.5	641.5	1521.4
	Indirect	940.0	0.4	43.9	1006.6	1990.9
	Induced	294.6	0.2	18.0	274.8	587.6
	Total	**2065.6**	**1.0**	**110.3**	**1922.9**	**4099.8**

		Irrigation	Forestry	Mining	Industry	Total
GDP (R'million)	Direct	394.3	0.3	28.3	173.9	596.7
	Indirect	391.0	0.2	18.3	418.7	828.1
	Induced	125.2	0.1	7.7	117.1	250.1
	Total	**910.6**	**0.5**	**54.2**	**709.6**	**1674.9**
Employment (Number)	Direct	4013.0	4.0	46.0	1639.0	5702.0
	Indirect	1404.0	1.0	66.0	1503.0	2974.0
	Induced	807.0	1.0	49.0	754.0	1611.0
	Total	**6224.0**	**6.0**	**161.0**	**3896.0**	**10287.0**
Income (R'million)	Direct	115.9	0.2	9.8	94.0	219.9
	Indirect	170.1	0.1	7.9	182.1	360.2
	Induced	59.6	0.0	3.6	55.8	119.0
	Total	**345.6**	**0.3**	**21.3**	**331.9**	**699.1**

Source: Urban-Econ Impact Modelling, 2013.

Summary: Crocodile sub-catchment

Table 4.29provides a summary of the economic baseline for the entire Crocodile sub-catchment.

Table 4.29 Economic baseline summary – Crocodile sub-catchment (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	1314.2	338.0	3862.2	1736.4	7250.8
	Indirect	1331.1	266.4	3484.1	2724.8	7806.3
	Induced	481.1	164.3	1426.4	743.9	2815.7
	Total	**3126.4**	**768.7**	**8772.6**	**5205.1**	**17872.7**
GDP (R'million)	Direct	695.9	214.3	2243.6	470.6	3624.4
	Indirect	553.7	110.8	1449.2	1133.4	3247.0
	Induced	204.4	68.9	607.7	316.9	1197.9
	Total	**1453.9**	**394.0**	**4300.5**	**1920.9**	**8069.3**
Employment (Number)	Direct	6346.0	3317.0	4447.0	4436.0	18546.0
	Indirect	1988.0	398.0	5202.0	4067.0	11655.0
	Induced	1317.0	438.0	3917.0	2068.0	7740.0
	Total	**9651.0**	**4153.0**	**13566.0**	**10571.0**	**37941.0**
Income (R'million)	Direct	228.3	119.4	774.1	254.5	1376.3
	Indirect	240.8	48.2	630.3	493.0	1412.3
	Induced	97.2	32.6	289.5	150.9	570.2
	Total	**566.3**	**200.2**	**1693.9**	**898.4**	**3358.8**

Figure 4.2 illustrates the contribution of each of the main economic activities within the Crocodile sub-catchment in relation to the direct macro-economic impact. The Urban-Econ calculations were based on Economic Impact Modelling, 2013.

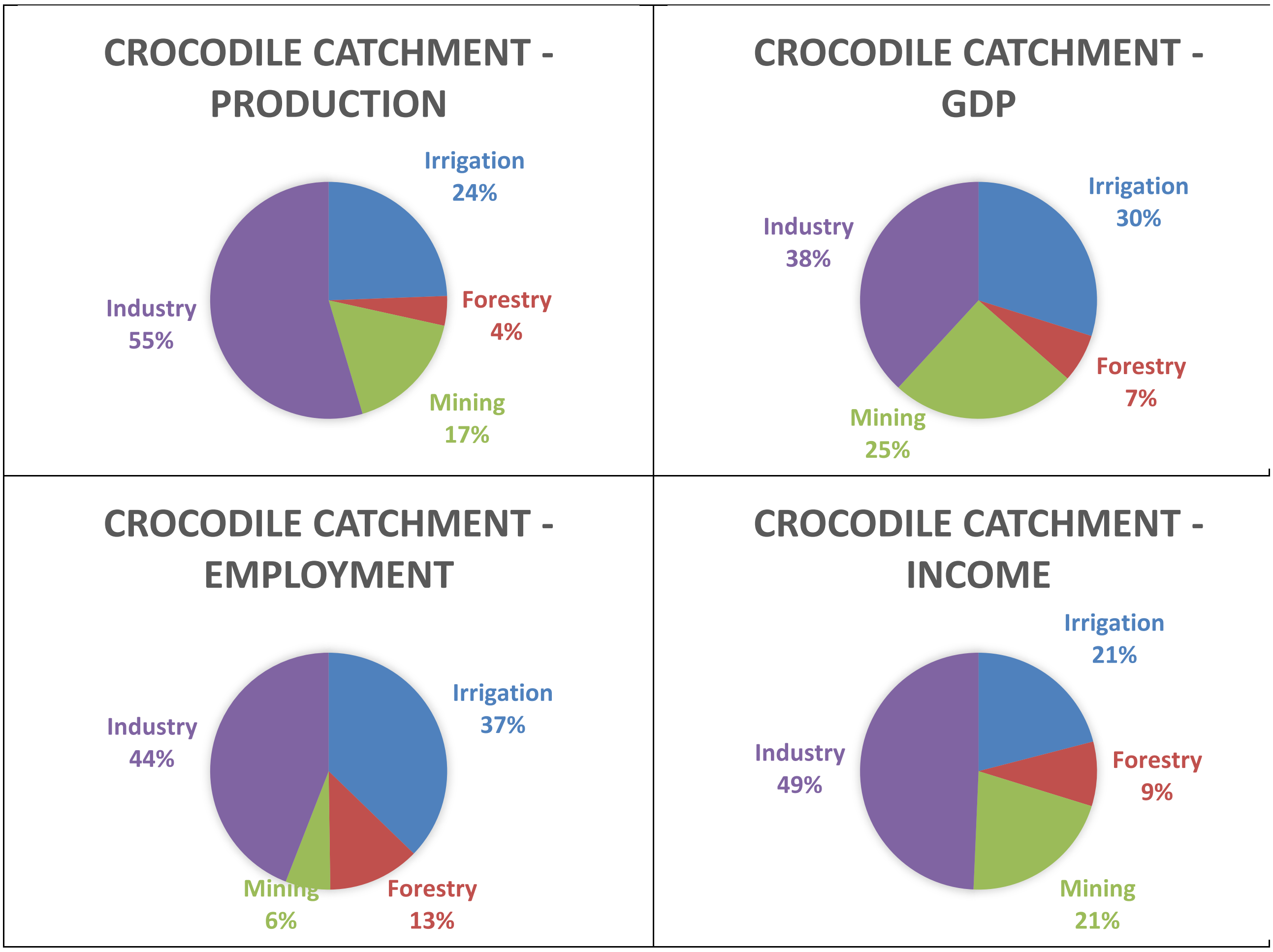

Figure 4.2 Direct Impact Contribution of the economic activities in the Crocodile sub-catchment (as % of the total)

The most dominant economic activity/sector in the **Crocodile sub-catchment is industry**, **contributing 38% of total GDP and 44% of the total jobs** in the catchment. **Irrigation agriculture contributes 30% to total GDP and 37% of the total jobs** in the catchment relating to surface water activities.

Sabie sub-catchment economic baseline

The data are presented for each of the three economic zones.

EZ 1: Sabie

Table 4.30illustrates the economic baseline for EZ1 – Sabie. The main economic activities are irrigation agriculture and industry. Irrigation agriculture contributes R714.1 million (total) to the local economy and 4,881 (total) jobs. Industry contributes R648.4 million (total) to the local economy and 3,560 (total) jobs.

Table 4.30 Economic baseline in EZ 1 – Sabie (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	651.7	118.2		586.2	1356.1
	Indirect	737.2	93.1		919.8	1750.2
	Induced	231.0	57.4		251.1	539.6
	Total	**1619.9**	**268.8**	**0.0**	**1757.1**	**3645.8**
GDP (R'million)	Direct	309.2	74.9		158.9	543.0
	Indirect	306.6	38.7		382.6	728.0
	Induced	98.2	24.1		107.0	229.3

		Irrigation	Forestry	Mining	Industry	Total
	Total	**714.1**	**137.8**	**0.0**	**648.4**	**1500.3**
Employment (Number)	Direct	3147.0	1160.0		1498.0	5805.0
	Indirect	1101.0	139.0		1373.0	2613.0
	Induced	633.0	153.0		689.0	1475.0
	Total	**4881.0**	**1452.0**	**0.0**	**3560.0**	**9893.0**
Income (R'million)	Direct	90.9	41.7		85.9	218.5
	Indirect	133.4	16.8		166.4	316.6
	Induced	46.7	11.4		51.0	109.1
	Total	**271.0**	**69.9**	**0.0**	**303.3**	**644.2**

Source: Urban-Econ Impact Modelling, 2013.

EZ 2: Inyaka/Maritsane

Table 4.31illustrates the economic baseline for Economic Zone 2 – Inyaka/Maritsane. The main economic activity is industry with a total GDP impact of R342.6 million and 1,881 (total) jobs to the local economy.

Table 4.31 Economic baseline in EZ 2 – Inyaka/Maritsane (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	145.1	60.4		309.7	515.2
	Indirect	164.1	47.6		486.0	697.7
	Induced	51.4	29.3		132.7	213.4
	Total	**360.7**	**137.3**	**0.0**	**928.3**	**1426.3**
GDP (R'million)	Direct	68.9	38.3		83.9	191.1
	Indirect	68.3	19.8		202.1	290.2
	Induced	21.9	12.3		56.5	90.7
	Total	**159.0**	**70.4**	**0.0**	**342.6**	**571.9**
Employment (Number)	Direct	701.0	593.0		791.0	2085.0
	Indirect	245.0	71.0		726.0	1042.0
	Induced	141.0	78.0		364.0	583.0
	Total	**1087.0**	**742.0**	**0.0**	**1881.0**	**3710.0**
Income (R'million)	Direct	20.2	21.3		45.4	86.9
	Indirect	29.7	8.6		87.9	126.2
	Induced	10.4	5.8		26.9	43.1
	Total	**60.3**	**35.7**	**0.0**	**160.2**	**256.2**

Source: Urban-Econ Impact Modelling, 2013.

EZ 3: Sand

Table 4.32illustrates the economic baseline for EZ3 – Sand. The main economic activity is irrigation agriculture with a total GDP impact of R206.3 million and 1,410 (total) jobs to the local economy. There are limited industry with a GDP contribution of R110.1 million (total) and 604 (total) jobs.

Table 4.32 Economic baseline in EZ 3 – Sand (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	188.3	20.6		99.5	308.4
	Indirect	213.0	16.2		156.2	385.4
	Induced	66.7	10.0		42.6	119.4
	Total	**468.0**	**46.7**	**0.0**	**298.4**	**813.1**
GDP (R'million)	Direct	89.3	13.0		27.0	129.3

		Irrigation	Forestry	Mining	Industry	Total
	Indirect	88.6	6.7		65.0	160.3
	Induced	28.4	4.2		18.2	50.7
	Total	**206.3**	**24.0**	**0.0**	**110.1**	**340.4**
Employment (Number)	Direct	909.0	202.0		254.0	1365.0
	Indirect	318.0	24.0		233.0	575.0
	Induced	183.0	27.0		117.0	327.0
	Total	**1410.0**	**253.0**	**0.0**	**604.0**	**2267.0**
Income (R'million)	Direct	26.3	7.3		14.6	48.2
	Indirect	38.5	2.9		28.3	69.7
	Induced	13.5	2.0		8.7	24.2
	Total	**78.3**	**12.2**	**0.0**	**51.6**	**142.1**

Source: Urban-Econ Impact Modelling, 2013.

Summary: Sabie sub-catchment

Table 4.33provides a summary of the economic baseline for the entire Sabie sub-catchment.

Table 4.33 Economic Baseline Summary – Sabie sub-catchment (2012 Prices)

		Irrigation	Forestry	Mining	Industry	Total
Production (R'million)	Direct	985.1	199.1	0.0	995.4	2179.6
	Indirect	1114.3	156.9	0.0	1562.0	2833.2
	Induced	349.2	96.8	0.0	426.4	872.4
	Total	**2448.6**	**452.8**	**0.0**	**2983.8**	**5885.2**
GDP (R'million)	Direct	467.4	126.2	0.0	269.8	863.4
	Indirect	463.5	65.3	0.0	649.7	1178.5
	Induced	148.5	40.6	0.0	181.6	370.7
	Total	**1079.4**	**232.1**	**0.0**	**1101.1**	**2412.6**
Employment (Number)	Direct	4757.0	1955.0	0.0	2543.0	9255.0
	Indirect	1664.0	234.0	0.0	2332.0	4230.0
	Induced	957.0	258.0	0.0	1170.0	2385.0
	Total	**7378.0**	**2447.0**	**0.0**	**6045.0**	**15870.0**
Income (R'million)	Direct	137.4	70.3	0.0	145.9	353.6
	Indirect	201.6	28.3	0.0	282.6	512.5
	Induced	70.6	19.2	0.0	86.6	176.4
	Total	**409.6**	**117.8**	**0.0**	**515.1**	**1042.5**

Figure 4.3 illustrates the contribution of each of the main economic activities within the Sabie sub-catchment in relation to the direct macro-economic impact. The Urban-Econ calculations were based on Economic Impact Modelling, 2013.

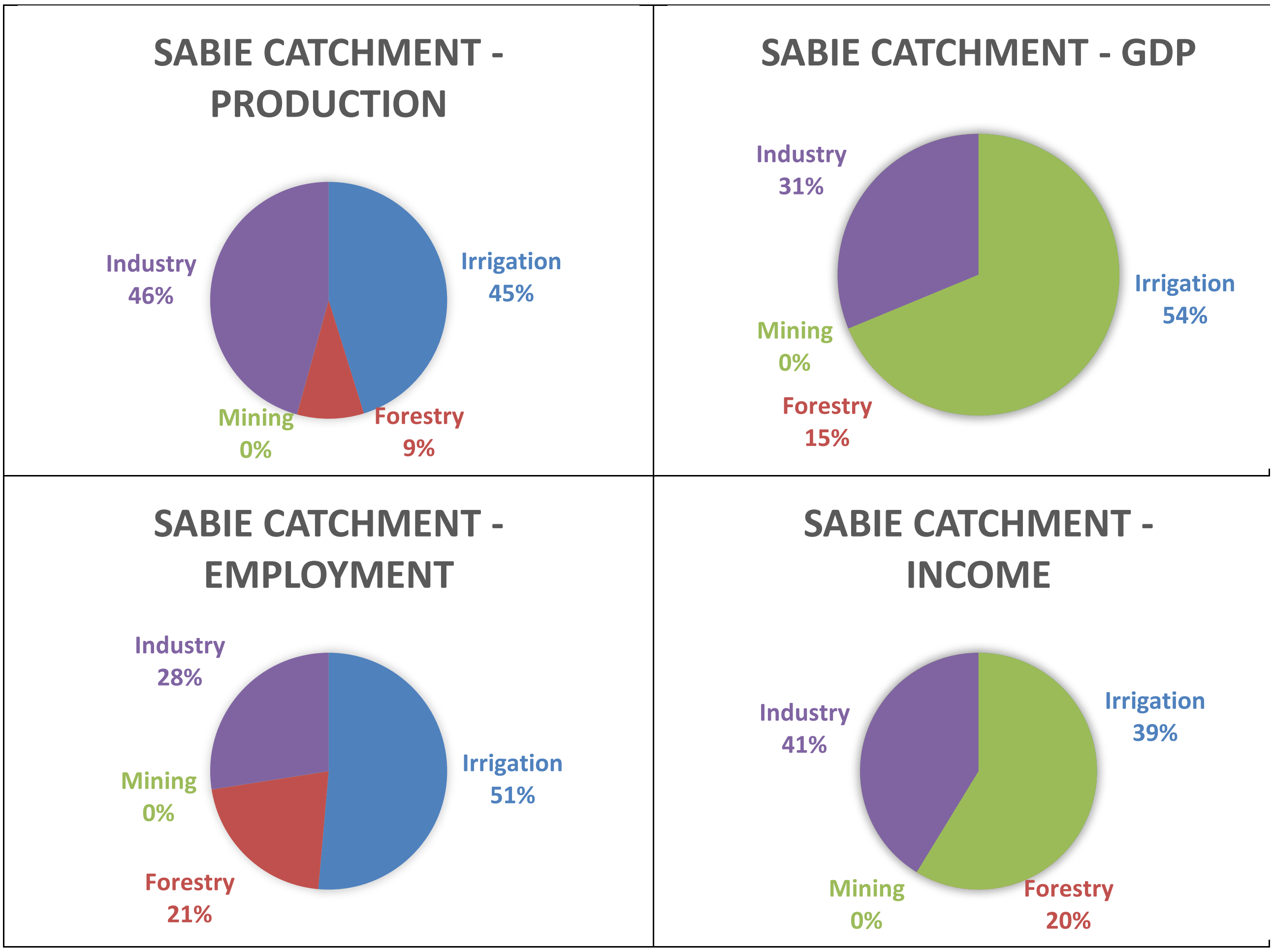

Figure 4.3 Direct Impact Contribution of the economic activities in the Sabie sub-catchment (as % of the total)

The **Sabie sub-catchment** does not have any significant mining activities. The two dominant economic activities are irrigation agriculture and industry.**Irrigation agriculture contributes 54% of total GDP in the catchment and 51% of total employment**. **Industry contributes 31% of total GDP and 28% of employment**.

4.5 ECONOMIC ZONES

The EZs for the Komati, Crocodile and Sabie river basins are provided in Figure 4.4 to Figure 4.6.

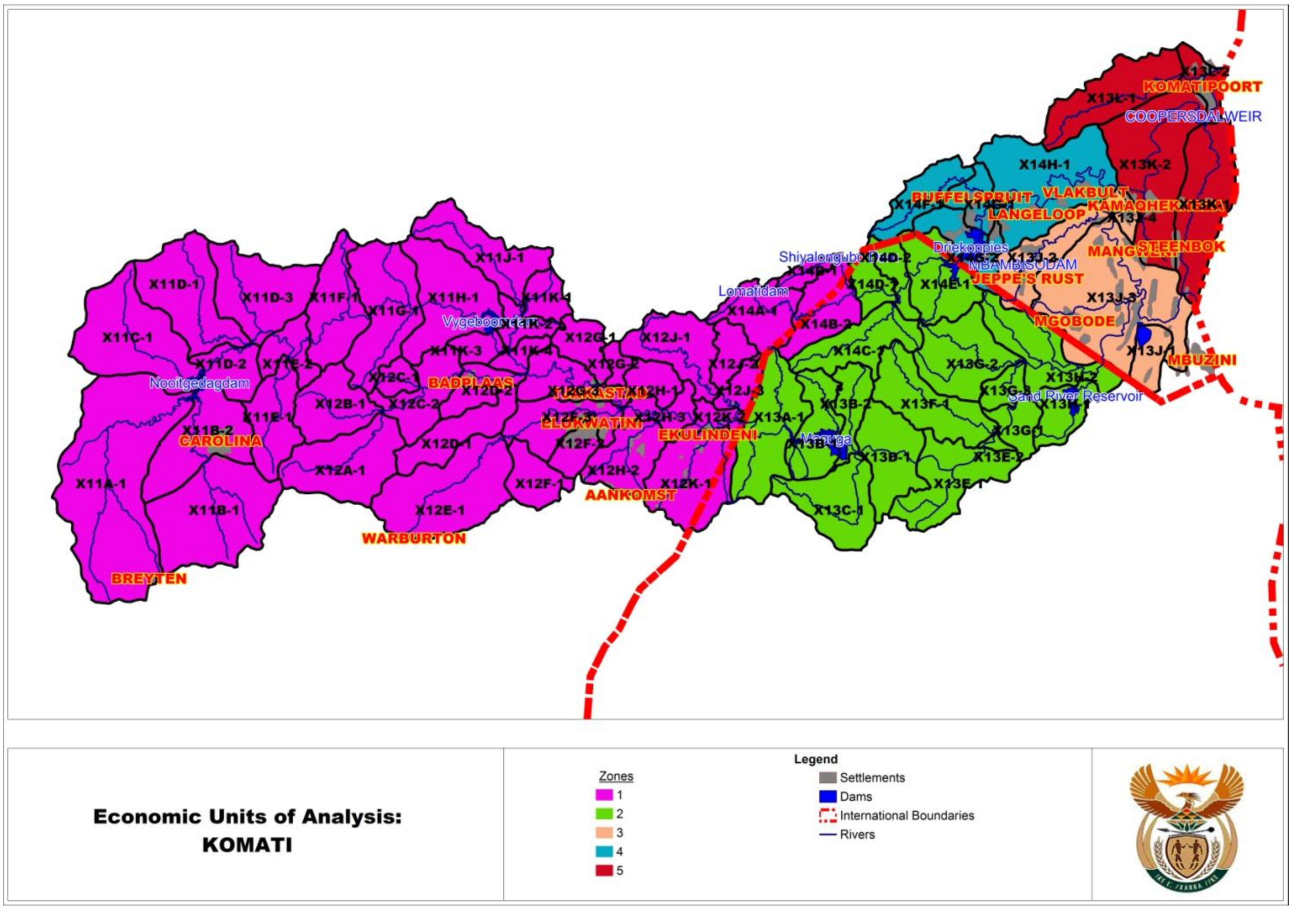

Figure 4.4 Economic Zones in the Komati River Basin

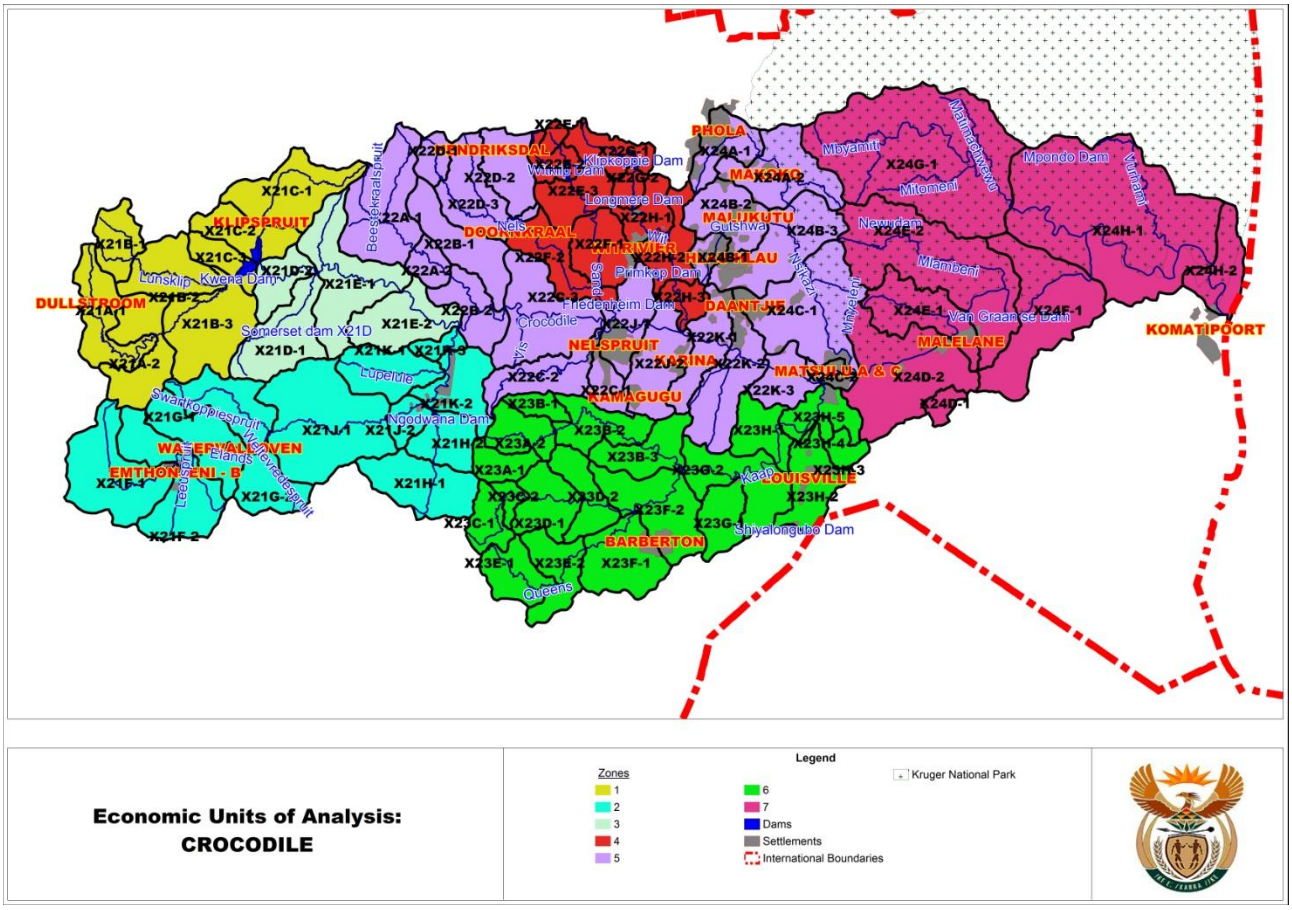

Figure 4.5 Economic Zones in the Crocodile River Basin

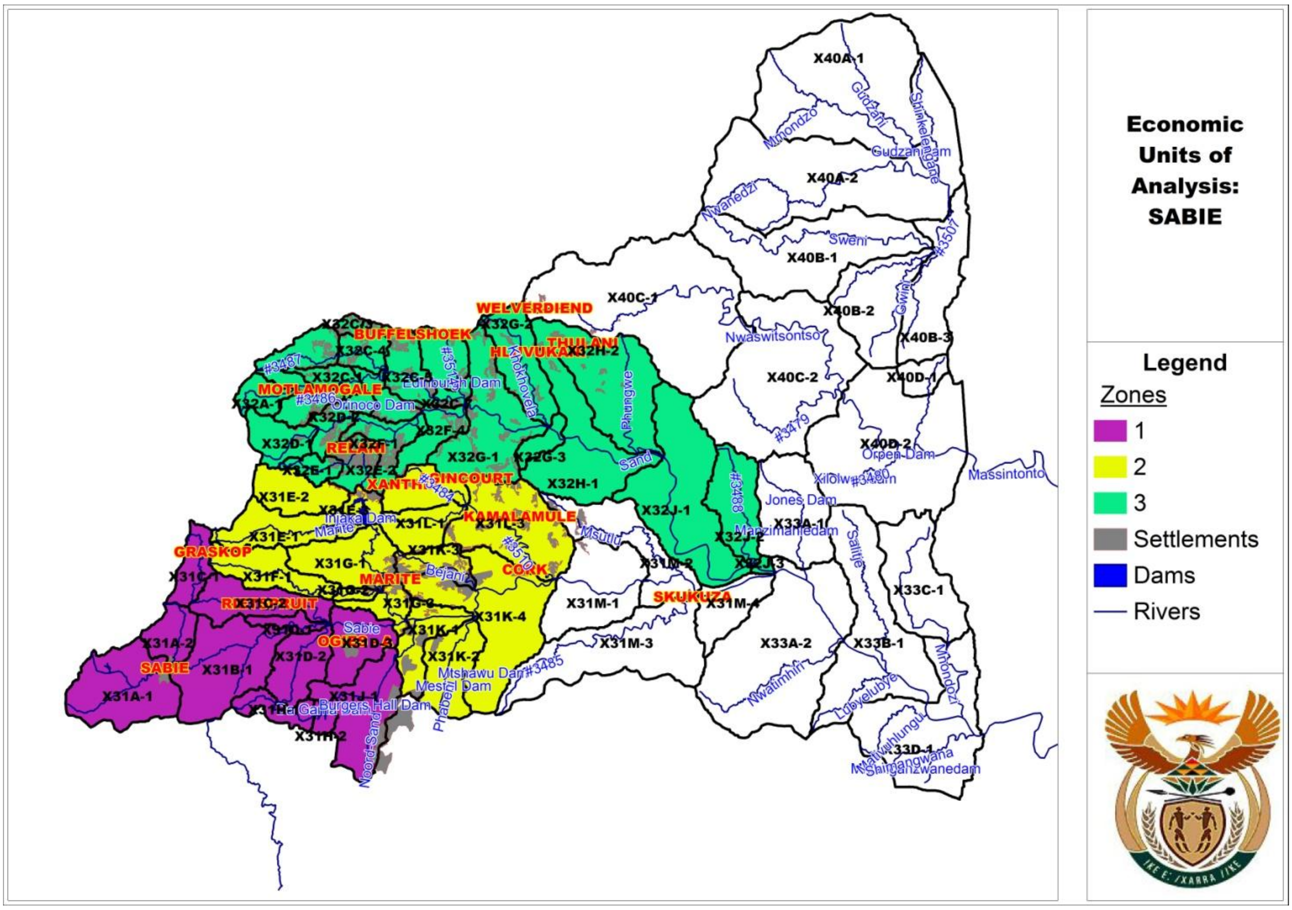

Figure 4.6 Economic Zones in the Sabie River Basin

5 STATUS QUO: WATER QUALITY

5.1 INTRODUCTION

This chapter describes the status quo of water quality in the study area and the identified hotspots.Focus is on the methods by which the water quality Status Quo was determined on a DESKTOP level, as required by the first step of the Water Resources Classification System (WRCS) process.

The approach or method taken to complete this task is shown in Section 5.2, with a general water quality overview shown in Section 5.3. Sections 5.4.1 to 5.4.3 describe water quality and identified hotspots per primary quaternary catchment, i.e. X1 through to X4 respectively. The Sabie (X3) and Sand (X4) secondary catchments are dealt with as one unit (Section 5.4.3).

5.2 APPROACH

The approach to determining the Status Quo of water quality in the study area can be summarised as follows:

- Define the study area.
- Collect land-use data – a land-use map may be used.
- Conduct an extensive literature review (but not yet data analysis at this stage), using the following types of available data:
  - Reserve data:
  - Outputs (Present Ecological State (PES) maps and fact sheets) of the national PES/EI/ES project for WMA5 (DWA, 2013e).
  - The 2012 Green Drop Report for WMA5 (DWA, 2012)
  - The water quality scores of the Water Resource Use Importance (WRUI) conducted for this study
- Identify driving forces in terms of water quality per area.
- Develop a general picture of water quality for the study area – see Section 5.3.
- Identify water quality hotspots, i.e. water quality scores of 3 - 5 according to the scoring system shown below and used in the PES/EI/ES study (DWA, 2013e):
  - Rating = 0: no impact (i.e. an A category)
  - Rating = 1: small impact (i.e. an A/B to B category)
  - Rating = 2: moderate impact (i.e. a B/C to C category)
  - Rating = 3: large impact (i.e. a C/D to D category)
  - Rating = 4: serious impact (i.e. a D/E to E category)
  - Rating = 5: critical impact (i.e. E/F to F category)

Information available on EWR studies is listed below.

- An Ecological Reserve determination was carried out for the Crocodile River in 2002. The water quality study was conducted by Claassen and colleagues (Claassen*et al*., 2002).
- A comprehensive Reserve was completed for the Komati (X1) catchment in 2006, which contained a specific water quality study (Afridev Consultants, 2006).
- A comprehensive Reserve Determination study was carried out for the Inkomati River System (WMA5) (DWA, 2010c).
- A 2009 study toward implementation and operationalization of the Reserve (DWA, 2009f), using the Komati River as pilot study area.

- A comprehensive Reserve was completed for the Crocodile (X2) and Sabie (X3) catchments in 2010 (DWA, 2010d).
- Development of the Strategy and Policy in 2009-2010 to implement the Komati River Reserve as operated by the Komati Basin Water Authority (KOBWA) (Nepid Consultants, 2009).
- A Water Research Commission (WRC) study to evaluate compliance of water quality status of the Crocodile River with the Reserve objectives set in 2010 (Palmer *et al*., 2012).

5.3 DESCRIPTION OF WATER QUALITY ISSUESIN WMA5

General land use practices that pose water quality problems within the study area include the following:

- Non-point source pollution from agriculture (pesticides, fertilizers).
- Non-point source pollution from residential areas (urban and rural townships) e.g. stormwater run-off, washing in rivers.
- Point source pollution from urban infrastructure (e.g. non-compliant wastewater treatment works, saw mills and paper and pulp mills in the X3 Sabie catchment, sugar mills and processing facilities in the X2 Crocodile catchment).
- Microbiological counts and nutrient concentrations are problematic in many catchments, as indicated by high algal growth.
- The presence of alien invasive plants, removal of vegetation and overgrazing within the riparian zone of rivers, which results in erosion and sedimentation.
- Dams are scattered throughout the catchments, which impact on the movement of sediment, and temperature and oxygen levels.
- Mining and manufacturing water quality issues were reported in a 2012 study on the Crocodile catchment (Palmer *et al*., 2012), i.e. chemicals from metal processing, such as iron and manganese; acid mine drainage; water seepage and improper closure of mine dumps.

5.4 WATER QUALITY ASSESSMENT PER SECONDARY CATCHMENT

5.4.1 Secondary catchment X1: Komati River

Background

The Komati River catchment (X1) within South Africa comprises two distinct sections: Komati West,comprising the area upstream of Swaziland, and Komati North, comprising the areadownstream of Swaziland. The main tributaries of the Komati River are the Lomati, Teespruit, Gladdespuit and Seekoeispruit.The key rivers in the sub-quaternary catchments are:
Vaalwaterspruit, Boesmanspruit, Komati, Witkloofspruit, Swartspruit, Klein-Komati, Bankspruit, Waarkraalloop, Gemakstroom, Ndubazi, Poponyane, Gladdespruit, Buffelspruit, Hlatjiwe, Phophenyane, Seekleispruit, Teespruit, Sandspruit, Motsoli, Mlondozi, Mhlangampepa, Maloloja, Nkomazana, Umlambongwenya, Mbuyane, Nyonyane, MZimnene, Mphofu, Mbulatana, Mlanghatane, Mgobode, Mzini, Mbiteni, Mambane, Nkwakwa, Ngweti, Lomati, Ugutugulo, Milambi, and Mhlambanyatsi.

The major stresses in the Komati catchment are the high water demands for ESKOM, irrigation, afforestation and industry and rapidly increasing domestic water demands.

Mining activities are an important contributor to water quality issues in secondary catchment X1. In January 2012 the raw water from Boesmanspruit Dam to Carolina town and surrounding farms, was contaminated with acid mine water seepage. After laboratory tests were done, it was discovered that water is contaminated with heavy metals such as iron, aluminium and manganese which could be traced to the mining activity in the surrounding areas (Mayoral statement, 2012) Four mines were evaluated for liability for the pollution incident, i.e. Northern Coal, Sipethe Coal, Union Colliery operated by BHP Billiton and Xstrata Msobo Coal within the Boesmanspruit sub-catchment. Two of the mines were linked to the pollution incident and issued with directives from DWA in July 2012, i.e. Northern Coal and Sipethe Coal, while the other two were still under consideration.

Water quality status quo

The water quality in the Upper Komati River is generally very good with main impacts relating to dry land farming and forestry. However, coal mining in the Upper Komati River catchment poses a very serious threat to the quality of the water that is transferred to the Eskom power stations. Coal mining activities could increase the sulphate levels in the water, which would have major implications for Eskom, and by implication to all electricity users. Coal mining has also threatened drinking water sources and water supply for agricultural activities, e.g. Carolina in 2012.

The middle Komati River catchment is generally in a moderate ecological condition, with the notable exception of the Gladdespruit River which is in a Largely Modified condition. The main impacts in the Gladdespruit relate to trout farms, gold mines, forestry, and excessive encroachment of alien vegetation. The main water quality issues are bacterial problems (cattle grazing, sewage effluent from waste water treatment works in the Seekoeispruit and lower Teespruit, runoff from poor sanitation in the area), nutrient enrichment, and some contamination from domestic washing powders (Afridev Consultants, 2006).

The lower Komati River catchment is in a poor ecological condition. The large number of weirs and associated irrigation in the lower reaches of the river has resulted in a deterioration of the water quality to such an extent that it has become enriched with nutrients and the dissolved oxygen levels become limiting to the ecology. There are extended periods of flow cessation, causedprimarily by diversion of water at Tonga Weir, which exacerbates water quality problems. The main water quality issues are nutrients (with associated benthic algal blooms) bacterial contamination, increased water temperatures and slight salinisation when the river stops flowing (Afridev Consultants, 2006).

The Komati River is therefore generally in a Good - Fair condition in terms of water quality, with a hot spot occurring at the lower Komati, down to the confluence with the Crocodile River (Afridev Consultants, 2006).

Green Drop ratings

The 2012 Mpumalanga Green Drop report for Wastewater Treatment Works (WWTW) in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings: '*Tonga WWTW on the Komati River, catchment code X13J-01130, Nkomanzi LM*[2]*:* ***Critical Risk***'.

No other High or Critical Risk WWTW listed in DWA (2012) were in the X1 secondary catchment area.

Conclusion: Water quality hotspots

The following Water Quality (WQ) hotspots have been identified in secondary catchment X1:

2Local Municipality.

1. Gladdespruit (X11K-01194): Impacts are related to a reduction in low-flows due to forestry, water quality problems due to acid mine drainage from old gold mines, sulphates and raw sewage, erosion and sedimentation, alien invasives and trout dams. **WQ RATING: 3.**
2. Komati River (X13J-01130): Sewage effluent and extensive settlements resulting in elevated nutrients. **WQ RATING: 3.**
3. Teespruit (X12E-01287):Lower reaches only due to sewage effluent resulting in elevated nutrients.**WQ RATING: 3.**
4. Boesmanspruit (X11B-01272): Four open-cast mines in the Boesmanspruit catchment have impacted on water quality in the area. **WQ RATING: 3.**
5. Seekoeispruit (X12D-01235): Number of WWTWresult in elevated nutrients and increased salination around Badplaas. **WQ RATING: 3.**
6. Lomati River (X14E-01151, X14G-01128, X14H-01066): Stretch includes Driekoppies Dam and impacts on temperature and oxygen; also elevated nutrients from irrigation return flows. **WQ RATING: 3.**
7. Middle Komati River (X13G-01282, X13H-01281, X13H-01277, X13H-01280): Irrigation return flows.**WQ RATING: 3.**
8. Lower Komati River (X13K-01114, X13J-012210, X13J-01210, X13J-01149): Irrigation return flows. **WQ RATING: 3.**
9. Lower Komati River (X13K-01114, X13J-012210, X13J-01210, X13J-01149): Irrigation return flows. **WQ RATING: 3.**
10. Lower Komati River (X13K-01038, X13L-01027, X13L-00995): Extensive agricultural activities and irrigation return flows, exacerbated by low flows. **WQ RATING: 4.**

5.4.2 Secondary catchment X2: Crocodile River

Background

The key rivers in 83 sub-quaternary catchments are:
Crocodile, Gemsbokspruit, Landslip, Alexanderspruit, Buffelskloofspruit, Leeuspruit, Dawsonsspruit, Elands, Rietvleispruit, Weltevredenspruit, Swartkoppiespruit, Ngodwana, Lupelule, Houtbosloop, Beestekraalspruit, Blystaanspuit, Houtbosloopspruit, Visspruit, Nels, Sand, Mbuzulwane, Blinkwater, Kaap, Noordkaap, Suidkaap, Nsikazi, Sithungwane, Gutshwa, Mnyeleni, Matjulu, Mlambeni, Mitomeni, Komapiti, Mbyamiti, Muhlambamadubo, and Vurhami.

The Crocodile River catchment is dominated by irrigation and forestry, with it being one of the most densely forested catchments in the country.Dry land agriculturalactivities are located primarily in the central parts of the catchment in the form of maize, subtropical fruits, nuts, citrus, coffee and vegetable cultivation.Primary irrigated agricultural crops grown include maize, citrus, tobacco, sugarcane and subtropical fruits, with sugarcane and citrus being the most important(Mbombela Water Reconciliation Strategy, 2012). The largest areas of irrigation are therefore located in the central and eastern regions of the catchment.

Industrial water use in the catchment is limited and consists mostly of the Sappi paper mill at Ngodwana and the sugar mills at Malelane and Komatipoort.The water requirements of the Ngodwana paper mill are supplied from the Ngodwana Dam, which is situated in the Elands catchment, while the water requirements of the Malelane sugar mill are abstracted from the Crocodile River.A large number of manufacturing activities are situated in and around Nelspruit and industrial development is expanding rapidly. There is also a ferro-chrome smelter at Machadodorp (Mbombela Water Reconciliation Strategy, 2012). The Kaap River sub-catchment has also been intensively mined for minerals and the impacts of these mining operations are still reflected in the water quality of streams and rivers in this sub-catchment (Heath, 1999).Urban requirements of the Crocodile sub-area are also mostly supplied from direct abstractions from the Crocodile River (DWA, 2009g).

Water requirements currently exceed the available resource, and the catchment is considered to be highly stressed, particularly considering the sub-area’s potential for economic growth (DWAF, 2004a).

Water quality status quo

The water quality in the Crocodile sub-area is generally Fair to Good although deterioration of the quality in the lower Kaap River (often high levels of arsenic) and lower Crocodile River is observed. This is due to return flows from upstream users including irrigation, urban areas and old gold mining activities, as well as wastewater treatments work, extensive sugarcane and sugar processing mills in the lower Crocodile catchment. Irrigation return seepage is noticeable during periods of low flow. The potential water quality problems emanating from the Sappi paper mill at Ngodwana is one the most serious water quality problem in the catchment. Effluent has been disposed of through irrigation for a number of years but the soil has become saturated with salts (especially chlorine) and these leach out into the Elands River and then enter the Crocodile River.

The recent Palmer *et al*. (2012) study has clearly shown a number of water quality problems in the Crocodile River catchment.A wide range of water quality issues were mentioned during structured interviews with stakeholders. The most common issue raised by participants was that of waste water treatment followed by irrigation-related pollution with specific mention being made of nitrates and phosphates. Sedimentation, as a result of erosion in the catchment, also featured significantly with manganese and iron just below that.An extract from the results are shown below:

- Regulators indicated that WWTW were problematic throughout the province and a major threat to water quality. Specific examples of non-compliance were WWTW at Komatipoort and Malelane.
- Two companies (iron/manganese processing) were identified as major contributors to iron and manganese-related water quality issues in the catchment. Effluent coming from Sappi (paper pulping/processing) was perceived to be causing sodium-related problems in the Elands River, and downstream testing revealed suspected high chlorine levels apparently from their mill that were affecting tobacco farmers.
- Citrus farmers/juice producers were identified as responsible for the discharge of hot water into the river.
- Salinization problems on sugarcane plantations were noted by stakeholders from the agricultural industry.
- Excessive use of fertilizers and poor drainage planning were identified as a problem for water quality management.

Note that although manganese and iron entering WWTW was highlighted as a major issue by stakeholders, the geology of the catchment was perceived to be a factor in the case of manganese elevations.

Green Drop ratings

The 2012 Mpumalanga Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

- Kanyamazane WWTW; Crocodile River, Mbombela LM: **Low Risk.**
- White River WWTW; Wit River, catchment code X22H-00836, Mbombela LM: **Low Risk.**

- Kingstonevale WWTW; tributary into the Crocodile River, Mbombela LM: **Low Risk.**
- Rocky Drift WWTW on the Wit River, Mbombela LM: **Low Risk.**
- Matsulu WWTW on the Crocodile River, catchment code X22K-00981, Mbombela LM: **Low Risk.**
- Malelane WWTW on the Crocodile River, catchment code X24D-00994, Nkomazi LM: **Critical Risk.**
- Mhlatikop WWTW on the Crocodile River, catchment code X24D-00994, Nkomazi LM: **High Risk.**
- Komatipoort WWTW on the Crocodile River, catchment code X24H-00934, Nkomazi LM: **Critical Risk.**
- Hectorspruit WWTW on the Crocodile River, catchment code X24F-00953, Nkomazi LM: **Critical Risk.**
- Kabokweni WWTW discharging to the Crocodile River, catchment code X22K-00981, Mbombela LM: **High Risk.**
- Machadodorp WWTW on the Elands River, catchment code X21F-01046, Emakhazeni LM: **High Risk.**
- Barberton WWTW, discharges into the Suidkaap River, Umjindi LM: **Critical Risk**according to DWA (2012), but discharge quality is stated to be reasonable according to DWA (2011b).

Belfast WWTW, Emakhazeni LM, is a **High Risk** plant, but does not impact directly on a river system.

Conclusion: Water quality hotspots

The following water quality hotspots have been identified in secondary catchment X2:

1. <u>Crocodile River (X22K-00981</u>): Extensive urban impacts from the Kanyamazane and Kabokweni area, including High Risk WWTW at Kabokweni which drains into the Crocodile River. **WQ RATING: 4.**
2. <u>Crocodile River (X24C-01033):</u>Impacts are from extensive settlements on the left bank and irrigation on the right bank. **WQ RATING: 3.**
3. <u>Crocodile River (X24D-00994):</u>Urban impacts, including extensive irrigation effluent impacting on water quality due to the Critical Risk WWTW at Malelane and the High Risk WWTW at Mhlatikop.**WQ RATING: 4.**
4. <u>Crocodile River (X24H-00880):</u> Irrigation effluent and upstream impacts. **WQ RATING: 3.**
5. <u>Crocodile River (X24H-00934):</u>Extensive irrigation effluent impacting on water quality and a Critical Risk WWTW at Komatipoort.**WQ RATING: 4.**
6. <u>Crocodile River (X24F-00953):</u>Extensive irrigation effluent impacting on water quality and a Critical Risk WWTW at Hectorspruit. **WQ RATING: 3.**
7. <u>Gutshwa River (X24B-00903)</u>: Extensive urban and rural impacts from the Kabokweni and Malekutu towns.**WQ RATING: 3.**
8. <u>Elands River (X21F-01046; around Machadodorp only):</u> Urban impacts, including the Critical Risk WWTW at Machadodorp and ferro-chrome processing. **WQ RATING: 3.**
9. <u>Noordkaap (X23B-01052):</u> Mining and water treatment impacts present. **WQ RATING: 3.**
10. <u>Kaap River (X23G-</u>01057): Mining activities and forestry in the upper catchment. **WQ RATING: 3.**
11. <u>Elands River (X21K-01035):</u> Impacts from Sappi Ngodwana directly into the Elands, and from impacts on the lower end of the Ngodwana Dam. **WQ RATING: 4.**

12. Crocodile River (X22J-00993): Urban impacts from Nelspruit. Diffuse source releases from Papas Quarry at the confluence with the Gladdespruit, is a source of increased manganese concentrations in the Crocodile River.**WQ RATING: 3.**
13. Crocodile River (X22J-00958): Urban impacts from Nelspruit. **WQ RATING: 3.**
14. Crocodile River (X22K-01018): Upstream impacts from Nelspruit, Kanyamazane and Kabokweni areas.**WQ RATING: 3.**
15. Wit River (X22H-00836): Urban impacts from White River and Kabokweni and agricultural impacts. **WQ RATING: 3.**

5.4.3 Secondary catchments X3 and X4: Sabie and Sand River

Background

The secondary catchment, X3**,** encompasses the Sabie and Sand sub-catchments. It is comprised of the quaternary catchments X31A – M, X32A – J, and X33A – D, as well as X40A - D. The key rivers in 68 sub-quaternary catchments are:
Sabie, Klein Sabie, Goudstroom, Mac-Mac, Sabani, Marite, Motitsi, White Waters, Noord-Sand, Bejani, Phabeni, Matsavana, Saringwa, Musutlu, Nwaswitshaka, Tlulandziteka, Motlamogatsana, Nwandlamuhari, Mphyanyana, Mutlumuvi, Nwarhele, Ndlobesuthu, Khokhovela, Phungwe, Sand, Nwatindlopfu, Nwatimhiri, Salitje, Lubyelubye, Mnondozi, Mosehla, Nhlowa andShimangwana.

The two inter-linked secondary catchments of X3 and X4 extend across the Ehlanzeni District Municipality, including the Bushbuckridge, ThabaChweu, Mbombela and Nkomazi local municipalities. A large portion of the Sabie River catchment is located within the KNP.

Various land use activities and water uses occur in the catchment areas along the Sabie River, which affects water quality. Predominant land uses in the Sabie sub-catchment are irrigation and forestry, as well as conservation within the KNP and other private nature reserves. Semi-urban and rural land uses are increasing, which also places a demand on water resources and affects surface water quality. Major impoundments include Inyaka Dam on the Marite River (X31E-00647), and the Maritsana (X31E) and Da Gama dams (X31H).

Commercial forestry plantations of exotic trees, especially *Pinus* and *Eucalyptus* species, occur within the upper catchment. Bananas, avocados, citrus, paw paws and vegetables are the major irrigation crops, cultivated mainly in the lower catchment (Chunnett, Fourie and Partners, 1990).Saw mills are located in the Klein Sabie River area. Sawdust mills impact on water quality during rain events by increasing acidity as a result of cresols and phenols that leach out of sawdust (ICMA, Unknown). Pulp and paper mills occur within the catchment, which contribute to water quality deterioration through irrigation wastewater. According to the DWA State of Rivers Report, run-off from sawmills discharge into the Sabie River (within EcoRegion 5.05), which also increases acidity (DWAF, 2002). Limited mining occurs around Sabie and Graskop (Zokufa, 2001).

In the upper catchment, sewage discharge lowers water quality, for example around Sabie, Graskop and Kiepersol.

Water quality status quo

Surface water quality in the Sabie River catchment is Good. Return flows are limited, and originate primarily from irrigation. Inyaka Dam provides substantial assimilative capacity to maintain good water quality in the Sabie River. Water quality monitoring over a ten year period by Weeks *et al*. (1996) demonstrated that surface water was suitable for domestic consumption, irrigation and livestock at the time. The Sabie River has been shown to be the least mineralized of all the rivers in the KNP (Van Veelen, 1991). These factors, coupled with observed low Total Dissolved Solids (TDS) concentrations, make this a stable but sensitive system (DWA, 2009g).

The **Sand River catchment** is a relatively dry catchment with limited waterresources but a large semi-urban population. The water requirements in thecatchment are mostly for domestic use and irrigation. The water resources of thecatchment are not sufficient to meet requirements (DWAF, 2004a). The surface water quality in the Sand River sub-catchment is not as good as in the Sabie River sub-catchment due to over-abstraction which reduces the natural assimilative capacity of the river. Occasional elevated levels of nutrients in the Sand River are noted, with informal housing developments a suspected cause. The large number of rural settlements which rely on pit latrines is cause for concern.

Green Drop ratings

The 2012 Mpumalanga Green Drop report for WWTW in the study area that potentially impact on rivers (DWA, 2012), showed the following wastewater risk ratings:

- Mkhuhlu WWTW; Bejani River, catchment code X31K-00713, Bushbuckridge LM: **High Risk.**
- Maviljan WWTW north of Inyaka Dam and near the Marite River, catchment code X31G-00728, Bushbuckridge LM: **High Risk.**
- Graskop and Sabie WWTW, ThabaChweu LM: **Low Risk.**
- Hazyview WWTW; Sabie River, catchment code X31D-00755, Mbombela LM: **Medium Risk.**
- Acornhoek WWTW on a tributary of the Marite River, Bushbuckridge LM: **Medium Risk.**
- Hoxane WWTW; Sabie River, catchment code X31K-00750, Bushbuckridge LM: **Low Risk** (introduction of hazardous microbial organisms into the river reported).
- Manghwazi WWTW on a tributary of the Sabie River, Bushbuckridge LM: **Medium Risk.**

No data was acquired for the Bushbuckridge College WWTWs.

Conclusion: Water quality hotspots

The following water quality hotspots have been identified in secondary catchment X3:

1. <u>A tributary into the Sabie River (X31K-00752):</u> Effluent discharge from the Manghwazi WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system.**WQ RATING: 3.**
2. <u>Sabie River (X31D-00755):</u> Hazyview WWTW. In addition, vegetation removal is high and irrigation is extensive within this catchment, with moderate irrigation effluent impacting on water quality. **WQ RATING: 3.**
3. <u>Ndlobesuthu (X32E-00639):</u> Urban run-off, effluent discharge and vegetation removal represent predominant and critical impacts. Sedimentation and erosion is serious. Indirect impacts are probably high turbidity and nutrient levels, the latter indicated by elevated algal growth. **WQ RATING: 4.**
4. <u>A tributary - Klein Sand River/Acornhoek (into Marite River:X31E-00647)</u>: Effluent discharge from the Acornhoek WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system. According to the DWA State of Rivers report, conditions are poor in the Klein Sand River, due to clearing of riparian vegetation and resultant erosion, coupled with alien plant infestation (DWAF, 2002). **WQ RATING: 3.**
5. <u>Marite River (X31E-00647):</u> Urban run-off and effluent from urban areas are the predominant water quality related impacts, along with extensive afforestation, vegetation removal and erosion, which most likely results in high turbidity levels and nutrient concentrations. **WQ RATING: 3.**

6. Marite River (X31G-00728): High algal growth is evident probably due to high nutrient inputs from irrigation run-off and agriculture. Erosion, alien vegetation, vegetation removal are also evident, with small impacts relating to urban run-off/effluent, sedimentation, and overgrazing. Indirect impacts are probably high turbidity and nutrient levels. According to the Inkomati Reserve Study (DWA, 2009g), increased suspended solids loads, elevated nutrients and toxics, as well as temperature and oxygen fluctuations at low flows occur. This is due to extensive citrus cultivation in the area and clearing for subsistence farming. The diatom *A. minutissimum* indicates anthropogenic disturbances and the presence of diffuse pollutants (upstream citrus farming) (EWR 5). According to the PES Fact Sheets irrigation run-off is moderate, which may result in pesticide and fertilizers discharging into the river. **WQ RATING: 4.**
7. Noord-Sand (X31J-00774):High algal growth is evident probably due to urban and irrigation run-off/effluent. Extensive vegetation removal and moderate afforestation probably results in high turbidity levels. Moderate impacts associated with erosion, alien vegetation, overgrazing and irrigation effluent are also evident. Indirect impacts are probably high turbidity and nutrient levels.**WQ RATING: 3.**
8. Noord-Sand (X31J-00835): Urban run-off and effluent from urban areas are the predominant impacts, with moderate levels of algal growth being the likely result of effluent discharges. Alien vegetation, overgrazing and irrigation effluent are also evident. Indirect impacts are probably high turbidity and nutrient levels.**WQ RATING: 3.**
9. Bejani (X31K-00713): Urban run-off, effluent discharge (i.e. Mkhuhlu WWTW) and vegetation removal represent serious impacts. Sedimentation and algal growth is high, with moderate erosion impacts. Indirect impacts are probably high turbidity and nutrient levels, especially since algal levels are high, as well as hazardous microbiological organisms.**WQ RATING: 3.**
10. A tributary that flows into Inyaka Dam, proximate to Marite River (X31G-00728): Effluent discharge from the Maviljan WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system.**WQ RATING: 3.**
11. Tlulandziteka (X32A-00583):The Reserve study of 2010 indicated a C category for this river, with elevated nutrients, turbidity and toxics present. Impacts on temperature and oxygen were also seen due to fluctuating flows.**WQ RATING: 3.**

PES data for the **X4 Sand catchment** area shows that there is no impact on water quality in most sub quaternary catchments, apart from Nwaswitsontso (X40C-00513), where there is a small impact. This is due to the fact that the X4 catchment is largely near natural, with limited disturbance.

There are therefore no water quality hotspots within the X4 Sand sub-catchment area.

5.5 CONCLUSION

Although future growth in the population is expected to be moderate and to be concentrated in the urban areas, with a decline in some rural areas (DWAF, 2004a), this growth will result in deteriorating water quality conditions if not associated with adequate sanitation facilities properly managed.

6 STATUS QUO: ECOSYSTEM SERVICES

6.1 INTRODUCTION

The study area is located in a region that is both rural in nature but with a number of high density settlements that are associated with the former homeland areas as well as and smaller satellite towns and rural settlements. As indicated the Inkomati WMA is wholly within South Africa. However, it forms a part of the InkomatiInternational River Basin which is shared between the Republic of Mozambique, the Kingdom of Swaziland and the Republic of South Africa. All the rivers in the Inkomati WMA flow through Mozambique to the Indian Ocean.Within the WMA three District Municipalities (DMs), Ehlanzeni, Gert Sibande, and Nkangala have portions of their areas of jurisdiction.

The Ehlanzeni DM includes:

- Bushbuckridge (Acornhoek, Bushbuckridge, Tulamahashe.
- Mbombela (Barberton, Hazeyview, Kabokweni, KaNyamazane, Nelspruit, Ngodwana, White River and other Communities in Southern Nsikazi).
- Nkomazi (Hectorspruit, Komatipoort, Malelane, Mazibikela, Tonga).
- ThabaChweu (Sabie and Graskop).
- Umjindi (Barberton).

The Gert Sibande DM includes:

- Albert Luthuli (Badplaas, Carolina, Elukwatini, Ekulindeni).
- Msukaligwa (Breyten).
- Steve Tshwete.

The Nkangala DM includes:

- Highlands (Dullstroom, Machadodorp, Waterval-Boven).

The Inkomati WMA has many commercial farmers as well a significant number of previously disadvantaged and emerging farmers. Approximately 9% of the WMA is within tribal area boundaries. Approximately 37% of the land area of the Inkomati WMA is covered by Nature Reserves. These include the KNP, Sabie Sand Game Reserve Complex and other Reserves under the management of the Mpumalanga Tourism and Parks Agency.

Agriculture is the most significant land use in terms of both geographical spread and in terms of water use. There are also significant urban, rural and industrial users in the catchment. Extensive afforestation is a feature of the catchment. The estimated current area of forestry in the WMA (including Swaziland) is 4000 km^2, which is 14% of the total WMA area. The Inkomati WMA has among the most numerous and largest Land Claims in the Country. Land reform, under the control of the Department of Land Affairs, will significantly impact the transformation of water users. Mining is also significant as a contributor to the overall economy.

The population estimate for the WMA is approximately 2350000 people or about 4.5% of the total South African population. It is estimated, based on the 2011 Census (Census, 2011) that approximately 67% of the population are living in the rural areas. Many of the settlements in the WMA that are classified as rural are being upgraded through the provision of services, and it might now be more appropriate to classify much of the population in these settlements as urban rather than rural.The term “peri urban” or “closer settlement”, is sometimes used.

High population densities occur in most of the former “homelands”, especially Bushbuckridge, which has amongst the highest population density in the country. The age distribution of the area reflects a young population, which is typical of a developing area. More than one-third (35.2%) of the population is aged younger than 15 years while 5.5% are 60 years or older.

Based on the status quo analysis the catchment has been divided into zones that reflect the ecological goods and services attributes as a direct dependent of land use.

6.2 APPROACH

The present-day status of the whole catchment is described, based on the economic and social importance assessed from a literature review as well as mapping information. The objective of describing communities and their well-being is to provide the baseline against which to estimate changes in social wellbeing for each of the catchment scenarios evaluated. 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 region, and to qualitatively estimate the value generated by that use. This will provide the baseline against which the implications of different scenarios can be compared.

It is important to point out that while Ecosystem Services was 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 Ecosystem Services values relative to a reference point rather than computing a baseline value. As such values with importance of Ecosystem Services is analysed in this step and the value will be attached as an output of later project tasks.This approach is largely informed by the Millennium Assessment.

The Millennium Assessment primarily focuses on the interaction between dependence on ecosystems, and how changes in ecosystem services have affected human well-being and will continue to impact people. The concept is developed around notions of dealing with vulnerability and poverty and promoting sustainability in the face of development challenges. The approach adopted for the Inkomati is informed by both the Millennium assessment as well as International Finance Corporation (IFC) Performance Standard 6 that give guidance on management of ecosystem services. As such the approach is a risk based rather than quantitative approach that seeks to:

- Provide a clear picture of the current state of ecosystems in the area.
- Provide an understanding of the relationship and linkages between ecosystems and human well-being, including economic, social and cultural aspirations in the Inkomati area.
- Acknowledge the potential of ecosystems to contribute to poverty reduction and enhanced well-being.
- Assess scenarios with respect to vulnerability and poverty impacts.

The approach being adopted is thus consistent with the objectives of both the Millennium Assessment and the IFC and is specifically developed to accommodate risk analysis and enhance decisionmaking.

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 three primary tools. These were:

- The 2011 census data that is available.
- 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 Ecosystem Services 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.

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 era. They include area associated with the former homeland system.

Further, each quaternary catchment of the Inkomati 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 Ecosystem Services 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 Ecosystem Services.

6.3 DESCRIPTION OF ECOSYSTEM SERVICES

For the purposes of this catchment five different land use forms that reflect types of ecological goods and services that might be associated with the usage have been identified. The land use based zones are:

- Recreation and Game Parks: Here the usage is largely recreational linked to the aesthetic appeal. The KNP and adjacent game parks make up the bulk of these zones.
- Commercial Agriculture and Forestry 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/tribal 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. Bushbuckridge is a typical example.
- High Density Formal Urban: These are the SQs heavily influenced by the formal towns such as Nelspruit, Hazyview, Sabie, and Malelane and the surrounding suburbs and satellite townships. 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.

The most important Ecosystem Services 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 including usage of plants for medicinal purposes.
- 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 KNP and other associated features.
- Dis-benefits associated with malaria, bilharzia, black fly and livestock disease.

6.4 STATUS QUO ASSESSMENT

Table 6.1 Criteria for the determination of Ecosystem Services zones

Criteria	Variables
Urban / Rural Setting	Urban and rural areas as defined by Census (2011).
Land-Use	Land-use as defined by overview analysis of mapping combined with GIS and Google earth images as well as analysis of topographic mapping.
Land-Tenure	Land tenure as determined by mapping of boundaries of areas with freehold title as opposed to those made up of tribal areas.
Water and Aquatic Resources	Analysis provided by project team members as to the status of water and aquatic resources per Sub Quaternary (SQ).
Tertiary catchments	Tertiary catchments as defined by watershed/catchment spatial data.

The definition of the zones was undertaken using spatial data that reflects the criteria provided in Table 6.1, employing ArcMap 9. This included the establishment of separate layers for each criterion that depicted key variables. The definition of socio-econmic zones was undertaken via a qualitative assessment of the above criteria, and no formal classification was adopted.

The study identified areas and communities that are significantly dependent on Ecosystem Services provided by the natural resource. The level of dependence can be determined based on the general principle that vulnerable communities will have limited access to formal resources and thus are more likely to be dependent on local natural resources.

An index or set of criteria was established to determine which areas and communities may be considered vulnerable and dependant on Ecosystem Services. For each criterion, a number of variables or thresholds were determined to permit the identification of specific areas/communities via spatial mapping. The criteria and thresholds are defined inTable 6.2.

Table 6.2 Criteria for the determination of priority communities with high Ecosystem Services dependence

Criteria	Variables/Indicator	Rationale
Rural Areas/Communities	Rural areas as defined by Census 2011.	Service delivery in rural areas is usually restricted and poorer communities are likely to be dependent on natural resources.
	Population density of less than 500 people per km^2.	Population density as a determinant of urban/rural environment, with variable as defined by Statistics SA.
	Tribal Authority Land as defined in Census 2011.	Tribal Authority lands is typically rural and historically has seen little investment in formal infrastructure, there communities are likely to be dependent on natural resources.
Water Supply	Where water supply to a significant percentage of local population (greater than 33%) is provided by natural resources. Census 2011 water supply criteria functions of key variables specifically (1) boreholes, (2) spring, (3) dam/pool/stagnant water, (4) river/stream, (5) water vendor and (6) other.	The lack of formal water infrastructure restricts local communities to source water from natural sources.
Sanitation	Majority of local population dependant on (1) pit latrines, (2) bucket latrine or none (as defined by Census 2011).	Limited formal sanitation is provided to a significant percentage of the local population, which are therefore reliant on natural resources.
Economic Development	1. Poverty Lines. 2. Income Levels. 3. Economic Growth.	Areas or communities where a significant proportion of the population (greater than 33%) are below the poverty line.
Subsistence	1. Areas or communities where subsistence agriculture is the primary land-use.	Areas or communities that are largely dependent on subsistence agriculture will likely be dependent on natural resources, with limited access to formal infrastructure.
Recreation / Tourism	1. Popular fishing and recreational areas. 2. Tourism hot-spots. 3. Recreational hot-spots.	Aquatic resources provide for recreational and tourism activities, specifically around fishing, water based recreational activities, and aesthetic value.
Infrastructure Delivery	Developed urban, freehold rural or communal tenure rural/closer settlement.	Where service delivery is well developed there is less likelihood of critical dependencies on Ecosystem Service, although this needs to be analysed with caution.
Land Tenure	Communal or Freehold title.	Communal tenure is more likely to be associated with the types of community dependencies of Ecosystem Services for livelihoods.

Criteria	Variables/Indicator	Rationale
Community Health	Health indicators including malnutrition, infectious diseases, waterborne diseases and water quality related diseases.	Health status is a proxy determinant of the overall access and quality of ecosystem services due to its impacts on community heath.

Census 2011 spatial data formed the basis for the classification of criteria and variables defined in Table 6.1 as it is the only data source with sufficient coverage of the WMA. The minimum level adopted for this study was determined by Census 2011 as the sub-place.

The identification of areas and communities was undertaken via a spatial mapping using ArcMap 9. This entails the generation of spatial layers for each of the criterion noted in Table 6.2. Priority areas and communities were determined using a combination and qualitative analysis and simple weighted factor analysis. The former is better suited on the identification of areas/communities based on expert judgement, while the latter allows for the determination of degrees of vulnerability of each area/community. Further analysis of the catchment per SQ generated an overview of the overall condition that pertains and likely significance of dependence on Ecosystem Services. Criteria as per Table 6.1 were summarised in a single score entitled resource dependence and linked to overall socio-cultural importance assessment of the SQ. The score used was between 0 (no resource dependence significance) and 5 (extreme dependence of significant communities on riverine Ecosystem Services). Table 6.3below sets out the SQs that have high scores (4) or very high scores (5).

For the most part areas with high resource dependence and associated Ecosystem Services utilisation by communities are in areas that were contained within the former homelands. Typically fertile areas with higher rainfall were settled by colonial famers in the 19th century. These have more or less remained in the hands of commercial farming enterprises and although not as well developed in terms of services as some of the urban areas at least reflect a degree of rural economic cohesion. Typically those areas demarcated as “tribal” or “homeland” areas were not as effectively developed and, following the dictates of apartheid planning, regarded as home to the more marginalised sectors of society.Very high population densities in these areas have however dramatically compromised the sustainability of many resources that would have been corner stones of livelihoods.

Table 6.3 SQs with high Ecosystem Services dependence

SQ number	River	Summary of Status Quo and linked Ecosystem Services Importance
X13B-01347		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X13B-01348		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X14C-01212	Phophonyane	Upper reaches (upper 50%) comprised solely of commercial agriculture (sugar cane) with no presence of human habitation. River extends past the Piggs peak area so elevated tourism/recreational value. Lower reaches (lower 50%) extends into the Komati township which has extensive rural homestead and informal agriculture along the river. High social value.
X14C-01203	Phophonyane	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river. High social value.
X14D-01174	Lomati	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river. High social value.
X14E-01172	Mlilambi	The upper reaches of the river section is located in Swaziland, and an area comprised of scattered rural homesteads, informal agricultural plots and open terrain. The lower reaches of the river extends into an area of higher population density (linked to the Hlohlo township) and extensive informal subsistence farm plots. Social value is high.
X13B-01270	Umlambongwe	Upper reaches of the river section extends through plantation forestry, and a large farm

SQ number	River	Summary of Status Quo and linked Ecosystem Services Importance
	nya	dam. The river then passes the rural village of Ndzingeni (which contains both households and industrial features). The lower half of the river section extends through a mosaic of rural homesteads with informal agriculture, open terrain. Social value is moderate to high.
X13C-01364	Mbuyane	The river section headwaters are located in Malolotja Nature Reserve in Swaziland. Much of the river extent is, however, a mosaic of rural homesteads, informal agriculture and open terrain. Social value is considered to be high.
X13D-01323	Komati	Much of the river extent is a mosaic of rural homesteads, informal agriculture and open terrain. Formal small-holdings noted. Social value is considered to be moderate to high.
X13E-01389	Nyonyane	River section extends largely through a mosaic of open terrain and formal smallholdings (small-scale agriculture). Rural homesteads noted but not extensive. Social value is moderate.
X13E-01346	Komati	Upper reaches of the river section comprised of open terrain. Mid-reaches extend north of a large rural settlement of Bhalekane and extensive informal agricultural fields. Commercial agriculture also present on the lower reaches. Social value Is high.
X13F-01252	Mzimnene	Upper portions of the river section comprised of plantation forestry. Upper and mid-section of the river extend through a mosaic of open terrain, and rural homestead with extensive informal agriculture. Lower reaches extend into moderate density township (Bhalekane) with commercial agriculture on the river banks. Social value is considered to be high.
X13G-01261	Mphofu	Upper reaches of the river extends through a mosaic of plantation forestry and natural forests. Lower reaches extend through rural settlement (low density homesteads) with extensive informal agricultural plots.
X13G-01216	Mbulatana	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high. Social value is considered to be moderate to high.
X13G-01259	Mphofu	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high. Social value is considered to be moderate to high.
X13G-01282	Komati	River section is flanked on both banks by extensive commercial agriculture.Beyond the agricultural fields, are extensive rural settlements (low-density homestead) which flank the river in certain areas.Social value is considered to be moderate to high.
X13H-01197	Mhlangatane	River section extends through a mosaic of low-density, rural homesteads with extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river. Social value is considered to be high.
X13H-01226		River section extends through a mosaic of low-density, rural homesteads with extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river. Social value is considered to be high.
X13H-01299		Upper reaches of the river section extends through rural settlements (rural homesteads) and extensive informal agricultural fields. Mid-reaches of the river section extend into open terrain/natural terrain with no human presence before discharging into the Sand River Reservoir. Lower reaches extend below the dam wall and cross commercial agricultural land. Social value is considered to be high.
X13H-01281	Komati	Small section of river which extends through commercial agricultural land, with rural homesteads found on the north bank. Social value is considered high.
X13J-01214	Mgobode	River section extends through open terrain and informal agricultural plots, of which the plots are linked to the MgodobeTownship located further down the river. The mid-reaches of the river extend through open terrain. The lower reaches of the river extend through the Madadeni Township, with some informal agricultural plots noted. Social value is considered to be moderate to high.
X13J-01141	Mzinti	River section is extends through extensive informal agricultural plots on it upper reaches, which are linked to the large Magogeni township located further down the river. The river extends through two additional large townships (Skoonplaas and Boschfontein). The lower reaches of the river include open terrain and an additional township (Mzinti). Social value is considered to be moderate to high.
X13K-01068	Nkwakwa	River section extends through a mosaic of open terrain, rural townships and limited informal agricultural plots. Lower-reaches of the river extend through commercial agriculture. Social value is considered to be moderate to high
X14E-01151	Lomati	The river section is located in Swaziland and extends through extensive commercial agriculture (sugar cane). The river extends into the Hlohlo township before discharging into the Driekoppies Dam in South Africa. Social value is considered to be high.
X24A-00826	Nsikazi	Upper reaches of the river section extends through Legogote Township and Manzini. Mid-reaches are comprised of open terrain and passes the Makoko Township.
X24C-00978	Nsikazi	Upper reaches of the river section passes the Ehlanzeni township, and then extends

SQ number	River	Summary of Status Quo and linked Ecosystem Services Importance
		through open/natural terrain, associated with a nature reserve. Lower reaches of the river passes the Matsulu township.
X31K-00713	Bejani	River extends through open terrain. Marongwana township located on the north bank on the upper reaches of the river. Much of the mid and lower-reaches extend through extensive rural townships.
X31M-00673	Musutlu	River extends through open terrain. Three large townships located on the banks of the river.
X32E-00629	Nwarhele	Upper section low population density some forestry then very dense settlement of Shatale and Dwarsloop.
X32E-00639	Ndlobesuthu	Short river section with very dense settlement of Marijane and Dwarsloop.

6.5 ECOSYSTEM SERVICES ZONES

Based on the status quo analysis the catchment has been divided into zones that reflect the Ecological Goods and Services Attributes (EGSA) as a direct dependent of land use attributed. For the purposes of this catchment five different land use forms that reflect types of ecological goods and services that might be associated with the usage have been identified. It should be noted that as the building block for the analysis of 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 as described in Section 6.3 above.

7 STATUS QUO: ECOLOGICAL WETLAND STATE

7.1 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. The assessment was conducted as a desktop exercise and made use of the Komati Wetland Scoping report (DWAF, 2005b), the Inkomati system wetlands report (DWA, 2010e), the National Freshwater Ecosystem Priority Areas (NFEPA) wetland classification and importance coverages, (Nel *et al.*, 2011) and the Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) work that was done for the Inkomati system (Kotze *et al.*, 2012).

7.2 APPROACH

Quaternary catchments within the X1, X2, X3 and X4 secondary catchments were assessed for potential wetland importance (Appendix C – Section 16.1) by combining the frequency of different wetland types (NFEPA classification of types) and the total extent of all wetland types (area) within each quaternary, and scoring the result 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 FEPAs (the final wetland FEPAs selected by review) as well as Ramsar sites was also considered for the scoring. Only wetlands classified as "natural" were used for the analysis.

The results were used together with a similar analysis at the sub-quaternary scale, to highlight a subset of SQs that warrant an assessment of PES, EI and ES for the wetland component within the respective SQ (Appendix C – Section 16.2). All SQs that achieved a score of 3 (potential wetland importance due to frequency of wetland occurrences in SQ) or contained a FEPA wetland were then assessed for PES, EI and ES. The PES, EI and ES was calculated using data from previous work (Kotze *et al.*, 2013),excluding riparian species, and PES was verified (or changed where necessary) using Google Earth Pro ©.

7.2.1 Sub quaternary catchment-scale desktop EI and ES wetland assessment

Data from the fact sheets and plant species lists of previous work (Kotze *et al.*, 2013)were used to calculate the general EI and ES of wetlands that occurred within, or were associated with each of the SQ (Appendix C - 16.1). When using vegetation species lists riparian species were excluded from the analysis.Crane data from the NFEPA database were used (Nel *et al.*, 2011). All criteria were rated from 1 (low) to 5 (very high) and the median score was converted to and importance or sensitivity score using to rule.

=IF(A1=0,"",IF(A1<1,"Very low",IF(A1<2,"Low",IF(A1<3,"Moderate",IF(A1<4,"High",IF(A1<5.1,
"Very High",""))))))

where A1 is the median of all criteria that were assessed.

Table 7.1 The list of criteria used to derive the sub-quaternary scale EIand ES scores for wetlands

Ecological Importance and Sensitivity criteria
Diversity of wetland types.
Density of wetlands.
Unique wetlands (size; type etc.).
Wetland species richness.
Importance of conservation & natural areas.
Migration route/ corridor or links to other systems / wetlands.
Rare/endangered/unique plant populations / species (International Union for Conservation of Nature (IUCN) listings).
Sensitivity to upstream flow changes.
Potential for wetland to be crane habitat.

7.2.2 Sub quaternary catchment-scale desktop PES wetland assessment

Data from the fact sheets of previous PES-EI-ES work (DWA, 2013e) were used to score various criteria (Table 7.2), the median of which was used to calculate a PES score using to rule

=IF(A1<0.3,"A",IF(A1<0.7,"A/B",IF(A1<1.3,"B",IF(A1<1.7,"B/C",IF(A1<2.3,"C",IF(A1<2.7,"C/D",IF(A1<3.3,"D",IF(A1<3.7,"D/E",IF(A1<4.3,"E",IF(A1<4.7,"E/F",IF(A1<5.1,"F","")))))))))))

where A1 is the median of all criteria that were assessed (Table 7.2). All PES scores were also verified using Google Earth Pro ©.

Table 7.2 Criteria (potential impacts) assessed for the desktop wetland PES assessment

Present Ecological State criteria
Afforestation / Invasive plants
Dams, irrigation, other flow reduction activities
Extent of Urbanisation / catchment hardening
Landuse activities (mining, agriculture, over grazing)
Flow Modification
Erosion of wetlands
Sedimentation
Potential Physico-chemical Mod Activities
Bed and Channel disturbance
Vegetation Removal

7.3 RESULTS

7.3.1 Wetlands Ecological Importance and Sensitivity

The integrated ecological importance and sensitivity is shown for the Inkomati system Appendix C – Section 16.3.

7.3.2 Wetlands Present Ecological State

The preliminary scores for wetland PES in each SQ are shown in Appendix C – Section 16.4. These are automated scores based on a summary of all the scores in the fact sheets of the PES-EI=ES study and are therefore not necessarily wetland specific. The assumption however is that the impacts that exist within the SQ will also be affecting any wetlands at present. PES scores were verified using Google Earth Pro © for only those SQs that were important, sensitive or contributed to hotspots. These final wetland PES scores are shown in Table 7.3, along with the main impacts that result in the PES score.

Table 7.3 Final wetland PES scores after verification using Google Earth Pro ©.

SQ reach code	SQ name	Median	PES	Primary PES Driver
X11A-01248	Vaalwaterspruit	2	C	Flow modification and landuse activities.
X11A-01354		2	C	Flow reduction and landuse activities.
X11B-01272	Boesmanspruit	2	C	Landuse activities.
X11C-01147	Witkloofspruit	2	C	Flow modification.
X11D-01129	Klein-Komati	2	C	Flow reduction activities.
X11E-01237	Swartspruit	1.5	B/C	Landuse activities, water quality.
X11G-01143	Gemakstroom	1.5	B/C	Flow. Non-flow and water quality aspects.
X11H-01140	Komati	2	C	Flow modification and overgrazing.
X11K-01194	Gladdespruit	1.5	B/C	Landuse activities.
X12A-01305	Buffelspruit	1.5	B/C	Forestry and Invasive vegetation.
X12C-01271	Buffelspruit	1	B	Landuse activities, overgrazing.
X12D-01235	Seekoeispruit	2	C	Urbanisation and landuse activities.
X12E-01287	Teespruit	1.5	B/C	Flow and non-flow related impacts
X13J-01149	Komati	3.5	D/E	Flow modification and agriculture
X13J-01205	Mbiteni	3	D	Flow, non-flow and water quality impacts.
X13J-01221	Komati	3	D	Flow modification, agricultural encroachment.
X13K-01068	Nkwakwa	3	D	Flow modification and reduction.
X13L-01000	Ngweti	3.5	D/E	Flow modification and reduction, dams.
X14G-01128	Lomati	4	E	Dams, flow modification and reduction.
X21A-00930	Crocodile	2	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.
X21A-01008		2.5	C/D	Flow reduction and small dams.
X21B-00898	Lunsklip	2	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.
X21B-00929	Gemsbokspruit	2	C	Small dams and pockets of forestry.
X21C-00859	Alexanderspruit	2.5	C/D	Dams, irrigation, forestry.
X21F-01046	Elands	2	C	Many small dams and agricultural encroachment.
X22C-01004	Gladdespruit	2	C	Afforestation/Invasive plants, landuse encroachment.
X22H-00836	Wit	4	E	Flow modification, Dams.
X23C-01098	Suidkaap			Afforestation/Invasive plants.
X23E-01154	Queens	2	C	Afforestation/Invasive plants.
X23G-01057	Kaap			Afforestation/Invasive plants and flow modification.
X24H-00934	Crocodile			Flow modification.
X31F-00695	Motitsi	2	C	Forestry.
X32A-00583	Thulandziteka	2.5	C/D	Vegetation removal and overgrazing.
X32B-00551	Motlamogatsana	2.5	C/D	Vegetation removal and overgrazing.
X32D-00605	Mutlumuvi	3	D	Vegetation removal and overgrazing.
X33A-00806	Nwatimhiri	0	A	In KNP.
X40A-00469	Nwanedzi	2	C	Weirs.

SeventeenSQs were highlighted as having potentially high wetland importance, 28 contained wetland NFEPAs and together 40 were highlighted for PES scoring. These generally coincided with areas highlighted in the wetland report (DWA, 2010e). These 17 SQS, together with SQs that did not score 3 for potential wetland importance but contained FEPA wetlands or Ramsar sites, were assessed in more detail to obtain a final wetland PES (Table 7.3), and a score for integrated ecological importance and sensitivity.

8 STATUS QUO: ECOLOGICAL RIVER STATE

8.1 INTRODUCTION

Determination of the 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, also Desktop, was developed by Dr Kleynhans (Kotze *et al.,*2012) with the specific purpose of building up a country wide database of PES and EI - ES. This project is referred to as the PESEIS project and is currently being finalised. The spreadsheets undertaken for the X tertiary catchment have been finalised (DWA, 2013e). This data was used as the baseline for the status quo assessment.

8.2 APPROACH

8.2.1 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 macro-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 8.1.)Ecologicalevaluation 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 8.1 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 8.1.

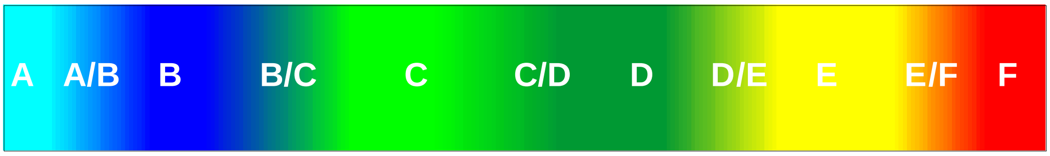

Figure 8.1 Illustration of the distribution of ecological categories on a continuum

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 8.2.

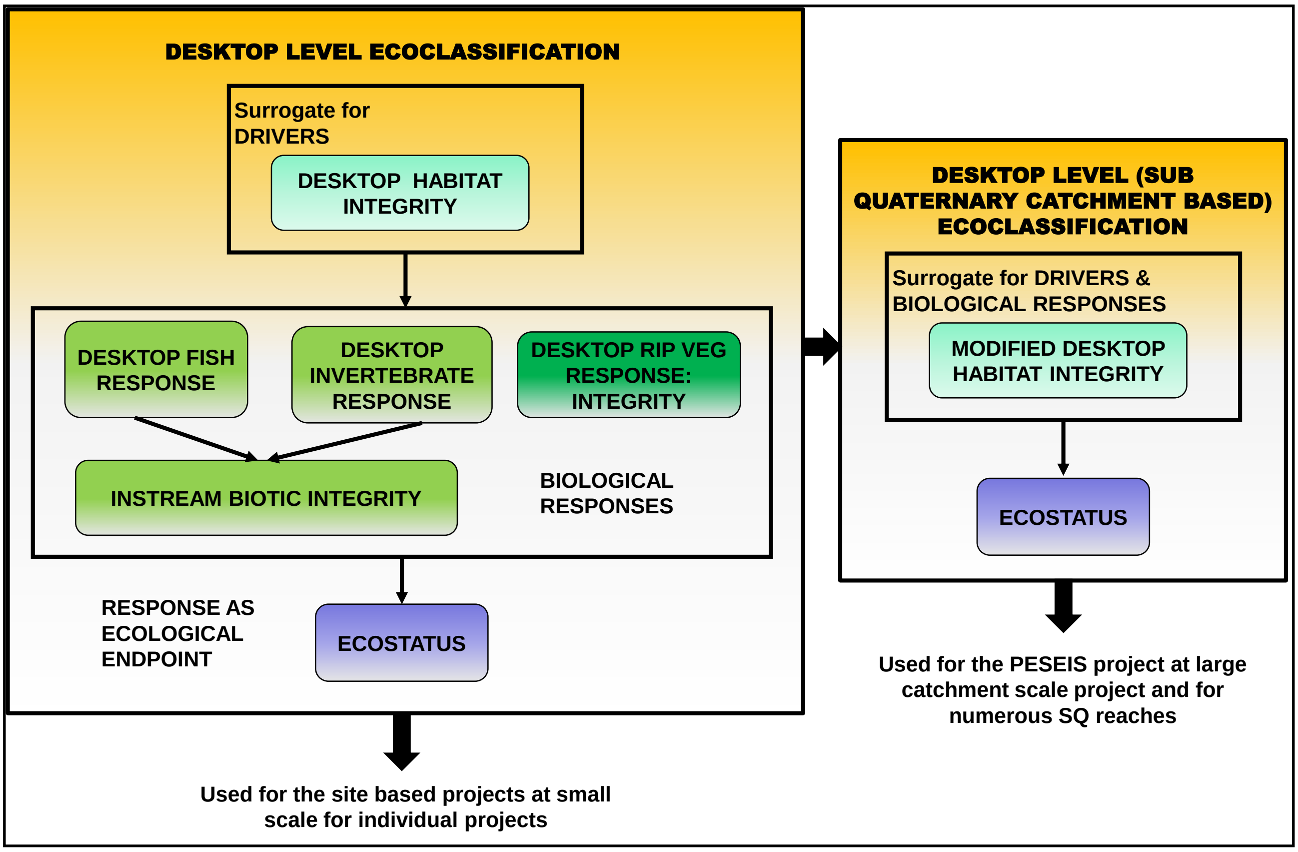

Figure 8.2 Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES

The PES is assessed according to six 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 8.2(DWAF, 2013e). Each metric is scored from zero to five.

Table 8.2 PES metrics and explanations

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 mollusca) 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, interbasin 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.

8.2.2 PES supporting information

Comments summarising the activities that result in the PES were provided for each SQ. Additional, the Ecosystem Services summary as well as the Water Resource Use Importance (WRUI) summary per SQ were also utilised to identify what the impacts were and whether they were flow or non-flow (including water quality) related. This study team also viewed each SQ using Google Earth^{TM} to provide the flow and non-flow impact assessment and to identify the key PES drivers.

8.2.3 Database for PES information in an Excelspreadsheet

The WMA consists of 237 SQ reaches excluding Swaziland. The final modelled information in the front end model for each secondary is available from Dr Kleynhans, Directorate: Resource Quality Services (D:RQS), DWA. Information was extracted in a 'master spreadsheet' that incorporates all the PESEIS (DWA, 2013e) results, as well as the additional information required for this project. Each secondary is provided as a separate spreadsheet. The spreadsheets will be available on the final data CD for this project and the columns of the PES sheet (called PES) is described below.

Note the PES_rawworksheet is a copy of the data as provided from the PESEIS project without any adjustments.

PES worksheet column descriptions in the master spreadsheet:

- Column A: SQ number: Individual code provided for each SQ by DWA and based on the codes used in the NFEPA (Nel *et al*., 2011) assessment.
- Column B: River: River name where available.
- Column C: Length km: River length of SQ.
- Column D - J: A zero to five rating for impacts for metrics as provided from the PESEIS study.
- Column K: Comments: Comments copied from the front end model providing a valuable summary of activities in the SQ.
- Column L: Water quality 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 have been completed.
- Column M: Water quality hotspot comments: Provides an indication of what the reasons are for the water quality hotspots.
- Column N: PES median of all metrics: PES value generated using the metrics as provided in Column D - J.
- Column O: PES category based on median of PES metrics: PES as an EC.
- Column Q: Flow: The word 'flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a flow impacts.
- Column R: WQ: The word 'WQ' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a WQ impact.
- Column S: Non-flow: The word 'non-flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a non-flow impact.
- Column U: Primary 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.

8.3 STATUS QUO ASSESSMENT

The status quo assessment is provided per secondary and consists of a table and short summary for each secondary. No key PES drivers are provided for rivers in a B or higher PES as the changes from natural are minor. Maps are provided of the IUAs which also include the PES results (Chapter 9, Figure 9.2 to Figure 9.5).

8.3.1 X1: Inkomati sub-catchment

Table 8.3 River PES and key drivers resulting in modification from natural

SQ reach	River	PES(EC[1])	Primary PES driver
X11A-01300		B	Non-flow: Sedimentation from grazing.
X11A-01354		C	Non-flow: Barriers of many farm dams and inundation of habitat.
X11A-01358	Vaalwaterspruit	C	Non-Flow: Barriers (farm dams), inundation, grazing.
X11A-01295	Vaalwaterspruit	C	Flow: Upstream farm dams and in tributaries. Non-Flow: Agricultural fields, grazing, mines in tributaries.
X11A-01248	Vaalwaterspruit	C	Non-Flow: Agricultural fields, grazing. Flow: Upstream farm dams and in tributaries.
X11B-01370	Boesmanspruit	B	Non-Flow: Grazing.
X11B-01361		B/C	Non-flow: Linked to grazing, bed and channel disturbance,

SQ reach	River	PES(EC[1])	Primary PES driver
			agricultural fields and alien vegetation.
X11B-01272	Boesmanspruit	C	Non-flow: Grazing, alien vegetation. Flow: Upstream dams and large dam (Boesmanspruit Dam).
X11C-01147	Witkloofspruit	C	Flow: Dams, irrigation. Non-flow: Barrier effect of farm dams, agricultural fields, grazing, alien vegetation.
X11D-01129	Klein-Komati	C	Non-flow: Barrier effect and inundation from numerous farm dams. Flow: Not as important as above, but also plays a role as many dams in tributaries (but probably mostly for trout).
X11D-01137	Waarkraalloop	C	Non-flow: Barrier effect and inundation from numerous farm dams. Grazing.
X11D-01219	Komati	C/D	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11D-01196	Komati	C	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11E-01237	Swartspruit	C	Non Flow: Water quality (trout), barriers. Agricultural fields.
X11E-01157	Komati	B/C	Flow: Upstream Nooitgedacht Dam and no release for EWRs.
X11F-01133	Bankspruit	B	Non-flow: Related to agriculture.
X11F-01163	Komati	B	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11G-01188	Ndubazi	B/C	Non-flow: Forestry.
X11G-01143	Gemakstroom	C	Non-flow: Barriers and inundation.
X11G-01142	Komati	B/C	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11G-01177	Komati	B/C	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11H-01140	Komati	C	Flow: Upstream Nooitgedacht Dam with no environmental releases.
X11H-01140	X11H-01140b	D	Immediately downstream of Vygeboom Dam.
X11J-01106	Mngubhudle	D	Flow: Mine, forestry, abstractions, interbasin transfer. Non-Flow: Physical disturbance from mine and forestry. WQ: Mine.
X11K-01165	Poponyane	C	Flow: Abstractions. Non-Flow: Barriers.
X11K-01199		D	Non-Flow: Barriers and inundation. Flow: Abstractions.
X11K-01179	Gladdespruit	C	Flow: Upstream flow abstractions and transfer.
X11K-01194	Gladdespruit	C	Flow: Upstream abstractions and transfer.
X11K-01227	Komati	B/C	Flow: Upstream dams and operation.
X12A-01305	Buffelspruit	C	Non-Flow: Forestry.
X12B-01246	Hlatjiwe	C	Non-Flow: Forestry, barriers, inundation.
X12C-01242	Phophenyane	B	Non-flow: Linked to grazing.
X12C-01271	Buffelspruit	B	Non-flow: Agriculture and grazing.
X12D-01235	Seekoeispruit	C	Non-Flow: Linked to agricultural fields, grazing, and urbanization. WQ: Linked to town.
X12E-01287	Teespruit	C	Non-Flow: Linked to subsistence agriculture and urban areas.
X12G-01200	Komati	C	Flow: Upstream dams and operation.
X12H-01338	Sandspruit	B	Non-Flow: Linked to impacts in the riparian zone due to overgrazing, trampling and vegetation removal.
X12H-01340		B	Non-Flow: Linked to impacts in the riparian zone due to overgrazing, trampling and vegetation removal.
X12H-01318	Sandspruit	C	Non-Flow and WQ: Linked to agricultural practices, and

SQ reach	River	PES(EC[1])	Primary PES driver
			Mooiplaas at source of river.
X12H-01296	Komati	B/C	Upstream dams and operation.
X12H-01258	Komati	B/C	Upstream dams and operation.
X12J-01202	Mtsoli	B	Non-flow: Forestry.
X12K-01333	Mlondozi	C	Non-flow and WQ: Linked to agricultural practices, and urbanisation.
X12K-01332	Mhlangampepa	B	Non-flow: Impacts linked to grazing.
X12K-01316	Komati	D	Flow: Upstream dams and operation. Non Flow: Agricultural fields and veg removal. WQ: Mining.
X13J-01214	Mgobode	C	Non-flow (2): Vegetation removal and overgrazing/ trampling.
X13J-01141	Mzinti	D	Non-flow (3): Agricultural fields, urbanization, overgrazing, vegetation removal and aliens, large dams and inundation. WQ (3): Sedimentation and algal growth. Flow (2): Abstraction for irrigation.
X13J-01205	Mbiteni	D	Non-flow (3): Agricultural fields, urbanization, grazing, vegetation removal and aliens. WQ (3): Sedimentation and runoff/effluent. Flow (3): Abstraction for irrigation.
X13J-01221	Komati	D	Flow (4): Upstream flow modification and abstraction for irrigation. WQ (3): Run-off/effluent, algal growth. Non-flows (3): Vegetation removal and aliens, agricultural fields, dams and inundation.
X13J-01210	Komati	D/E	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Farm dams and inundation, channel disturbance, vegetation removal and aliens. WQ (3): Sedimentation and irrigation return-flows, algal growth.
X13J-01149	Komati	D/E	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Agricultural fields, bed and channel disturbance, overgrazing, vegetation removal and aliens, farm dam inundation. WQ (3): Sedimentation and run-off/effluent, algal growth.
X13J-01130	Komati	D/E	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Dams and inundation, vegetation removal and aliens, agricultural fields, bed and channel disturbance. WQ (3): Sedimentation and run-off/effluent, algal growth.
X13K-01136	Mambane	D	Non-flow (3): Agricultural fields, bed and channel disturbance, vegetation removal, aliens and overgrazing/ trampling. Flow (2): Abstraction
X13K-01068	Nkwakwa	C/D	Non-flow (4): Dams and inundation, vegetation removal, grazing, bed and channel disturbance. Flow (3): Abstraction for irrigation.
X13K-01114	Komati	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Dams and inundation, bed and channel disturbance, vegetation removal, agricultural fields, overgrazing and trampling, bed and channel disturbance. WQ (3): Sedimentation and run-off/effluent, algal growth.
X13K-01038	Komati	E	Non-flows (5): Bed and channel disturbance, dams and inundation, vegetation removal and aliens, agricultural fields. Flow (4): Upstream flow modification and abstraction for irrigation. WQ (4): Run-off/effluent, algal growth.
X13L-01000	Ngweti	D	Non-flow (4): Farm dams and inundation, vegetation removal,

SQ reach	River	PES(EC[1])	Primary PES driver
			agricultural fields, overgrazing. Flow (4): Abstraction for irrigation.
X13L-01027	Komati	E	Non-flow (4): Bed and channel disturbance, dams and inundation, vegetation removal, agricultural fields, roads. Flow (4): Upstream flow modification and abstraction for irrigation. WQ (3): Run-off/effluent, algal growth, sedimentation.
X13L-0995	Komati	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Bed and channel disturbance, dams and inundation, alien vegetation, urbanization, roads. WQ (3): Run-off/effluent, industries, algal growth, sedimentation.
X14A-01173	Lomati	B/C	Non-flow (2): Agricultural fields, forestry, overgrazing and trampling.
X14B-01166	Ugutugulo	C	Non-flow (2): Forestry, alien vegetation, agricultural fields. Flow (2): Abstraction for irrigation.
X14F-01085	Mhlambanyatsi	C	Non-flow (2): Forestry, vegetation removal and aliens, bed and channel disturbance.
X14G-01128	Lomati	D/E	Non-flow (5): Large dams inundation, agricultural fields, overgrazing, vegetation removal and aliens, bed and channel disturbance. Flow (4): Upstream flow modification and abstraction for irrigation, increased flows. WQ (3): Sedimentation and run-off/effluent, algal growth.
X14H-01066	Lomati	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (3): Agricultural fields, overgrazing, vegetation removal and aliens, bed and channel disturbance, farm dams and inundation. WQ (3): Sedimentation and algal growth.

1 Ecological Category.

The Komati River in South Africa and Swaziland is extensively modified through flow regulation and inundation (large number of dams and weirs). In the lower Komati downstream of Swaziland there are basically no sections of river left that have not been inundated. Other notable impacts in the Komati catchment include forestry, some mining in the upper areas, sections with extensive alien vegetation, overgrazing and sedimentation.

There are 10 SQ reaches in a B PES (outside of Swaziland). Most of these reaches are upstream of Swaziland. The reasons for the relatively good state aredue to inaccessibilityrelated to the mountainous terrain. Eight of the 10 SQs are source rivers. The other two SQsare described below:

- X11F_01163 (Komati River): Protected by private reserves and trout lodges. Impacts related to crossings, roads and some trout dams.
- X12C-01271 (Buffelspruit): Only impact related to grazing.

The upper Komati (upstream from Swaziland) is primarily in a C (and B/C) PES with the most significant impacts being irrigation, agriculture, mining, flow regulation, inundation, forestry and alien vegetation.

Downstream of Swaziland and the eastern sections of Swaziland is dominated by D rivers, with seven SQ reaches in an unacceptable D/E and E PES. The reasons for these are described below:

- X13L-01027, X13K-01038, X13J_01130, X13J_1149, X13J-01210 (Komati River): Inundation.
- X13H-01277 (Komati River): Irrigation right to rivers edge and return flows.
- X14G-01128 (Lomati River): Inundation by Driekoppies Dam for more than 50% of SQ, barrier effect, sedimentation and flow regulation.

8.3.2 X2: Crocodile sub-catchment

Table 8.4 River PES and key drivers resulting in modification from natural

(blue shading in column one and two refers to rivers that are in totality in the greater KNP)

SQ reach	River	PES (EC)	Primary PES driver
X21A-01008		C/D	Non-flow: Bed and Channel disturbance, small (farm) dams, inundation.
X21A-00930	Crocodile	C	Non-flow: Small (trout) dams, inundation, grazing (land-use). Water quality: Nutrients.
X21B-00929	Gemsbokspruit	C/D	Non-flow: Small (farm) dams, inundation, recreation. Water quality: Algal growth.
X21B-00898	Lunsklip	C/D	Flow: (many small dams also in tributaries). Non-flow: Small (farm) dams, inundation, recreation. Water quality: Nutrients (algal growth).
X21B-00925	Lunsklip	C	Flow: Many small dams. Non-flow: Small (farm) dams, inundation. Water quality: Algal growth.
X21B-00962	Crocodile	C	Flow: Abstraction and various small dams in catchment. Non-flow: Agricultural fields, grazing (land-use). Water quality: Nutrients(algal growth),
X21C-00859	Alexanderspruit	C	Non-flow: Agricultural fields, small (farm) dams, inundation, forestry.
X21D-00957	Buffelskloofspruit	C	Non-flow: Agriculture, livestock, limited forestry.
X21D-00938	Crocodile	C	Flow: Large dam (Kwena), increased flows.
X21E-00897	Buffelskloofspruit	B	Non-flow: Forestry (natural areas/nature reserves).
X21E-00947	Crocodile	B	Flow: Kwena Dam, increased flows.
X21E-00943	Crocodile	C	Flow: Kwena dam regulation, abstraction, irrigation. Non-flow: Agricultural fields, roads. Water quality: Algal growth, runoff/effluent: Irrigation.
X21F-01046	Elands	C	Flow: Large number of small dams. Non-flow: Recreation (trout lodges), grazing (land-use). Water quality: Nutrients.
X21F-01100	Leeuspruit	C	Non-flow: Small (farm) dams, grazing (land-use). Water quality: Urban runoff (Machadodorp and Emthonjeni).
X21F-01091	Rietvleispruit	C	Flow: Many small farm/trout dams. Non-flow: Small (farm) dams, inundation, grazing (land-use). Water quality: Increased nutrients.
X21F-01092	Leeuspruit	C/D	Non-flow: Small (farm) dams, grazing (land-use). Water quality: Urban runoff (Machadodorp and Emthonjeni).
X21F-01081	Elands	C	Flow and Non-flow: Small (farm) dams, inundation, grazing (land-use),
X21G-01090	Weltevredespruit	C	Non-flow: Forestry, farming. Water quality: Algal growth.
X21G-01016	Swartkoppiespruit	C	Non-flow: Small (farm) dams, recreation and forestry. Water quality: Nutrients (algal growth).
X21G-01037	Elands	D	Flow: Various small dams. Non-flow: Bed and channel disturbance, small (farm) dams, inundation, roads, recreation, farming. Water quality: Urban runoff, nutrient enrichment.
X21G-01073	Elands	C	Flow: Upstream small dams.

SQ reach	River	PES (EC)	Primary PES driver
			Non-flow: Bed and channel disturbance, roads, vegetation removal. Water quality: Increased nutrients.
X21H-01060	Ngodwana	C	Flow: Large dams. Non-flow: Forestry.
X21J-01013	Elands	C	Non-flow: Agricultural fields, forestry, roads, irrigation. Water quality: Nutrients (algal growth).
X21K-01007	Lupelule	B	Non-flow: Forestry.
X21K-01035	Elands	D	Flow: Ngodwana and other smaller dams. Non-flow: Forestry, roads, vegetation removal. Water quality: Nutrients and runoff/effluent: Industries.
X21K-00997	Elands	C	Flow: Ngodwana and other smaller dams. Non-flow: Forestry, roads, vegetation removal. Water quality: Nutrients and runoff/effluent: Industries.
X22A-00875	Houtbosloop	B/C	Non-flow: Forestry.
X22A-00887	Beestekraalspruit	B/C	Non-flow: Forestry.
X22A-00824	Blystaanspruit	B/C	Non-flow: Forestry.
X22A-00920		B	Non-flow: Forestry.
X22A-00919	Houtbosloop	B/C	Non-flow: Forestry.
X22A-00917	Houtbosloop	C	Non-flow: Forestry.
X22A-00913	Houtbosloop	C	Non-flow: Low water crossings, agriculture, abstraction.
X22B-00987	Crocodile	C	Flow: Kwena dam flow regulation, canals, abstraction (irrigation). Non-flow: Agricultural fields. Water quality: Ngodwana (industrial) and nutrients.
X22B-00888	Crocodile	C	Flow: Kwena dam flow regulation, canals, abstraction (irrigation). Non-flow: Agricultural fields. Water quality: Ngodwana (industrial) and nutrients.
X22C-00990	Visspruit	B/C	Non-flow: Forestry, irrigation.
X22C-01004	Gladdespruit	C	Non-flow (3): Forestry and associated roads with bed and channel disturbance, alien vegetation.
X22C-00946	Crocodile	C	Flow: Kwena Dam and canal flows modification, abstraction (Irrigation). Water quality: Runoff/effluent: Irrigation.
X22D-00843	Nels	C	Non-flow (3): Forestry and associated roads with bed and channel disturbance, vegetation removal and aliens.
X22D-00846		C	Non-flow (3): Forestry and associated roads with bed and channel disturbance, vegetation removal and aliens.
X22E-00849	Sand	C	Non-flow (3): Forestry and associated low water crossings with bed and channel disturbance, vegetation removal and aliens.
X22E-00833	Kruisfonteinspruit	C	Non-flow (3): Forestry and associated low water crossings with bed and channel disturbance, vegetation removal and aliens (Witklip Dam).
X22F-00842	Nels	C	Non-flow (3): Forestry, bed and channel disturbance, vegetation removal and aliens. Flow (2) Some abstraction for irrigation.
X22F-00886	Sand	C	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (3): Large dam (Witklip Dam), forestry, bed and channel disturbance, vegetation removal and aliens.
X22F-00977	Nels	C/D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (3): Agricultural fields, farm dams and inundation. WQ (3): Runoff/effluent and associated algal growth.
X22H-00836	Wit	D/E	Flow (4): Upstream flow modification and abstraction for

SQ reach	River	PES (EC)	Primary PES driver
			irrigation. Non-flow (4): Forestry, many large and small dams and inundation. WQ (3) Algal growth.
X22J-00993	Crocodile	D	Flow: Kwena Dam flow regulation. Non-flow: Roads, urbanization. Water quality: Urban runoff, nutrients (WWTW).
X22J-00958	Crocodile	C	Flow (3): Upstream flow modification and abstraction for irrigation. WQ (3): Runoff/effluent and associated algal growth. Non-flow (2): Roads, urbanization, industries.
X22K-01042	Mbuzulwane	B	Non-flow (3): Small farm dams.
X22K-01043	Blinkwater	B	Non-flow (2): Small farm dams.
X22K-01029	Blinkwater	C	Non-flow (2): Agricultural fields, alien vegetation.
X22K-00981	Crocodile	C	Flow (4): Upstream flow modification and abstraction for irrigation. WQ (4): Runoff/effluent and associated algal growth.
X22K-01018	Crocodile	C	Flow (4): Upstream flow modification and abstraction for irrigation. WQ (3): Runoff/effluent and associated algal growth. Non-flow (2): Roads
X23B-01052	Noordkaap	D	Non-flow (3): Agricultural fields, bed and channel disturbance, vegetation removal. WQ (3): Runoff/effluent and associated algal growth.
X23C-01098	Suidkaap	C	Non-flow (3): Forestry. Flow (2): Abstraction for irrigation.
X23E-01154	Queens	C	Non-flow (3): Forestry. Flow (2): Abstraction for irrigation.
X23F-01120	Suidkaap	C	Flow (3): Abstraction for irrigation. Non-flow (2): A diversity of impacts: Bed and channel disturbance, vegetation removal and aliens, agricultural fields, farm dams and inundation.
X23G-01057	Kaap	D	Flow (3): Abstraction for irrigation. WQ (3): Runoff/effluent and associated algal growth. Non-flow (2): A diversity of impacts: Bed and channel disturbance, vegetation removal and aliens, agricultural fields, farm dams and inundation.
X24A-00826	Nsikazi	C	Non-flow (3): Rural impacts - Agricultural fields, vegetation removal, overgrazing and trampling.
X24A-00860	Sithungwane	A	Non-flow (1): Mostly natural areas, some roads and vegetation removal.
X24A-00881	Nsikazi	B	Non-flow (1): Mostly natural areas, some roads, small dams and vegetation removal.
X24B-00903	Gutshwa	D	Non-flow (3): Rural impacts - Agricultural fields, vegetation removal, overgrazing and trampling.
X24B-00928	Nsikazi	A/B	Flow (2): Mostly natural areas, upstream flow modifications in tributaries. Non-flow (1): Vegetation removal.
X24C-00969	Mnyeleni	A	Impacts very low.
X24C-00978	Nsikazi	B	Impacts very low.
X24C-01033	Crocodile	C/D	Flow (4): Upstream flow modification and abstraction for irrigation. WQ (3): Runoff/effluent and associated algal growth. Non-flow (3): Roads, urbanization, bed and channel disturbance, alien vegetation, vegetation removal.
X24D-00994	Crocodile	C/D	Flow (4): Upstream flow modification and abstraction for irrigation.

SQ reach	River	PES (EC)	Primary PES driver
			WQ (4): Runoff/effluent and associated algal growth. Non-flow (3): Bed and channel disturbance, vegetation removal and agricultural fields.
X24E-00973	Matjulu	B	
X24E-00922	Mlambeni	A/B	
X24E-00982	Crocodile	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (3): Roads, vegetation removal and agricultural fields. WQ (3): Runoff/effluent and associated algal growth.
X24F-00953	Crocodile	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (3): Farm dams and inundation. Vegetation removal, bed and channel disturbance. WQ (3): Runoff/effluent and associated algal growth.
X24G-00902	Mitomeni	A	
X24G-00876	Komapiti	A	
X24G-00844	Mbyamiti	A	
X24G-00823	Muhlambamadubo	A	
X24G-00820	Mbyamiti	A	
X24G-00904	Mbyamiti	A	
X24H-00882	Vurhami	A	
X24H-00892	Mbyamiti	A	
X24H-00880	Crocodile	D	Flow (4): Upstream flow modification and abstraction for irrigation. Non-flow (4): Roads, vegetation removal and agricultural fields. WQ (4): Runoff/effluent and associated algal growth.
X24H-00934	Crocodile	C/D	Flow (4): Upstream flow modification and abstraction for irrigation. WQ (4): Runoff/effluent and associated algal growth. Non-flow (3): Roads, vegetation removal and agricultural fields.

The Crocodile catchment is heavily utilised and one of the catchments that have been over-allocated. In terms of flow regulation, the Elands River is probably the least impacted. Impacts in the main Crocodile River are dominated by Kwena Dam operation and flow regulation of the downstream river for irrigation. Specific impacts are associated with increased (above natural) flows during the dry season, daily fluctuations due to the pumping and abstraction regime and abstraction of flows to such a degree that the river stops flowing at localised stretches. Irrigation return flows and urban runoff impact on water quality. In tributaries such as the Elands, Kaap and Nels rivers, extensive forestry take place. The lower Crocodile River and its tributaries from the Nsikazi River are bordered by or fall within the KNP.

Upstream of the Kaap River confluence, the PES is dominated by a C EC. Downstream of the Kaap River confluence, the Crocodile River is in a D with most of the tributaries being in an excellent state as they are mostly located within the KNP.

Twenty one SQ reaches are in anA, B or B/C PES. Of these, fifteen fall within the KNP from source to confluence with the Crocodile River or borders the KNP. The rest of these SQ reaches are discussed below:

- Six SQ reaches (X22A-00824, 00875, 00887, 00917, 00919, 00920) fall in the upper reaches of the Houtbosloop and Blystaanspruit. Land use is mostly forestry with reasonable buffer zones, hence the good PES.

- X21K-01007 (Lupelele): Whole tributary to the Elands River in a B with forestry as the main land use.
- X22C-00990 (Visspruit): Mostly forestry, some natural bush and irrigation
- X22K-1042 and 1043 (Mbuzulwane and Blinkwater): Mixed land use with mostly natural areas.
- X21E-00947 (Crocodile River): Short section of 1.6 km with irrigation.
- X21E-00897 (Buffelskloofspruit): Forestry and inaccessible area.

There is one SQ with PES lower than a D (PES D/E: X22H-00836). This SQ represents the Wit River with extensive upstream flow modification (abstraction for irrigation), agricultural fields, farm dams and inundation as well as water quality problems with associated algal growth. The two most downstream Crocodile River SQ reaches have instream components that result in an E PES for instream components. The reason for this is due to the extensive sugarcane irrigation on the right bank with cessation of flow at localised areas and water quality problems particularly related to irrigation return flows and temperature fluctuations related to flow modification (abstraction).

8.3.3 X3: Sabie sub-catchment

Table 8.5 River PES and key drivers resulting in modification from natural

(blue shading in column one and two refers to rivers that are in totality in the greater KNP)

SQ reach	River	PES (EC)	Primary PES driver
X31A-00741	Klein Sabie	C	Non-flow: Alien vegetation, forestry. Water quality: Sabie town, lower reaches.
X31A-00778	Sabie	C	Non-flow: Forestry, urbanization. Water quality: Sawmills, urban runoff.
X31A-00783		C	Non-flow: Forestry.
X31A-00786		B	Non-flow: Forestry, natural areas/nature reserves, recreation.
X31A-00794		B	Non-flow: Forestry (natural areas/nature reserves).
X31A-00796		B	Non-flow: Forestry (natural areas/nature reserves).
X31A-00799	Sabie	C	Non-flow: Bed and channel disturbance, alien vegetation, Forestry.
X31A-00803		B/C	Non-flow: Alien vegetation, forestry, vegetation removal.
X31B-00756	Sabie	B/C	Non-flow: Forestry, agriculture. Water quality: Nutrients enrichment (irrigation return flows).
X31B-00757	Sabie	C	Non-flow: Forestry, agriculture. Water quality: Nutrients enrichment (Sabie town runoff).
X31B-00792	Goudstroom	B/C	Non-flow: Forestry.
X31C-00683	Mac-Mac	B/C	Non-flow: Forestry, (natural areas/nature reserves). Water quality: Very limited, saw mill?
X31D-00755	Sabie	C	Flow: Irrigation abstraction (and forestry). Non-flow: Agricultural fields, recreation, vegetation removal, forestry.
X31D-00772	Sabie	C	Non-flow: Agricultural fields, inundation, vegetation removal.
X31D-00773	Sabani	C/D	Flow: Abstraction, various small instream dams. Non-flow: Agricultural fields, forestry (upper reaches), small (farm) dams, inundation. Water quality: Irrigation return flows.
X31E-00647	Marite (US of dam)	B/C	Non-flow: Forestry, vegetation removal.
X31F-00695	Motitsi	C	Non-flow: Forestry, vegetation removal. Water quality: Graskop town.
X31G-00728	Marite	C/D	Flow: Inyaka Dam, increased flows, irrigation. Non-flow: Agricultural fields. Water quality: Nutrients (algal growth).

SQ reach	River	PES (EC)	Primary PES driver
X31H-00819	White Waters	C	Flow: Large dam, abstraction (irrigation). Non-flow: Forestry, agricultural fields. Water quality: agricultural return flows.
X31J-00774	Noord-Sand	D	Flow: Small farm dams. Non-flow: Small (farm) dams, inundation, roads, urbanization, vegetation removal, highly populated rural area. Water quality: Nutrient enrichment runoff/effluent: Urban areas.
X31J-00835	Noord-Sand	D	Flow: Abstraction. Non-flow: Agricultural fields, highly populated rural and urban area, small (farm) dams, and roads. Water quality: Runoff/effluent: Urban areas.
X31K-00713	Bejani	D	Non-flow: Bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), urbanization, vegetation removal. Water quality: Nutrient enrichment, runoff/effluent: Urban areas.
X31K-00715	Sabie	C	Flow: Upstream abstraction (irrigation). Non-flow: Agricultural fields highly populated rural area and Mkhuhlu town, (KNP:Natural areas/nature reserves on right bank). Water quality: Nutrient enrichment, irrigation return flows.
X31K-00750	Sabie	C	Flow: Limited (Inyaka Dam) and abstraction (irrigation). Non-flow: Agricultural fields highly populated rural area and Mkhuhlu town, (KNP:Natural areas/nature reserves on right bank). Water quality: Nutrient enrichment, irrigation return flows.
X31K-00752	Sabie	C	Flow: Inyaka Dam releases and abstraction (irrigation). Non-flow: Rural area, subsistence farming, agriculture, bed and channel disturbance, overgrazing/trampling, recreation, vegetation removal. Water quality: Hazyview town, irrigation return flows.
X31K-00758	Sabie	C	Flow: Inyaka Dam releases and abstraction (irrigation). Non-flow: Agriculture, bed and channel disturbance, overgrazing/trampling, recreation, vegetation removal. Water quality: Hazyview town, irrigation return flows.
X31K-00771	Phabeni	B	
X31L-00657	Matsavana	C	Non-flow: Bed and channel disturbance, overgrazing/trampling, grazing (land-use), vegetation removal. Water quality: Nutrient enrichment.
X31L-00664	Saringwa	C	Non-flow: Bed and channel disturbance, low water crossings, overgrazing/trampling, sedimentation, grazing (land-use), urbanization, vegetation removal. Water quality: Nutrient enrichment.
X31L-00678	Saringwa	B/C	Non-flow: Impacts only in lower reaches - overgrazing/trampling, sedimentation, grazing (land-use), urbanization, vegetation removal. Water quality: Nutrient enrichment.
X31M-00673	Musutlu	B/C	Non-flow: Low water crossings, natural areas/nature reserves, recreation, roads, grazing (land-use).
X31M-00681	Sabie	B/C	Flow: Upstream abstraction (irrigation). Non-flow:Natural areas/nature reserves/recreation. Water quality: Upstream impacts (nutrients, erosion).
X31M-00739	Sabie	B	Flow: Upstream abstraction (irrigation). Non-flow:Natural areas/nature reserves/recreation. Water quality: Upstream impacts (nutrients, erosion).
X31M-00747	Sabie	B	Flow: Upstream abstraction (irrigation). Non-flow:Natural areas/nature reserves/recreation. Water quality: Upstream impacts (nutrients, erosion).

SQ reach	River	PES (EC)	Primary PES driver
X31M-00763	Nwaswitshaka	A	
X32A-00583	Tlulandziteka	D	Non-flow (4): Agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (3): Algal growth. Flow (2): Abstraction for irrigation.
X32B-00551	Motlamogatsana	C	Non-flow (3): Agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Flow (3):Abstraction for irrigation. Water quality (2): Runoff/effluent and associated algal growth.
X32C-00558	Nwandlamuhari	C	Non-flow (3): Agricultural fields, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Flow (2): Abstraction for irrigation. Water quality (2): Runoff/effluent and associated algal growth.
X32C-00564	Mphyanyana	C	Non-flow (3): Agricultural fields, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (2): Runoff/effluent and associated algal growth.
X32C-00606	Nwandlamuhari	C	Non-flow (3): Agricultural fields, roads, vegetation removal.
X32D-00605	Mutlumuvi	D	Non-flow (4): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Flow (3): Abstraction for irrigation. Water quality (2): Runoff/effluent and associated algal growth.
X32E-00629	Nwarhele	C/D	Non-flow (3): Forestry, rural influences (agriculture and urbanization). Water quality (2): Runoff/effluent and associated algal growth. Flow (2): Abstraction for irrigation.
X32E-00639	Ndlobesuthu	D/E	Non-flow (4): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (4): Runoff/effluent and associated algal growth.
X32F-00597	Mutlumuvi	C/D	Non-flow (4): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Flow (2): Abstraction for irrigation.
X32F-00628	Nwarhele	C/D	Non-flow (3): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (2): Runoff/effluent and associated algal growth.
X32G-00549	Khokhovela	C	Non-flow (3): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (2): Runoff/effluent and associated algal growth.
X32G-00565	Sand	C	Non-flow (3): Impacts associated with rural agriculture: agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. Water quality (2): Runoff/effluent and associated algal growth. Flow (2): Abstraction for irrigation.
X32H-00560	Phungwe	A	
X32H-00578	Sand	C	Non-flow (4): Natural areas/nature reserves, sedimentation.
X32J-00602	Sand	B	

SQ reach	River	PES (EC)	Primary PES driver
X32J-00651	Mutlumuvi	A	
X32J-00730	Sand	B	
X33A-00661	Nwatindlopfu	A	
X33A-00731	Sabie	B	
X33A-00737	Sabie	B	
X33A-00806	Nwatimhiri	A	
X33B-00694	Salitje	A	
X33B-00784	Sabie	B	
X33B-00804	Sabie	B/C	Non-flow (3): Natural areas/nature reserves, roads, small dam and inundation.
X33B-00829	Sabie	A/B	
X33B-00834	Lubyelubye	A	
X33C-00701	Mnondozi	A	
X33D-00811	Sabie	B	
X33D-00861	Sabie	B	
X33D-00864	Mosehla	A	
X33D-00894	Nhlowa	A	
X33D-00908	Shimangwana	A	
X33D-00911	Nhlowa	A	
X31E-00647	Marite (ds of Dam)	D	Flow: Inyaka dams flow regulation. Non-flow: Forestry, vegetation removal, subsistence farming, over grazing, erosion. Water quality: InyakaDam, highly populated rural areas.

A large section of the eastern part of this catchment falls within the Greater Kruger National Park All the SQs in the Greater KNP are either in a B or A PES apart from one SQ in the Sabie River which is in a C due to the presence of dams and weirs. There are three SQs in the Sabie River which borders the KNP and are in a C PES.

The Sabie River catchment outside of the KNP is dominated by forestry and irrigation for agriculture (orchards). Some water quality deterioration is associated with Sabie town effluents. Outside of the KNP, the majority of the SQs are in a C with 5 SQs in a D EC. There are 6 SQs which are in a B or B/C PES:

- X31C-00683 (MacMac River): The river falls within forestry areas for most of it length.
- X31B-00792 (Goudstroom): Forestry.
- X31B-00756 (Sabie): Forestry and roads.
- X31A-00786, 794, 796: Natural areas and forestry

The Sand River outside of the Greater KNP is dominated by forestry in the upper areas and subsistence agriculture with extensive erosion, overgrazing and human settlements on the lower lying areas. The PES is mostly a C with three D PES SQ reaches. It must be noted though that many of the rivers with their sources in the Drakensberg have A to B sections followed by a much lower PES in the lower section of an SQ (as low as E PES).

8.3.4 X4: Nwanedzi and Nwaswitsontso

Table 8.6 River PES and key drivers resulting in modification from natural

(blue shading in column one and two refers to rivers that are in totality in the greater KNP)

SQ reach	River	PES (EC)
X40A-00437	Shinkelengane	A
X40A-00454	Mmondzo	A
X40A-00479	Nwanedzi	A
X40A-00492	Rihlazeni	A
X40A-00433	Mtomeni	A
X40A-00420	Gudzani	A
X40A-00426	Mavumbye	A
X40A-00475	Mavumbye	A/B
X40A-00459	Nwanedzi	A
X40A-00486	Nwanedzi	A/B
X40A-00469	Nwanedzi	B
X40B-00534	Nungwini	A
X40B-00537	Gwini	A
X40B-00532	Mrunzuluku	A
X40B-00497	Sweni	A
X40B-00531	Mrunzuluku	A
X40B-00530	Mrunzuluku	A
X40B-00511	Sweni	A
X40C-00592	Ripape	A
X40C-00513	Nwaswitsontso	B
X40D-00663	Shilolweni	A
X40D-00594	Metsimetsi	A
X40D-00598	Nwaswitsontso	A/B
X40D-00660	Nwaswitsontso	A

The Nwanedzi/Nwaswitsontsorivers are seasonal systems that mostly originate in the Kruger National Park and drain separately through the Lebombo Mountains towards the Inkomati River in Mozambique. The Nwaswitsontso River is the only river originating outside the Park and the first 5 km of 97 km falls outside the KNP and adjacent Reserve areas. The occurrence of dams, overgrazing, erosion and agriculture renders this SQ-reach (X40C-00513) an EC of a B. The rest of the Nwaswitsontso River tributaries (X40C and X40D) are mostly unmodified and in an A category.

The Nwanedzi river system consists of the Nwanedzi and Sweni tributaries (X40A and X40B), and the majority of these seasonal streams are unmodified. The only adverse impacts in the two tributaries are tourist roads, river crossings and small dams. The lower section of the Nwanedzi River are rated a B category due to dams and abstraction for a tourist camp.

The Sweni River system (X40B) runs mainly through a wilderness area with very little notable impacts and is in an A PES. Impacts on this river include overgrazing by game, water abstraction for tourist facilities and erosion.

9 PRELIMINARY IUAS

9.1 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 IUAsis therefore to establish broader-scale units for assessing the socio-economic implications of different scenarios and to report on ecological conditions at a SQ scale.

Zones have been established for water resource use, economics, Ecosystem Services 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 9.1. Once the IUAs are delineated, biophysical nodes must be identified for different levels of EWR assessment.

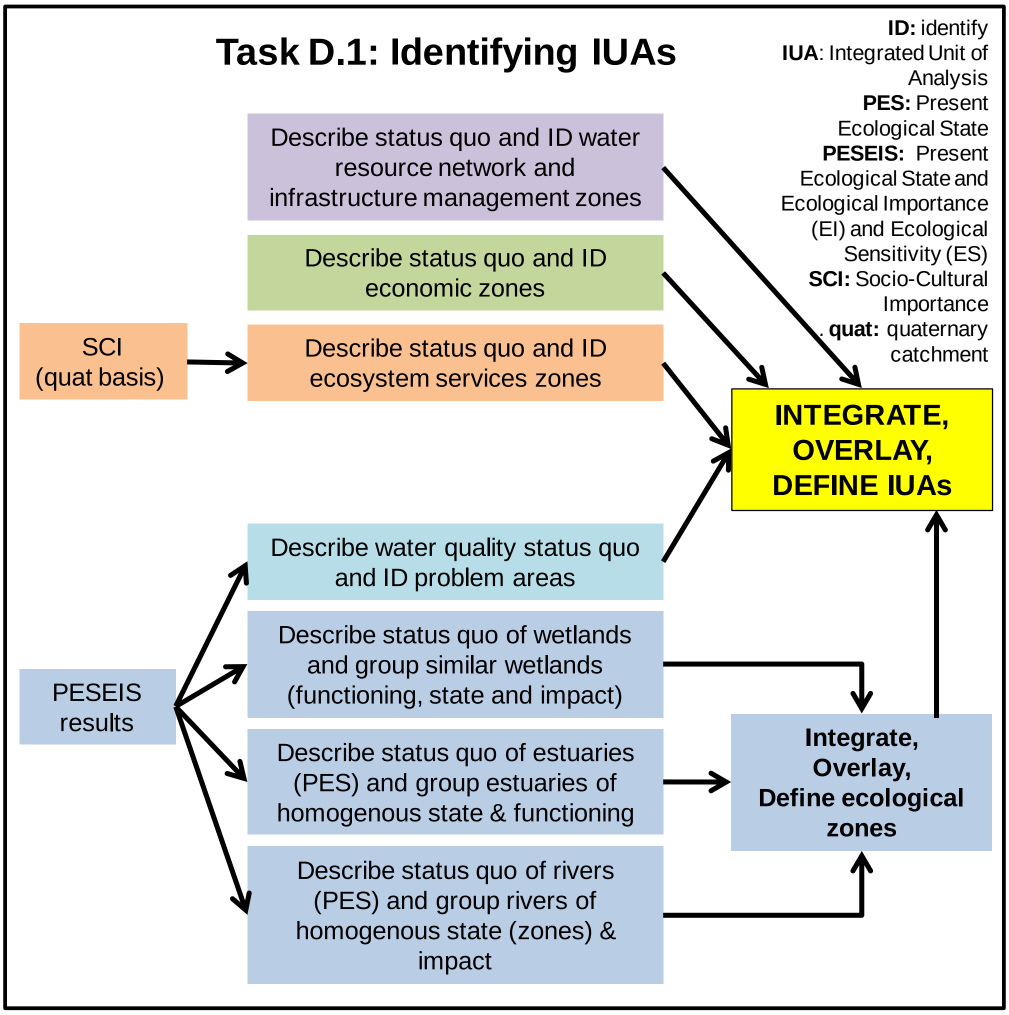

Figure 9.1 Summary of process to identify IUAs

9.2 DESCRIPTION OF STATUS QUO PERIUA IN X1 (KOMATI RIVER)

The selected IUAs are illustrated in Figure 9.2to Figure 9.5at the end of the chapter. The status quo for all the different components is described for each IUA in the subsections below.

9.2.1 IUA X1-1 (Catchment upstream of Nooitgedacht Dam)

Water resources: Surface water

This IUA consists of the headwater catchments of the Komati River up to and including the Nooitgedacht Dam. In addition to the Nooitgedacht Dam, the only other significant Dam is the Boesmanspruit Dam which supplies the town of Carolina. Water from the Nooitgedacht Dam is transferred to the Olifants River catchment for cooling of the coal-fired power stations located there. There are limited farm dams in the catchment but several waste water containment dams which are supposed to contain the highly acidic runoff from coal mines in the area.

This area is relatively flat and a large proportion of this IUA is endorheic, as is evidenced by the large number of natural plans. Land use in the catchment is mostly grazing and dry land crops. There is limited irrigation of maize in this IUA.

Water resources: Ground water

The geology underlying the IUA is mainly represented by the shales, sandstones and coal beds of the Karoo Super Group. These weathered and fractured aquifers are generally not of high water bearing capacity and as a result groundwater use for domestic or irrigation from these aquifers is minimal.

Water resources:Water qualityhotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X11B-01272	Boesmanspruit	Large (3)	AMD at Carolina, 2012

Economy

The most significant economic activities in the IUA are the coal collieries that have a significant economic impact as well as employment. A large part of the IUA is used for grazing and dry land crops.

Ecosystem Services

For the most part the river sections extend through commercial farmland. There is virtually no presence of human habitation in proximity to river. Carolina Town is however within 2km of the river and is the largest single area of population density in the IUA. Low to Moderate social value is associated with Ecosystem Services as utilisation is very low.

Ecology (rivers)

The IUA is dominated with C PES with two SQs in a B PES and one in a B/C PES. Impacts are largely non flow-related due to agriculture (grazing and dry-land), barrier effects and inundation due to numerous farm dams and some alien vegetation. Flow also plays a role due to the mostly run of river abstractions for irrigation and the farm dams.

Ecology (wetlands)

At the quaternary scale, X11A, X11B and X11C all score high for wetland importance, with frequent and extensive wetlands (covering 24.24, 19.55 and 26.99 km^2 respectively). These quaternaries include frequent NFEPA wetlands as well as wetland clusters and X11A and X11B also have close proximity to Chrissiesmeer pans. Wetland types are dominated by pans, depressions, channelled valley-bottom wetland and some seeps and flat areas, although several of the channelled valley-bottom wetlands are artificial and associated with mostly small dams (with the exception of the backup zone of Nooitgedacht Dam. The SQs that were highlighted for priority wetlands include X11A-01248 (Vaalwaterspruit), X11A-01354, X11B-01272 (Boesmanspruit) and X11C-01147 (Witkloofspruit). The PES was predominantly a category C with the main PES drivers being flow modification and landuse activities such as agriculture and overgrazing. Integrated EIS was mostly moderate to high.

IUA rationale

All the SQs are upstream of Nooitgedacht Dam and not influenced by Nooitgedacht Dam's operation. Land uses are similar in all SQs (mostly dry land agriculture) and the PES varies between a B and C EC.

9.2.2 IUA X1-2 (Komati River between Nooitgedacht and Vygeboom Dam)

Water resources: Surface water

This IUA consists of the main stem of the Komati River commencing immediately downstream of the Nooitgedacht dam and ending with the Vygeboom Dam. Other than the Vygeboom Dam, there is no significant storage in the IUA. There is however a weir located on the river between the two dams from which water is pumped by Eskom for transfer to the Olifants system. The other significant abstraction is from the Vygeboom Dam, also for transfer to the Olifants.

This IUA is relatively flat in the upper reaches but becomes increasingly incised progressing downstream, although the catchment flattens out again in the vicinity of the Vygeboom Dam. Land use is grazing, dry land crops and limited irrigation.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the shales, mudrock and quartzites of the Pretoria Group with the Malmani dolomite outcrop forming the “Great Escarpment” which in turn overlies the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. Within the IUA a close inter-dependence exists between groundwater and surface water. Although groundwater is limited to rural domestic supplies, as well as for game and livestock watering in the drier parts, further (large scale) development of groundwater is likely to directly impact on the availability of surface water.

Water resources:Water quality

There are no hotspots in this IUA.

Economy

There is a weir located on the river from which water is pumped to the Olifants. Other than the water transfer there is some limited irrigation that is happening from the river, but it is mostly used for domestic consumption.

Ecosystem Services

The IUA extends through commercial farmland and open terrain with commercial forestry in parts. There is little presence of human habitation, with the exception of farm houses, found in proximity to the river. Overall a low population density is found in the IUA. The presence of farm dams is noted and therefore the associated recreational use and also some land set aside for nature reserves. The IUA has a low to moderate social value.

Ecology (rivers)

The IUA consists of the main Komati River which is dominated by changes in flow largely due to the operation of Nooitgedacht Dam. The six SQs consist of two C ECs and one C/D immediately below the dam. The PES is mostly a result of the changes in flow regime from Nooitgedacht Dam. Further downstream the river is more protected (game reserves) and the flow impact improves slightly as tributaries bring in some flow and variability. These three SQs are in a B and B/C (2) EC.

Ecology (wetlands)

At the quaternary scale X11D scored high for wetland frequency and X11D, X11E, and X11G all have NFEPA wetlands as well as wetland clusters. Wetland types are dominated by pans, depressions and flat areas. The only SQ that was highlighted for priority wetlands was X11H-01140 (Komati) where the predominant wetland type is channelled valley-bottom wetlands, although about half of these are artificial and associated with backup from the Vygeboom Dam. The wetland PES for this SQ is a C, with the main PES drivers being flow modification and overgrazing. Integrated EIS was high.

IUA rationale

The main river was placed in its own IUA as it is operated and functions completely differently to the tributaries. The main river is dominated by the operation (and transfers) from Nooitgedacht Dam. The resulting ECs range from a C/D (below the dam) and improve downstream as tributary inflows mitigate the impact of Nooitgedacht Dam.

9.2.3 IUA X1-3 (All tributaries between Nooitgedacht and Vygeboom Dam excluding the main Komati River)

Water resources: Surface water

This IUA consists of the tributaries which feed into the main stem of the Komati River, represented by the X1_2 IUA. Storage in this catchment is limited to a few small farm dams. These tributaries become increasingly steep and mountainous as one proceeds down the Komati River. Land use consists of grazing, limited dry land crops and irrigation, and forestry in the high lying areas.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by rocks of the Pretoria Group with the Malmani dolomite outcrop forming the “Great Escarpment” which in turn overlies the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. These weathered and fractured aquifers are generally not of high water bearing capacity. Although higher borehole yields are expected in the dolomite aquifer, the topography, geomorphic conditions, land use and the availability of surface water in this region, resulted in an un-developed resource. Groundwater use for domestic or irrigation in these aquifers is minimal.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The main economic activity in the IUA is commercial forestry which contributes a significant amount to the local economy as well as employment in the IUA. There are also a number of irrigated crops in the IUA

Ecosystem Services

The IUA extends through commercial farmland and open terrain with forestry in parts. There is little presence of human habitation, with the exception of farm houses, found in proximity to the river. Overall a low population density is found in the IUA. The presence of farm dams is noted and therefore the associated recreational use. The aesthetic features of the IUA with some notable waterfalls is worthy of mention although the IUA has a low social value overall.

Ecology (rivers)

The six SQs mostly have non-flow related impacts which are dominated by the effect of barriers (farm and trout dams) and inundation. Other impacts link to agriculture (grazing, some limited irrigation and dryland agriculture. Of the six SQs, four are in a C EC, one in a B EC and one in a B/C EC. The B and B/C SQs are in a good state as the river is within a gorge (i.e. inaccessible) for large sections of the SQ.

Ecology (wetlands)

At the quaternary scale X11D scored high for wetland frequency and X11D, X11E, and X11G all have NFEPA wetlands as well as wetland clusters. Wetland types are dominated by pans, depressions and flat areas. The SQs that were highlighted for priority wetlands include X11D-01129 (Klein Komati), X11E-01237 (Swartspruit) and X11G-01143 (Gemakstroom). The PES was predominantly a B/C with the main PES drivers being landuse activities such as agriculture and overgrazing. Integrated EIS was mostly moderate to high (Swartspruit).

IUA rationale

The tributaries to the Komati in IUA X1_2 are independent from the operation of the main river. Land uses are mostly similar - dry land agriculture and grazing. The PES is mostly in a C due to non-flow related impacts.

9.2.4 IUA X1-4 (Gladdespruit catchment)

Water resources: Surface

This IUA consist of the Gladdespruit tributary, which is undeveloped in terms of storage with only a few small farm dams. The catchment is mountainous with the river rising on the Highveld escarpment and descending over 800 m to the low-lying plateau on which the Vygeboom Dam is located.

There are large areas of forestry in the upper reaches of the IUA but grazing is also a prominent land use activity. There is limited dry land agriculture in the lower reaches of this IUA. There is also a large Nickel mine in this IUA which has recently expanded from a purely underground operation to an open-cast operation.

Water use in this IUA consists mainly of transfers to the Vygeboom Dam in support of the transfers to the Olifants system. Other water use is limited irrigation in the lower reaches and water use by the mine, which is also limited.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by rocks of the Pretoria Group with the Malmani dolomite outcrop forming the “Great Escarpment” which in turn overlies the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. These weathered and fractured aquifers are generally not of high water bearing capacity. Although higher borehole yields are expected in the dolomite aquifer, the topography, geomorphic conditions, land use and the availability of surface water in this region, resulted in an un-developed resource. Groundwater use for domestic or irrigation in these aquifers is minimal.

Water resources:Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X11K-01194	Gladdespruit	Large (3)	Trout farms, gold mines, forestry, and excessive encroachment of alien vegetation.

Economy

The main economic activities in the IUA are mining, agriculture and forestry. The Nickel mine located in the IUA has a very large economic impact on the local economy and employs a large labour force.

Ecosystem Services

IUA extends through commercial farmland and open terrain with commercial forestry in parts. TheIUA section headwaters are located on a plateau of open terrain and include the Nkomati Mine and the Nelshoogte Nature Reserve and cradle of life bio-park. There are some Game and trout lodges.There is moderate presence of human habitation, found in proximity to the river. Overall a low population density is found in the IUA. The presence of farm dams is noted and the recreational use associated with these and land set aside for nature reserves increases value of Ecosystem Services to a moderate score.

Ecology (rivers)

The five SQs, two is in a D and 3 in a C. The causes and sources are both flow, non-flow and water quality related. The water quality issues are linked to the mine in the upper area reach X11J-01106. The flow impacts are related to abstraction and an interbasin transfer from the Gladdespruit catchment to the Vygeboom Dam. Non-flow related impacts are the barrier and inundation effect of numerous farm dams and impacts with reference to farm dams.

Ecology (wetlands)

At the quaternary scale X11K scored high for wetland extent, with 11.26% of the catchment comprising wetlands. Both NFEPA wetlands as well as priority wetland clusters also occur in the quaternary. Wetland types are dominated by channelled valley-bottom wetlands (many associated with tributaries) with some flat areas and seeps. The only SQ that was highlighted for priority wetlands were X11K-01194 (Gladdespruit). The PES was a B/C with the main PES drivers being landuse activities such as agriculture, overgrazing and some forestry. Integrated EIS was moderate).

IUA rationale

The Gladdespruit warrants its own IUA as it is different to other tributaries downstream of Vygeboom Dam and the main river. It is however a very varied catchment due to the varied land uses. The catchment is dominated by transfers to Vygeboom Dam, mining and forestry.

9.2.5 IUA X1-5 (Komati River downstream of Vygeboom Dam to Swaziland)

Water resources: Surface

This IUA consists of the main stem of the Komati River from the outlet of the Vygeboom Dam down to the Swaziland border. This stretch of river is relatively flat but flows through a deeply incised valley. Land use in this IUA is mainly grazing with limited dryland crops. There are no dams along this stretch of river although there are a few small weirs.

The main water use in this IUA is domestic use which is abstracted directly from the river to supply the numerous villages in the area. In addition there is limited irrigation supplied out of the river.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. These Basement aquifers have no primary porosity and have a low groundwater potential. The alluvial sand deposits of unconsolidated clayey silts forms primary aquifer of high yielding potential along watercourses and valleys but may be limited in extent.Within the IUA a close inter-dependence exists between groundwater and surface water. Although groundwater is limited to rural domestic supplies, as well as for game and livestock watering in the drier parts, further (large scale) development of groundwater is likely to directly impact on the availability of surface water.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The river is used mostly for domestic water consumption by the rural settlements that line the river. Other uses include grazing and nature conservation, with a section of the IUA cutting through the Songimvelo Nature Reserve.The economic impact of the river is limited to minor irrigation activities that are supplied out of the river and nature conservation.

Ecosystem Services

The IUA starts within commercial farming and plantation forestry and then extends through open terrain and through the large, rural townships (Tjakastad). The IUA also includes the Songimvelo Nature Reserve. As there is an increasing population density and evidence of some intensive utilisation of the Ecosystem Services combined with recreational and aesthetic aspects linked to the river the IUA has a moderate to Ecosystem Services value.

Ecology (rivers)

The main Komati River consists of five SQs of which three is in a B/C and one in a C EC. Most of the impacts are flow related due to upstream dams and the operation of the dams. The river is still in a reasonable condition, mostly as it is situated in some protected areas such as Songimvelo and is inaccessible in other areas. One SQ (X12K-01316) is in D PES due to the same flow-related issues as the upstream SQs, but also include barriers and inundation impacts from weirs, as well as water quality issues from mining and extensive agricultural fields and vegetation removal.

Ecology (wetlands)

At the quaternary scale a portion of X11K is considered and scored high for wetland extent, with 11.26% of the catchment comprising wetlands. Both NFEPA wetlands as well as priority wetland clusters also occur in this quaternary. Other quaternaries (X12H, X12K and X12G) did not score high for priority wetlands. Wetland types are dominated by channelled valley-bottom wetlands (many associated with tributaries) with some flat areas and seeps. No SQs were highlighted for priority wetlands.

IUA rationale

As with the Komati River upstream of Vygeboom Dam, this stretch is dominated by the operation of Vygeboom Dam and is very different to the north and south flowing tributaries. It therefore warrants an IUA on its own. The PES is similar (B/C and C) due to similar land uses and protection in areas such as Songimvelo Nature Reserve.

9.2.6 IUA X1-6 (All tributaries downstream of Vygeboom Dam in X1_6 excluding the Gladdespruit)

Water resources: Surface water

This IUA consist of all the tributaries flowing into the Komati River within X1_Kom5. The terrain is similar to that of X1_Kom2, i.e., a flat high-lying escarpment area with tributaries flowing steeply to the Komati through deeply incised valleys. There are no significant dams in this IUA and a limited number of small farm dams. Land use consists mostly of forestry as well as grazing with limited dry land agriculture.Water use in this area consists of domestic supply to villages and small areas of irrigation.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. These Basement aquifers have no primary porosity and have a low to moderate groundwater potential. Groundwater is largely for rural domestic supplies while use for irrigation is minimal.

Water resources: Water qualityhotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X12D-01235	Seekoeispruit	Large (3)	No of WWTWand elevated salinities around Badplaas.
X12E-01287	Teespruit	Large (3)	Lower reaches only due to presence of WWTW so elevated nutrient levels.

Economy

The main economic activities in the IUA are commercial forestry plantations and dry land agriculture. The main water consumption is from domestic users in the rural settlements with small pockets of irrigation.Commercial forestry has a significant impact on the local economy.

Ecosystem Services

The IUA is made up of a number of tributaries and land utilisation is highly varied. The upper forestry dominated areas give way to more open terrain with commercial mixed farming and then an increasing population density. The towns of Badplaas and associated eManzana are in the IUA as is Elukwatini and associated subsistence agriculture. As there is an increasing population density and evidence of some intensive utilisation of the Ecosystem Services linked to the river the IUA has a moderate to high Ecosystem Services value.

Ecology (rivers)

The SQs consists of various tributaries. Of the 12 SQs, five SQs form part of the Seekoeispruit. Two of these five SQs are in a B and three in a C PES. The major reasons are forestry in the upper reaches and agricultural practices with resulting overgrazing and trampling in the lower reaches. The other seven SQs are situated in 5 different tributaries. Four of the SQs are in a B and three in a C PES. The reasons are all non-flow related linked and dominated by overgrazing, trampling and vegetation removal. Forestry is present in one tributary and some water quality issues due to urbanisation are present in some of the SQs. The SQs with a B PES is mostly due to areas that are protected due to the nature of the topography.

Ecology (wetlands)

At the quaternary scale only X12D scored high for wetland extent with 8.9% of the catchment comprising wetlands. X12A, B, C, D, E, F and G all have NFEPA wetlands as well as priority wetland clusters. Wetland types are dominated by seeps and flat areas in the upper reaches and channelled valley-bottom wetlands in the lower reaches. At the SQ scale the Buffelspruit (X12A-01305, X12C-01271), Seekoeispruit (X12D-01235) and the Teespruit (X12E-01287) were highlighted for priority wetlands. The Buffelspruit has a wetland PES of B and B/C for the two SQs respectively with mostly natural seeps and channelled valley-bottom wetlands with an integrated EIS of moderate to high. The main PES driver is forestry, invasive vegetation and overgrazing. The Seekoeispruit has a wetland PES of C and moderate Ecological Importance and Sensitivity (EIS), while the Teespruit wetlands are in a B/C category and have high EIS with extensive channelled valley-bottom wetlands.

IUA rationale

The north and south flowing tributaries are different from the main river and sufficiently similar to each other to warrant its own IUA. Land use consists of forestry in some of the upper parts of the river, with trampling, overgrazing, vegetation removal, i.e. non-flow related impact. Areas that are in a B PES are protected in inaccessible areas.

9.2.7 IUA X1-7 (Lomati catchment upstream of Swaziland)

Water resources: Surface water

This IUA consist of the headwater catchments of the Lomati River. There are two small but significant dams in this IUA, the Lomati Dam which transfers water to Barberton and the Shiyalongubo Dam which transfers water to irrigators in the Louws Creek River, a tributary of the Kaap River.

This IUA is located on the escarpment in a relatively mountainous area. The dominant land use is forestryalthough there is also some grazing.

While there is no direct water use in this catchment, the yield made available from the two dams is transferred out of the catchment.

Water resources: Ground water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic Basement rocks of the Barberton Super Group. These Basement aquifers have no primary porosity and have a low to moderate groundwater potential. Groundwater is largely for rural domestic supplies while use for irrigation is minimal.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The IUA has extensive commercial forestry activities that have a significant economic impact on the economy. Minimal grazing of livestock is taking place. There is no direct water use in the IUA but the transferred water out of the IUA does have some economic value.

Ecosystem Services

This is a very low population density IUA with extensive forestry. The Barberton Nature Reserve falls partly within the IUA and overall the IUA has a low social value.

Ecology (rivers)

This IUAconsists of only two SQs, both in the upper Lomati catchment and in a reasonably good state (B/C PES). The impacts are mostly non-flow related in the form of forestry, vegetation removal and aliens, and bed or channel disturbance.

Ecology (wetlands)

There were no priority wetlands highlighted in X14A or X14B.

IUA rationale

These two SQs do not warrant an IUA on its own, but the exclusion of Swaziland in this assessment has isolated these two rivers from the downstream IUAs.

9.2.8 IUA X1-8 (Lomati catchment downstream of Driekoppies Dam)

Water resources: Surface water

This IUA consist of the Lomati River downstream of the Swaziland border and down to the confluence with the Komati River. The large Driekoppies Dam is located in this IUA although there are also numerous farm dams as well.

The area is mostly very flat although bordered by mountains in the North West. Land use consists mostly of extensive irrigated crops although there is also some grazing of livestock. There are also numerous villages in this area.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic Basement rocks of the Nelspruit Suite and Barberton Super Group. These Basement aquifers have no primary porosity and have a low groundwater potential. However, deeply weathered and fracture zones may yield boreholes that sustain small scale irrigation and rural domestic supplies. Alluvial aquifers are only present in the IUA to a very limited extent. Groundwater use occurs throughout the area and is largely for rural domestic supplies of which many is entirely dependent on groundwater.

Water resources: Water quality hotspot

SQ reach	River name	Water quality impact (rating)	Water quality issues
X14E-01151	Lomati (Swaziland)	Large (3)	Driekoppies Dam (low temperature and oxygen issues) and irrigation return-flows.
X14G-01128	Lomati	Large (3)	Irrigation return flows and flow modification.
X14H-01066	Lomati	Large (3)	Irrigation return flows and flow modification.

Economy

The main economic activities in the IUA are irrigation crops and grazing. The irrigation crops consists mainly of sugarcane, citrus, vegetables and avocado. There is some commercial forestry and saw milling in the IUA. There are a number of large settlements and are significant domestic water users.

Ecosystem Services

Large sections of the IUA are comprised of plantation forestry, and commercial agriculture (including sugar cane), and open terrain. Within 2km of the river is the large Shongwe settlement. Part of the IUA is located within the Driekoppies Dam. With regard to the river section located downstream of the Driekoppies Dam land-use is exclusively intensive agriculture on the north bank, and the upper portions of the south bank. Five large townships are located on the south bank of the river. The Social value is considered to be moderate to high.

Ecology (rivers)

The Lomati main stream in this IUA flows from the Driekoppies Dam immediately downstream of Swaziland, and due to the impact of the large dam, the first SQ has a PES of a D/E. The main stream is further influenced by flow-related impacts of upstream flow modification, abstraction for irrigation, and increased flows, as well as non-flow impacts such as large dams and inundation, and poor land-use, resulting in a D PES river. The one tributary (Mhlambanyatsi) is impacted by non-flow factors such as forestry and vegetation removal, and present a C PES river.

Ecology (wetlands)

At the quaternary scale X12G and X14H scored high for wetland frequency and extent. None of these wetlands are NFEPA wetlands or priority wetland clusters however. Wetland types are dominated by seeps in the upper reaches (not associated with the main channel), artificial channelled valley-bottom wetlands associated with the Driekoppies Dam and floodplain wetlands along the Lomati River. At the SQ scale the Lomati River (X14G-01128) was highlighted for priority wetlands due to extent but these are largely artificial or downstream of the Driekoppies Dam and hence have wetland PES of E and moderate integrated EIS. The main PES driver is dams and flow modification and reduction.

IUA rationale

The Lomati River downstream of Driekoppies Dam is in its own IUA due to the role in operation and land use that Driekoppies Dam plays. One tributary is excluded and though very different to the Komati River, it did not warrant an IUA on its own.

9.2.9 IUA X1-9 (Komati catchment downstream of Swaziland to the Lomati River confluence)

Water resources: Surface water

This IUA consist of the lower Komati River from the Swaziland border to the confluence with the Lomati River. There are two small but significant dams in this IUA, the Mambiso and Masibikela dams, the latter of which is an off-channel storage dam. The area is flat and dominated by irrigated crops, mostly sugar cane although there is also extensive stock grazing taking place.

Water in this area, supplied from the Maguga Dam, is used mostly to irrigate sugar cane while there is also significant domestic use.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic rocks of the Nelspruit Suite and the Barberton Super Group including the volcanic rocks of the Lebombo Group (Karoo Super Group). These weathered and fractured aquifers are generally not of high water bearing capacity but the potential to sustain small scale water supplies to communities is possible. Alluvial aquifers are only present in the IUA to a very limited extent. Many rural villages occurring in this region are in all probability dependent on groundwater for domestic water supplies.

Water resources:Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X13J-01221	Komati	Large (3)	Extensive irrigation; return flows so elevated salts and nutrients.
X13J-01210	Komati	Large (3)	
X13J-01149	Komati	Large (3)	
X13J-01130	Komati	Large (3)	Irrigation return flows and Tongo WWTW; critical Risk category.

Economy

The main economic activity in the IUA is irrigation of sugarcane. Extensive livestock grazing takes place in the IUA. The main water users in the IUA are the irrigators and the domestic water users.

Ecosystem Services

The IUA extends largely through open terrain and low intensity informal agricultural plots, of which the plots are linked to the myriad peri-urban and urban settlement that ensure a high population density. There are patches of commercial agriculture and intense subsistence agriculture as well. As there is an increasing population density and evidence of some intensive utilisation of the Ecosystem Services linked to the river the IUA has a moderate to high Ecosystem Services value. However density of utilisation probably means resource sustainability is compromised.

Ecology (rivers)

The Komati main stem leaves Swaziland as a PES D river, and the three downstream SQs deteriorate all to PES D/E status, mainly due to upstream flow modification and abstraction for irrigation. Additional impacts are non-flow related with the main influences being dams and associated inundation, as well as changes in land cover due to agriculture and human inhabitation. The three tributaries (PES D rivers) flowing into the Komati are mostly affected by non-flow aspect comprising agriculture (fields, grazing,large dams and associated inundation) and other impacts on land cover (urbanization, vegetation removal and alien plants).

Ecology (wetlands)

At the quaternary scale X13J scored high for wetland extent with 23.5km^2 of wetlands. Both NFEPA wetlands and priority wetland clusters also occur in the quaternary. Wetland types are dominated by channelled valley-bottom and floodplain wetlands. At the SQ scale the Komati (X13J-01149, X13J-01221) and Mbiteni Rivers (X13J-01205) were highlighted for priority wetlands. The Komati and Mbiteni wetlands have a PES of D and D/E with moderate EIS. The main PES drivers are flow modification and agriculture.

IUA rationale

The main river (and tributaries) is all dominated by dams, inundation, subsistence agriculture, rural settlements, and sugarcane. Although the operation from Maguga Dam and other infrastructure play a major role in the river, the non-flow aspects dominate. The IUA ends at the Lomati confluence due to a change in land use downstream and change in flow regime from the Lomati River.

9.2.10 IUA X1-10 (Komati catchment downstream of the Lomati River)

Water resources: Surface water

This IUA consist of the Komati River and tributaries downstream of the confluence of the Lomati and Komati rivers, down to the confluence with the Crocodile River. There are numerous farm dams in this IUA, many of which are used as off-channel storage, as well as numerous weirs on the main stem of the river.The area is very flat. Land use is mostly irrigated crops with the remainder of the area used for grazing.

Water in this IUA, supplied from the Maguga and Driekoppies dams, is used for irrigation, mostly sugar cane although there is also significant domestic use and water use by the Komati sugar mill (limited).

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic rocks of the Nelspruit Suite and the Barberton Super Group including the volcanic rocks of the Lebombo Group (Karoo Super Group). These weathered and fractured aquifers are generally not of high water bearing capacity but the potential to sustain small scale water supplies to communities is possible. Alluvial aquifers are only present in the IUA to a very limited extent. Many rural villages occurring in this region are in all probability dependent on groundwater for domestic water supplies.

Water resources: Water qualityhotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X13K-01114	Komati	Large (3)	Extensive irrigation return flows so elevated salts and nutrients, and impacts from Komati sugar mill.
X13K-01038	Komati	Serious (4)	
X13L-01027	Komati	Serious (4)	
X13L-0995	Komati	Serious (4)	

Economy

The main economic activities in the IUA are irrigation crops and sugar milling. The biggest economic contributors are irrigated crops like sugarcane, macadamia, citrus, avocado and banana and the Komati sugar mill. These activities have a significant economic impact as well as employment impacts.

Ecosystem Services

The IUA includes mixed land use including high density peri-urban and urban settlement and low density but very high intensity irrigated commercial agriculture. The dense settlement includes high reliance on Ecosystem Services although constrained sustainability but the lower density commercial areas probably have little Ecosystem Services reliance. Overall the IUA has a moderate Ecosystem Services value.

Ecology (rivers)

The receiving main stem in the Komati emerge from IUA X1_9 as a D/E PES. Initially it improves to a D PES, but then the following two SQs deteriorate to an E PES, and ends again with a D PES at the confluence with the Crocodile River. Impacts affecting the Komati are varied, with upstream flow modification and abstraction for irrigation (flow), bed and channel disturbance, dams and inundation (non-flow), run-off/effluent and algal growth (water quality) being the major factors.

The tributaries are all in a rather poor state of a C/D to D PES, mainly due to non-flow impacts such as vegetation removal, agricultural fields, overgrazing/ trampling, bed and channel disturbance, farm dams and inundation. Flow related impacts, mainly abstraction for irrigation, also add to the influence on the PES.

Ecology (wetlands)

At the quaternary scale X13K scored high for wetland frequency, although neither NFEPA wetlands nor priority wetland clusters occur in the quaternary. Wetland types are dominated by channelled valley-bottom with some unchannelled valley-bottom wetlands and flat areas. At the SQ scale the Nkwakwa (X13K-01068) and Ngweti Rivers (X13L-01000) were highlighted for priority wetlands. Both these rivers however have poor wetland PES categories (D and D/E respectively) with low EIS. Wetlands are mostly artificial or are dams with the main PES drivers being flow modification and reduction and inundation by dams.

IUA rationale

The main river in this IUA is mostly in an E PES due to the inundation and barrier impacts. The main river (and tributaries) therefore warrants its own IUA as the management of this IUA will be different from upstream.

9.3 DESCRIPTION OF STATUS QUO PER IUA IN X2 (CROCODILE RIVER)

The selected IUAs are illustrated in Figure 9.2to Figure 9.5at the end of the chapter. The status quo for all the different components is described for each IUA in the subsections below.

9.3.1 IUA X2-1 (Crocodile sub-catchment upstream of Kwena Dam)

Water resources: Surface water

This IUA consist of the catchment upstream of the Kwena Dam. In addition to farm dams and numerous trout dams, the Kwena Dam, the largest and most important dam in the Crocodile River catchment, is located at the outlet to this this IUA.

This IUA rises at over 2 000m on the escarpment and forms increasingly deep valleys moving downstream towards Kwena Dam.Landuse consists of forestry, grazing, irrigation and dry-land crops, trout farming.Water use in the IUA consists of limited irrigation and domestic use.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the shales, mudrock and quartzites of the Pretoria Group. The area is further characterised by Intrusive lithologies (diabase dykes and sills) which may act as barriers to groundwater flow and form shallow perched aquifer. These fractured aquifers are generally not of high water bearing capacity. Groundwater development in the area is largely for rural domestic supplies, as well as for game and livestock watering. However, groundwater use in the agricultural sector might be underestimated.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

Economic activities in the IUA are mainly commercial forestry, grazing, trout fishing and irrigation. The irrigated crops in the IUA include citrus and maize. There are both gum and pine plantations in the IUA. Tourism in the form of trout fishing and recreation is also prevalent in the IUA.

Ecosystem Services

The IUA largely includes open terrain and grazing land. The only major human settlement is Dullstroom Town. A number of small dams are noted in the IUA and upstream of Kwena Dam and farming is mixed with forestry and irrigation noted as present. Tourism and recreation associated with the river and dams are an important aspect of the area. As such recreational and aesthetic aspects of Ecosystem Services are important.

Ecology (rivers)

The reaches in this zone are all moderately modified falling in a PES of C to C/D. The impacts are mostly non-flow related in the form of small farm and trout dams, livestock farming (grazing) and recreation. Some water quality related impacts are also associated with this land-use type (increased nutrients and sediment runoff). The large number of small dams also impact on the flow to some extent.

Ecology (wetlands)

All three quaternaries score high for wetland density and extent, with X21A and B having small portions in the VerlorenValei Nature Reserve RAMSAR site. Both quaternaries have NFEPA wetlands as well as priority wetland clusters. The wetlands are dominated by high altitude seeps, with some channelled valley-bottom wetlands in the vicinity of Kwena Dam.The wetland PES ranges from C to C/D with integrated EIS generally High or Very High. Impacts are mostly small dams and agricultural encroachment.

IUA rationale

The river upstream of Kwena Dam and the one tributary flowing into Kwena Dam is not influenced by the Kwena Dam. The land use is similar (trout fishing and dams, grazing) and the ecological state is similar (C dominant). This warrants these SQs to be in one IUA.

9.3.2 IUA X2-2 (Crocodile River downstream of the Kwena Dam to the Elands River)

Water resources: Surface water

This IUA consist of the Crocodile River and tributaries from the Kwena Dam to the confluence of the Elands River. There are a few small farms dams in the IUA.

The terrain consists of a deeply incised valley although the valley bottom is sufficiently wide for extensive agricultural lands. Land consists mostly of forestry and grazing with irrigation in lower lying areas.Water use consists of irrigation, with water supplied out of the Kwena Dam and tributaries.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by rocks of the Pretoria Group and to the east the outcropping Malmani dolomite. The area is further characterised by Intrusive lithologies (diabase dykes and sills) which may act as barriers to groundwater flow and form shallow perched aquifer. The alluvial sand deposits of unconsolidated clayey silts forms primary aquifer of high yielding potential along watercourses and valleys but may be limited in extent. The fractured Pretoria Group aquifers are generally not of high water bearing capacity and although the groundwater potential of the dolomites is suspected to be high no information concerning utilization and exploration potential is readily available. Groundwater development in the area is largely for rural domestic supplies, as well as for game and livestock watering. However, groundwater use in the agricultural sector might be underestimated.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The main economic activities in the IUA are commercial forestry and commercial agriculture. The IUA has both pine and gum plantations with irrigation of crops like citrus and macadamia taking place.

Ecosystem Services

The river section extends largely through a river valley with commercial agriculture/orchards noted along much of the extent. Much of the agriculture is concentrated on the river banks and few settlements werenoted other than sporadic farm houses. Some tourism elements werenoted and as such recreational and aesthetic aspects of Ecosystem Services are of moderate importance.

Ecology (rivers)

The reaches in this zone ranges from largely natural (PES=B) for the upper Crocodile River (X21E-00947) and northern Buffelkloofspruit (X21E-00947) to moderately modified condition (PES=C) for the southern Buffelkloofspruit (X21D-00957) and lower Crocodile River reaches (X21D-00938, X21E-00943). The primary impact in this zone is related to flow regulation by the Kwena Dam, while non-flow related impacts (especially in the tributaries) are related to forestry, agriculture and livestock farming activities.

Ecology (wetlands)

There were no SQs that were highlighted for wetland importance.

IUA rationale

The main river is dominated by the releases of Kwena Dam to the Elands River. As the Elands River contributes significant flow (and natural patterns) to the Crocodile River, the impact of Kwena Dam is somewhat mitigated. The Crocodile River upstream of the Elands River to Kwena Dam therefore warrants its own IUA. Two tributaries are included in this IUA with mostly non-flow regulated impacts.

9.3.3 IUA X2-3 (Elands catchment upstream of the Weltevredespruit (excluded))

Water resources: Surface water

This IUA consists of the upper reaches of the Elands River catchment. There are a few farms dams and trout dams in the catchment and a small dam which supplies water to Machadodorp. The catchment rises on the escarpment and is generally undulating although becoming increasingly mountainous as the river drops down the escarpment in near Waterval Boven. Land uses consist of forestry, grazing and dry-land crops.

There is limited water use in this IUA, consisting mostly of domestic use in towns such as Machadodorp, Waterval Boven and increasing water use by eco-resorts. There is limited irrigation in this catchment and the water use by the smelter located near Machadodorp is also limited.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the shales, mudrock and quartzites of the Pretoria Group. The area is further characterised by Intrusive lithologies (diabase dykes and sills) which may act as barriers to groundwater flow and form shallow perched aquifer. These fractured aquifers are generally not of high water bearing capacity. Groundwater development in the area is largely for rural domestic supplies, as well as for game and livestock watering. However, groundwater use in the agricultural sector might be underestimated.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X21F-01046	Elands	Large (3)	Around Machadodorp only. Urban impacts include Critical Risk WWTW andferro-chrome processing.

Economy

The main economic activities in the IUA are mining, forestry, tourism and a ferrochrome smelter. There are some gold mining activities in the vicinity of Machadodorp as well as a ferrochrome smelter which has a significant impact on the local economy. There are some forestry and livestock grazing in the IUA.Settlements like Machadodorp and Waterval Boven has domestic users as well as tourism activities and resorts that make use of the water.

Ecosystem Services

The IUA largely includes open terrain and grazing land. The only major human settlements are Waterval Boven and Machadodorp. A number of small dams are noted in the IUA and farming is mixed. Tourism and recreation associated with the river are an important aspect of the area. As such recreational and aesthetic aspects of Ecosystem Services are important.

Ecology (rivers)

The reaches in this zone are all moderately modified falling in a PES of C to C/D. The impacts are mostly non-flow related in the form of small farm and trout dams, livestock farming (grazing) and recreation. Some water quality related impacts are also associated with this land-use type (increased nutrients and sediment runoff) as well as the runoff and waste water treatment works of Machadodorp and Waterfall Boven towns.

Ecology (wetlands)

At the quaternary scale X21F scored high for wetland occurrence with both NFEPA wetlands as well as priority wetland clusters present. Wetlands are dominated by high altitude seeps, with some flat areas. Only the Elands River (X21F-01046) was highlighted for priority wetlands with a PES C and a HIGH integrated EIS. Impacts are mostly small dams and agricultural encroachment.

IUA rationale

No major water infrastructure, landuse and impacts are similar and this warrants the rivers to fall into its own IUA. At the lower end of the IUA Waterval Boven occurs in the reach and the water quality impacts will affect the downstream reach of the IUA.

9.3.4 IUA X2-4 (Elands River downstream of X2_3 to the Ngodwana confluence, including the Weltevredenspruit, the Ngodwana River upstream of the Ngodwana Dam and the Lupelele River)

Water resources: Surface water

This IUA consists of the Eland River and tributaries commenting downstream of Waterval Boven and ending at the confluence with the Ngodwana River. The Lupelele River is included in this IUA. In addition to small farm dams, the Ngodwana dam is located in this IUA. This dam supplies water to the SAPPI paper mill. The landscape consists of a deeply incised but wide-bottom valley. The landuse consist of extensive forestry with grazing and irrigators crops.Water in this IUA is used equally for irrigation and industrial use at the SAPPI Paper Mill.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by rocks of the Pretoria Group and to the east the outcropping Malmani dolomite. The area is further characterised by Intrusive lithologies (diabase dykes and sills) which may act as barriers to groundwater flow and form shallow perched aquifer. The alluvial sand deposits of unconsolidated clayey silts forms primary aquifer of high yielding potential along watercourses and valleys but may be limited in extent. The fractured Pretoria Group aquifers are generally not of high water bearing capacity and although the groundwater potential of the dolomites is suspected to be high no information concerning utilization and exploration potential is readily available. Groundwater development in the area is largely for rural domestic supplies, as well as for game and livestock watering. However, groundwater use in the agricultural sector might be underestimated.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The IUA is characterised by extensive pine and gum plantations with the Ngodwana Mill having the biggest economic impact on the IUA both from an economic perspective as well as from an employment perspective. Irrigation of crops and livestock grazing are other agriculture related activities in the IUA

Ecosystem Services

The IUA largely runs through the river valley with commercial agriculture and orchards located in direct proximity to the river, and along the river banks. Tourism related lodges were noted although no settlements were present with the Sappi mill occurringin thelower reach of the river. The tributaries that contribute to the IUA consist of low density commercial farming and forestry areas.Ecosystem Services utilisation is low although some aesthetic and recreational aspects are important in limited sections.

Ecology (rivers)

All of the reaches in this zone is moderately modified (PES=C) except the Lupelule stream (X21K-01007) that is largely natural (PES = B). Impacts are mostly non-flow related associated with forestry, farming, irrigation and the presence of small (farm) dams. Some water quality deterioration, associated with these land-uses (irrigation return flows, recreation and upstream towns) is also prevalent.

Ecology (wetlands)

There were no SQs that were highlighted for wetland importance in this IUA.

IUA rationale

The impacts are similar for the Elands, the Ngodwana upstream of the Ngodwana Dam and the Lupelele River. The land use is dominated by forestry and farming with some irrigation.

9.3.5 IUA X2-5 (Elands River downstream of the Ngodwana River)

Water resources: Surface water

This IUA consist of the Eland River commencing at the confluence of the Ngodwana River and ending with the confluence with the Crocodile River. The landscape is similar to that of IUA 5, i.e., a deeply incised wide-bottomed valley. Landuse consists mostly of forestry with grazing and limited irrigation. There are no significant dams in this IUA.The only water use in the IUA is limited irrigation and domestic water supply to the village of Elandshoek.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the outcropping Malmani dolomite and the underlying crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. The alluvial sand deposits of unconsolidated clayey silts forms a primary aquifer of high yielding potential along water courses and valleys (especially along the Elands River). Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Most of the groundwater contribution to surface flow probably comes from springs and seeps along the escarpment, as well as from the dolomitic formation which extends partially across the headwaters of the Crocodile River catchment. Large scale development of groundwater within these aquifer systems is likely to directly impact on the availability of surface water. Groundwater use in these aquifers is expected to be limited to domestic supply and small scale irrigation.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X21K-01035	Elands	Large (3)	Impact of Ngodwana Sappi mill.

Economy

The main economic activity in the IUA is commercial forestry. There are limited grazing of livestock and irrigation taking place in the IUA.

Ecosystem Services

The upper reaches of the IUA extend from below the Sappi mill and the Ngodwana Township. The remaining extent of the river extends through natural/open terrain. The lower section of the IUA extends through open terrain with limited commercial agriculture/orchards. No settlements noted and Ecosystem Services utilisation is low.

Ecology (rivers)

All of the reaches in this zone is moderately modified (PES=C). Impacts are mostly related to potential water quality deterioration associated with industries and irrigation return flows, while non-flow related impacts are associated with forestry, farming, irrigation and the presence of small (farm) dams.

Ecology (wetlands)

There were no SQs that were highlighted for wetland importance in this IUA.

IUA rationale

The rest of the Elands River (and a very short section of the Ngodwana River) is largely impacted on by the Ngodwana Dam and the impacts of the Ngodwana (SAPPI) paper mill. These SQs, although short, are different from the rest of the river and therefore warrants a separate IUA.

9.3.6 IUA X2-6 (Crocodile River to the Nels River confluence)

Water resources: Surface water

This IUA consists of the main stem of the Crocodile River from the confluence with the Elands down to the confluence with the Nels River. The river flows through a wide valley with high mountains on either side. There are no dams on the stretch of river, only a weir just upstream of Nelspruit which diverts water to the Nelspruit water treatment works. The main land use is irrigation.Water use in this IUA consist of irrigation, supplemented with releases from the Kwena Dam, and supply to Nelspruit and surrounding towns for domestic and industrial purposes.

Water resources: Ground water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. The alluvial sand deposits of unconsolidated clayey silts forms a primary aquifer of high yielding potential along water courses and valleys (especially along the Crocodile River). Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Large scale development of groundwater within these alluvial systems is likely to directly impact on the availability of surface water.Given the relatively good availability of surface water, only limited abstraction of groundwater occurs in the IUA.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X22J-00993	Crocodile	Large (3)	Nelspruit urban area. Diffuse source releases from Papas Quarry at the confluence with the Gladdespruit, is a source of increased manganese.
X22J-00958	Crocodile	Large (3)	Nelspruit urban area.

Economy

The IUA main economic use is the supply of water to irrigators in the region. Water is also diverted to Nelspruit and Rockys Drift for domestic and industrial use.

Ecosystem Services

The upper IUA section is comprised of commercial agriculture on the river banks, and open terrain further beyond the banks. Some tourism/recreational facilities (guest houses) were noted and no settlements were noted in this part. The middle IUA extends through commercial agriculture with some recreational/tourism (lodges). The mid-reaches extend along the outskirts of Nelspruit and the lower IUA section extends along the northern outskirt of Nelspruit. Ecosystem Services utilisation is moderate given population densities but is moderated by the nature of the development.

Ecology (rivers)

This reach consists of the Crocodile River downstream of the Elands River confluence to the Nels River confluence. The upper section (two sub-quaternary reaches) is moderately modified (PES=C) and it deteriorates further in the lower reach after the inclusion of Nelspruit urban impacts. The primary source of deterioration is flow related due to the Kwena Dam flow modification as well as abstraction for agriculture. Water quality deterioration is associated with the Elands River inflow, irrigation return flows while non-flow related impacts are related to agriculture, urban areas and its associated infrastructure.

Ecology (wetlands)

There were no SQs that were highlighted for wetland importance in this IUA.

IUA rationale

The main Crocodile River downstream from the Elands to Nelspruit is influenced largely by the operation of Kwena Dam in conjunction with the Elands River flows. This river is very different to the tributaries which form a separate IUA. Nelspruit with its associated urban impacts result in a set of different impacts; many water quality related and this provides the rationale for ending the IUA at Nelspruit.

9.3.7 IUA X2-7 (Houtbos and Visspruit Rivers)

Water resources: Surface water

This IUA consist of the major tributaries of the Crocodile River flowing within IUA 6. This included the Houtbosloop, State and the Visspruit rivers. These tributaries rise on the escarpment and have steep gradients flowing through mountainous areas. There are no significant dams in this IUA. Land use consists of forestry, grazing and irrigation.Water use in this IUA consists of irrigation.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. These weathered and fractured aquifers are generally not of high water bearing capacity and as a result, groundwater use for domestic or irrigation in these aquifers is minimal. However, many rural villages occurring in this region are in all probability dependent on groundwater for domestic water supplies.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The main economic activities are commercial forestry and irrigation of crops. There is also some livestock grazing taking place in the IUA.

Ecosystem Services

The upper portion of the IUA extends through natural forest, in the river valley bottom. Plantation forestry is present on the plateaus. Campsites were noted on the mid reaches and some recreational Ecosystem Services importance is evident.No settlements were noted. The lower section of the IUA is a mosaic of open terrain, plantation forestry and commercial agriculture, however open terrain is dominant.Tourism and recreational facilities were present in the lower section and no were settlements noted.

Ecology (rivers)

The upper reaches of the Houtbosloop, including the Beestekraalspruit and Blystaanspruit, are currently in a slightly to modified condition, falling in a PES of B to B/C. This are is predominantly impact by forestry (non-flow related impact). The lower reaches of the Houtbosloop is slightly more deteriorated falling in a PES of C (Moderately modified), with the primary impacts being non-flow related (forestry and agriculture). The Visspruit is also in a slightly modified condition (PES=B/C) due to primarily non-flow related impacts (forestry and irrigation).

Ecology (wetlands)

There were no SQs that were highlighted for wetland importance in this IUA.

IUA rationale

The two tributaries to the Komati in X2_6 are both dominated by forestry and irrigation. Impacts range from B to a C and are all related to non-flow related impacts.

9.3.8 IUA X2-8 (Nels, Wit, and Gladdespruitrivers)

Water resources: Surface Water

This IUA consists of the major tributaries entering the Crocodile River downstream of IUA 6 and 7. These tributaries included the Nels, Wit and Gladdespruit rivers. There are several significant dams in this IUA, namely, the Witklip, Klipkopjes, Longmere and Primkop dams. The landscape is undulating and landuse consists mainly of forestry, irrigation as well urban and industrial areas.Water use in this IAU is domestic and industrial as well as irrigation.

Water resources: Surface Water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. These weathered and fractured aquifers are generally not of high water bearing capacity. But deeply weathered zones and structural fractures form secondary aquifers capable of sustaining small communities with water. Alluvial aquifers are only present in the IUA to a very limited extent. Groundwater use occurs (albeit in limited quantities) throughout the area and is largely for rural domestic supplies.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X22H-00836	Wit	Large (3)	Urban impacts from White River and Kabokweni and agricultural impacts.

Economy

The economic activities in the area are forestry, commercial agriculture as well as industrial activities. There is significant irrigation of crops including sugarcane, citrus, macadamia and avocado. There are a lot of industrial users in the IUA which has a significant impact on the local economy and job creation potential. The domestic water usage is also significant in the IUA.

Ecosystem Services

Upper IUA largely made up of plantation forestry. Mid-reaches comprised of extensive commercial agriculture and some plantation forestry as well as being comprised of open terrain with lesser presence of commercial agriculture. No major settlement or recreational/tourism facilities were noted. The lower IUA section extends into Nelspruit and as such is largely urbanised on the west bank with peri-urban and open terrain on the east bank.Ecosystem Services utilisation is moderate given population densities at the lower end of the IUA but moderated by the nature of the development.

Ecology (rivers)

Six of the upper tributaries (Gladdespruit, Sand and upper Nels Rivers) are mostly influenced by forestry and associated impacts, which place them all in a C PES. Downstream flow becomes more of an problem as abstraction for irrigation deteriorate the Sand, lower Nel's and Wit rivers, and with some water quality issues and non-flow impacts such as many dams, the PES decline from a C to a C/D to a D/E respectively

Ecology (wetlands)

The Gladdespruit (X22C-01004) and Wit (X22H-00836) rivers were highlighted for wetland frequency some of which are classified as NFEPA wetlands. Wetlands on the Gladdespruit are dominated by channelled valley-bottom wetlands and seeps with a PES of C and an integrated EIS of High. Main impacts are afforestation/Invasive plants and vegetation removal. Wetlands on the Wit River are mostly dams or associated with dams but some channelled valley bottom wetlands occur around the town of White River. Most NFEPA wetlands should not be priority wetlands. The wetland PES is an E with severe flow modification and numerous dams. The integrated EIS is High however due to species diversity and threatened and endemic wetland species (which occur irrespective of whether wetlands are natural or artificial).

IUA rationale

These tributaries warrant their own IUA as they are different to the main Komati River. Impacts are similar (forestry and irrigations, while there are additional impacts in the Wit River (resulting in a D/E PES) from water quality issues, and dams.

9.3.9 IUA X2-9 (Crocodile River to the Kaap confluence (including the Blinkwater tributary))

Water resources: Surface water

This IUA consists of the main stem of the Crocodile River from Nelspruit down to the confluence with the Kaap River, including the Blinkwater River. There are no dams in this IUA. The landscape is undulating flat although the Blinkwater River flows through a mountainous area.Water use in the area consists of irrigations and domestic use. Water is abstracted out of this section of river for supply to the Nsikazi South area.

Water resources: Ground water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. These weathered and fractured aquifers are generally not of high water bearing capacity. But deeply weathered zones and structural fractures form secondary aquifers capable of sustaining small communities with water. Alluvial aquifers are only present in the IUA to a very limited extent. Groundwater use occurs (albeit in limited quantities) throughout the area and is largely for rural domestic supplies.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X22K-00981	Crocodile	Serious (4)	WWTW = low risk; Kanyamazane; WWTW = high risk; Kabokweni.
X22K-01018	Crocodile	Large (3)	Upstream impacts from Nelspruit, Kanyamazane

			and Kabokweni areas.

Economy

The main economic activity is agriculture with crop irrigation being a major element in the local economy. Domestic water use in the IUA is also high. There are some commercial forestry plantations in the middle reaches of the crocodile.

Ecosystem Services

The upper part of the IUA crosses extensive smallholding and commercial agriculture, and some open terrain it then extends south of two Kanyamazane townships.The IUA also includes plantation forestry in the middle reaches of the Crocodile River. The lower reaches of the Crocodile River portion of the IUA extend through a mosaic of open terrain and commercial agriculture and into the gorge. No settlement were noted other than farm houses. No tourism/recreational elements were noted in the part of the IUA. The river section extends through open/natural terrain.The Mbuzulwane and Blinkwater rivers are made up of smallholdings with some tourism lodges. Ecosystem Services utilisation is moderate although some aesthetic and recreational aspects are important in limited sections

Ecology (rivers)

The main stem of the Crocodile River in IUA X2_9 is subject to upstream flow modification all the way to the Kwena Dam, as well as additional abstraction for irrigation as it flows towards the Lowveld. The Blinkwater catchment are reasonably healthy, and most of it is in a B PES, however lower down increased agriculture and alien vegetation push the PES into a C EC.

Ecology (wetlands)

The main stem of the Crocodile River in IUA X2_9 is subject to upstream flow modification all the way to the Kwena Dam, as well as additional abstraction for irrigation as it flows towards the Lowveld. The Blinkwater catchment are reasonably healthy, and most of it is in a B PES, however lower down increased agriculture and alien vegetation push the PES into a C EC.

IUA rationale

The Crocodile River downstream from Nelspruit flows through a gorge (with an offtake and canal systems for various irrigations schemes). The end of the IUA was identified as the Kaap River confluence. A reason for this was the proposed dam in the lower Kaap River which has implications for the downstream Crocodile River. Furthermore, the Crocodile River soon after the Kaap River forms the border of the KNP which result in a different situation from a land use perspective.

9.3.10 IUA X2-10 (Kaapcatchment)

Water resources: Surface water

This IUA consists of the Kaap River catchment, a major tributary of the Crocodile River. There are no major dams in the Kaap River catchment but there are several farm dams. The Kaap River rises on the escarpment and drops off steeply to a wide valley floor. Landuse in this IUA consists of forestry, grazing and irrigation.Water use in this IUA consists of irrigation and limited gold mining. The water requirements of Barberton are supplied from the Komati catchment.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Barberton Supergroup and the Kaap Valley Tonalite. These weathered and fractured aquifers are generally not of high water bearing capacity. Alluvial aquifers are present in the IUA along major river tributaries. However, large scale development of groundwater within these alluvial systems is likely to directly impact on the availability of surface water. Groundwater use occurs (albeit in limited quantities) in the upper parts of the catchment and is largely for rural domestic supplies.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X23B-01052	Noordkaap	Large (3)	Mining and water treatment activities.
X23G-01057	Kaap	Large (3)	Mining activities and forestry in the upper catchment.

Economy

The main economic activities in the IUA are forestry, agriculture and mining. There are significant forestry plantations in the IUA, both pine and gum. The irrigated crops include citrus, sugarcane and banana. There is some gold mining taking place in the IUA which contributes to the economy and employment. Livestock grazing is also taking place in the IUA.

Ecosystem Services

The Noordkaap makes up half of this IUA and extends through plantation forestry, and a mosaic of open terrain and commercial agriculture. Mid-reaches of the Noordkaapextend into a river valley (Barberton Nature Reserve).The lower reaches of the Noordkaapcomprised of open terrain, and rural homesteads. The Suidkaap makes up the remainder of the IUA and extends through plantation forestry. The mid and lower reaches of the Suidkaap extend through a mosaic of open terrain and commercial agriculture. No settlement notes other than farm houses. There is some tourism and recreational development on the Kaap proper (X23F 0122).

Ecology (rivers)

The upper Kaap system is covered with forestry which is the main influence on the rivers in the upper catchments. In the lower streams (Kaap and Suidkaap) dams increase and the main influences on these lower reaches are abstraction for irrigation with associated return flows that impact on the water quality of these systems.

Ecology (wetlands)

The Queens River (X23E-01154) was highlighted for wetland frequency although none of these were classified as NFEPA wetlands. Wetlands are predominantly seeps with a PES of C and a Low integrated EIS. Main impacts are forestry and alien woody vegetation.

IUA rationale

The Kaap was included as one IUA as there is no large water resource infrastructure or distinct change in land use that necessitates more than one IUA. Impacts are largely non-flow related linked to forestry, mining and irrigation.

9.3.11 IUA X2-11 (Crocodile River from the Kaap confluence to the Komati River)

Water resources: Surface water

This IUA consists of the Crocodile River (outside of the KNP) from the confluence with the Kaap River down to the confluence with the Komati River. There are few off-channel farm dams in this IUA as well as a small dam, Van Graan se Dam, on the main stem of the river. The landscape in this IUA is very flat and landuse consists of extensive irrigation, grazing and game farming.The water use in this IUA consists of irrigation and limited domestic use from towns such as Malelane, Hectorspruit and Komatipoort.

Water resources: Groundwater

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Barberton Supergroup and the Kaap Valley Tonalite. These weathered and fractured aquifers are generally not of high water bearing capacity. Alluvial aquifers are present in the IUA along the Crocodile River. Groundwater use is minimal and is mainly developed for rural domestic supplies, as well as for game and livestock watering.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X24C-01033	Crocodile	Large (3)	Impacts are from extensive settlements on the left bank and irrigation on the right bank.
X24D-00994	Crocodile	Serious (4)	Urban impacts, including extensive irrigation effluent impacting on water quality due to the Critical Risk WWTW at Malelane and the High Risk WWTW at Mhlatikop.
X24F-00953	Crocodile	Large (3)	Discharges from Hectorspruit WWTW (Critical Risk category) and extensive irrigation.
X24H-00880	Crocodile	Serious (4)	Irrigation effluent and upstream impacts.
X24H-00934	Crocodile	Serious (4)	Extensive irrigation effluent impacting on water quality and a Critical Risk WWTW at Komatipoort.

Economy

The IUA is characterised by extensive irrigation in the form of citrus, sugarcane, avocado and banana crops. Livestock grazing is also evident along the IUA with game farming activities in the Komatipoort area. Other tourism and recreation activities are evident in the IUA. The TSB Sugar Mill in Malelane has a significant impact on the local economy as well as employment. Limited industrial activities are taking place in the Komatipoort area.

Ecosystem Services

The upper section of the IUA is located on the southern outskirts of the Matsulu Township (north bank).The south bank of the river section comprised of commercial agriculture.Further downstream thenorth bank of the river section is the KNP while the south bank comprised of commercial agriculture and then made up of Malelane town. Tourism/recreational features associated with the river and the KNPwere noted. Downstream of Malelane the KNP makes up the northern bank with the southern bank made up of intensive agriculture (sugar cane is evident) as well as tourism facilities.Ecosystem Services is high given mixed use and the tourism and recreational elements allied to higher population densities.

Ecology (rivers)

The entire main stem of the lower Crocodile River is utilised intensively, especially for irrigation. Although most of the northern river banks are situated in the KNP, the southern bank is intensively developed. Flow modification due to abstraction for irrigation and the resultant return flows; have major impacts on water quantity and quality. These factors are exacerbated by many non-flow factors and the outcome of this pressure on the river result in a PES of a C/D to a D.

Ecology (wetlands)

No priority wetlands were highlighted in this IUA.

IUA rationale

The Crocodile River downstream of the Kaap River to the Crocodile River confluence is similar in terms of operation and landuse. The operation of the system is dominated by the irrigation requirements and direct pumping from the river.

9.3.12 IUA X2_12 (Nsikasi River)

Water resources: Surface water

This IUA consists of the Nsikasi River catchment, a tributary of the Crocodile River. There are no significant dams in this IUA although there are few small farm dams. The landscape is undulating and landuse consist mostly of wilderness area (within the KNP) but in the west there are sprawling rural villages and more formal housing developments. There remainder of the area is used for grazing. Water use in the area is for domestic purposes but this is supplied mostly from the Crocodile River. There is limited supply from run-of-river out of the Nsikasi River and also from groundwater.

Water resources: Ground water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. These weathered and fractured aquifers are generally not of high water bearing capacity. Given the relatively good availability of surface water, it is expected that only limited abstraction of groundwater occurs in the IUA. The level dependence (solely or largely) of these communities on groundwater is unknown.

Water resources: Surface water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X24B-00903	Gutshwa	Large (3)	Extensive urban and rural impacts from the Kabokweni and Malekutu towns.

Economy

The link between the economy and water supply in this IUA is week since most of the water is being used by domestic water users located in the settlements spread throughout the IUA. Some grazing of livestock by subsistence farmers is also evident in the IUA.

Ecosystem Services

The western portions of the IUA extend through dense settlement with mosaics of open terrain and subsistence agriculture. The eastern portions of the IUA are largely associated with the KNP. Ecosystem Services is high given mixed use and the tourism and recreational elements associated with the Kruger Park as well as livelihood dependence allied to higher population densities.

Ecology (rivers)

Most of the Nsikazi catchment is situated in the wilderness area of the KNP, with very little impacts apart from firebreak roads, resulting in a PES between A and B. The B PES results from the moderate influence in the form of upstream flow modifications (small dams). The two streams originating from the west outside of the Park borders (Nsikazi origin and Gutshwa) are mostly influenced by non-flow rural impacts such as agricultural fields, vegetation removal, overgrazing and trampling.

Ecology (wetlands)
No priority wetlands were highlighted in this IUA.

IUA rationale
The Nsikasi catchment is separate from other tributaries to the Komati in X2-Croc11 as it borders mostly the KNP, has two pristine tributaries, and, outside of the KNP, is dominated by dense rural settlements, subsistence agriculture, overgrazing and trampling.

9.3.13 IUA X2-13 (Northern tributaries of the Crocodile River located in the KNP)

This IUA is made up of the rivers within the KNP and are natural or near natural.

9.4 DESCRIPTION OF STATUS QUO PER IUA IN SABIE-SAND RIVER

The selected IUAs are illustrated in Figure 9.2 to Figure 9.5 at the end of the chapter. The status quo for all the different components is described for each IUA in the subsections below.

9.4.1 IUA X3-1 (Sabie catchment upstream of the Klein Sabie (included) confluence)

Water resources: Surface water
This IUA consists of the headwaters of the Sabie River down to the confluence with the Klein Sabie River. There are no significant dams in the IUA. The Sabie River rises on the escarpment and drops off steeply through mountainous terrain as it flows through this IUA. Landuse in this IUA is mostly forestry with some wilderness areas and urban areas. Water use in the IUA is limited to the urban use of Sabie. There is very little irrigation in this area.

Water resources: Groundwater
The geology underlying the IUA is characterised predominantly by rocks of the Pretoria Group and to the east the outcropping Malmani dolomite. The alluvial sand deposits of unconsolidated clayey silts forms primary aquifer of high yielding potential along watercourses and valleys but may be limited in extent. The fractured Pretoria Group aquifers are generally not of high water bearing capacity and although the groundwater potential of the dolomites is suspected to be high no information concerning utilization and exploration potential is readily available. Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Most of the groundwater contribution to surface flow probably comes from springs and seeps along the escarpment, as well as from the dolomitic formation which extends partially across the headwaters of the Sabie River catchment. Large scale development of groundwater within these alluvial systems is likely to directly impact on the availability of surface water. Groundwater use for domestic or irrigation in these aquifers is minimal. However, groundwater use in the agricultural sector might be underestimated.

Water resources: Water quality
There are no hotspots in this IUA.

Economy
The main economic activity in the IUA is commercial forestry. There is domestic water use in the Sabie region with very limited irrigation of crops. Some tourism activities have been noted in the IUA.

Ecosystem Services

The IUA extends through steep land with plantation forestry dominant and with some natural vegetation noted on the river banks. Some tourism/recreational features (waterfalls) were also noted. The southern portion of the IUA is given over to commercial farming of a mixed variety. The town of Sabie is located in the lower portions of the IUA. Ecosystem Services is moderate with population densities generally low and only aesthetic and recreational aspects elevating the score.

Ecology (rivers)

The rivers in this zone (X31A) ranges between slightly modified (PES=B to B/C) for the unnamed tributary and moderately modified (PES=C) for the Sabie main stem and Klein Sabie. The primary impact in this zone is non-flow related associated with forestry, while some water quality deterioration is also evident in the lower Sabie reach due to urban runoff and sawmill industries.

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale:

The rivers are dominated by forestry with some water quality issues. Ecological state is similar and the downstream border is dictated by Sabie town with its related water quality problems further downstream.

9.4.2 IUA X3-2 (Sabie River downstream of X3-1 to the Marite confluence including the Goudstroom, MacMac, Motitsi and Marite upstream of Inyaka Dam)

Water resources: Surface water

This IUA consist of the upper reaches of the Marite River down to the Inyaka Dam, the Mac-Mac and Motitsi rivers, and the Sabie River from the X3-2 IUA down to the confluence with the Marite River. The terrain is mostly steep and mountainous. This IUA includes the Inyaka Dam, by far the largest dam in the Sabie catchment, as well as Maritsane dam located upstream of the Inyaka dam. Land use in the IUA consists mostly of forestry although there are significant wilderness areas, area under irrigation and urban/rural development. The towns of Graskop, Hazeyview and parts of Bushbuckridge are located in this IUA.Water use in the IUA consists of irrigation, domestic use and transfers out of the Inyaka Dam to the Sand River catchment (IUA SAB7).

Water resources: Groundwater

The geology underlying the IUA is characterised by the Malamni dolomites (in the east) and the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Most of the groundwater contribution to surface flow probably comes from springs and seeps along the escarpment. The fractured Pretoria Group aquifers are generally not of high water bearing capacity and although the groundwater potential of the dolomites is suspected to be high no large scale groundwater abstractions occur. As a result, groundwater use for domestic or irrigation is minimal.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X31D-00755	Sabie	Large (3)	Hazyview WWTW and irrigation return-flows.
X31G-00728	Marite	Large (3)	Urban discharges and agricultural activities including fertilizer use.

Economy

The main economic activities in the IUA are commercial forestry, agriculture (both dry land and irrigation) and tourism activities. There are a number of large settlements in the IUA, including Hazyview, Graskop and Sabie. The irrigated crops include banana, avocado, citrus and macadamia. From an industry perspective it is mostly saw milling that is taking place in the IUA.

Ecosystem Services

The upper part of the IUA has Sabie town located on the headwaters and then extends through a mosaic of plantation forestry and natural vegetation. A number of farm smallholdings were noted as are tourism/recreational features (lodges).The northern part of the IUA extends through plantation forestry and the town of Graskop is present in upper reaches as are parts of Bushbuckridge. Natural vegetation noted in gorges on mid and lower reaches of the northern part of the IUA and some significant tourism aspects are present. Also present is Inyaka Dam. The lower part of the IUA extends through farm smallholdings and again significant tourism and recreational features are present. Hazyview town is located in the lower reaches of the IUA.Ecosystem Services is moderate to high with population densities generally low but aesthetic and recreational aspects elevating the score.

Ecology (rivers)

The rivers in this zone ranges between slightly modified (PES=B/C) for the Sabie (X31B-00756), Goudstroom (X31B-00792), Mac-Mac (X31C-00683) and the Marite River upstream of Inyaka Dam (X31E-00647a) and moderately modified (PES=C) for the Sabie main stem (X31B-00757, X31D-00755 and X31D-00772) and the Motitsi River (X31F-00695). The primary impact in this zone are non-flow related associated with forestry and agricultural fields, while some water quality deterioration is also evident in the some areas due to urban runoff (Graskop in the Motitsi) and sawmill industries.

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale

This is a large IUA which includes the Sabie River downstream of Sabie town and tributaries of Sabie and the Marite River. These rivers are grouped into one IUA due to their similar land use dominated by forestry with some farming and recreation and reasonable ecological state (PES of B/C and C)

9.4.3 IUA X3-3 (Marite and Sabie River downstream of Inyaka Dam to the Sand confluence)

Water resources: Surface water

This IUA consists of the main stem of the Marite and Sabie Rivers from the Inyaka Dam to the confluence with the Sand River. There are no dams on the river although there is a significant weir at Hoxane where water is abstracted for domestic use. The terrain is relatively flat and landuse consists of irrigation and grazing.

Water use in this IUA is mostly domestic use. There are large abstractions from the Hoxane weir for domestic use on both sides of the river. There is also a significant amount of irrigation use.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Groundwater is limited to rural domestic supplies, as well as for game and livestock watering, however, further (large scale) development of groundwater is likely to directly impact on the availability of surface water.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X31E-00647b	Marite	Large (3)	Discharges from the Maviljan WWTW.
X31K-00752	Sabie	Large (3)	Effluent discharge from the Manghwazi WWTW causing high nutrient levels and introducing hazardous microbiological organisms into the system.

Economy

The main economic activities in the IUA are agriculture in the form of grazing and irrigation. Some of the irrigation crops include; banana, citrus and avocado. There is also a significant amount of domestic water use.

Ecosystem Services

This IUA includes a great many land types and uses. The IUA includes the townships of Hazyview, Belfast and Mkhuhlu and also includes farmland/smallholdings and open terrain as well as patches of land used for small scale but intensive agriculture. The IUA includes the KNP and the main rest camp at Skukuza. As such extensive tourism/recreational features are present. Ecosystem Services is moderate to high with population densities moderate to high in places and aesthetic and recreational aspects elevating the score.

Ecology (rivers)

The river reaches in the upper section of this zone (Marite Downstream of Inyaka Dam and upper Sabie section) is moderately to largely modified (PES C to C/D), but improving further downstream (main Sabie River) closer to the nature conservation areas (especially on right bank). The primary impacts in the upper reaches of this zone are flow-related due to the Inyaka Dam (Marite River) regulation as well as abstraction for irrigation. The middle and lower section of this zone is impacted more by non-flow related activities (agriculture, rural settlements) and to some extent water quality deterioration (increased nutrients, Hazyview town runoff).

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale:

Inyaka Dam results in a change in the operation of the downstream Marite River as well as in the Sabie River. As the operations of these two rivers are therefore different to those of the tributaries, a separate IUA was defined. The confluence of the Sand River forms the end of the IUA because of the changes in the Sabie River associated with the Sand River (e.g. sedimentation).

9.4.4 IUA X3-4 (Sabaan, Noord-Sand, Bejani, Saringwa, Musutlurivers)

Water resources: Surface water

This IUA consists of the Sabaan River (a highly developed tributary of the Sabie), the Noord-Sand and White Waters Rivers as well as the Saringwa and Musutlu Rivers on the north bank of the Sabie River. The IUA contains the Da Gama Dam and the several farm dams, especially on the Sabaan River. This terrain is undulating and land uses are varied, consisting of forestry, intense irrigation activity, and numerous villages.Water use in this IUA consists of irrigation, supplied out of the Da Gama dams and farm dams on the Sabaan River, as well as large domestic use, supplied from the Sabie River.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite and the Cunning Moor Tonalites. These Basement aquifers have no primary porosity and have a low groundwater potential. However, deeply weathered and fracture zones may yield boreholes that sustain small scale irrigation and rural domestic supplies. Groundwater use occurs throughout the area and is largely for rural domestic supplies of which many is entirely dependent on groundwater.

Water resources: Water qualityhotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X31J-00774	Noord-Sand	Large (3)	Urban and irrigation runoff.
X31J-00835	Noord-Sand	Large (3)	Urban and irrigation runoff.
X31K-00713	Bejani	Large (3)	Urban runoff and discharges from Mkhuhlu WWTW.

Economy

The main economic activities in the IUA are commercial forestry, and intensive irrigation. The forestry plantations include both pine and gum plantations. Irrigated crops include, citrus, avocado and banana. There is also a large domestic water use in the IUA.

Ecosystem Services

The western part of the IUA extends through a mosaic of plantation forestry, open/natural terrain and farmland. No settlements were noted. The Da Gama Dam located in the IUA with tourism/recreational features noted on the dam. Downstream of the dam, the river extends through commercial farmland (orchards) and natural terrain. There are a number of large towns and peri-urban settlements associated with the IUA these include Hazyview, Tsabalala, Legogote, Marongwana, Xanthia Agincourt, Bushbuckridge Cunningmoore-A and part of Belfast. Ecosystem Services is moderate to high with population densities increasing and some aesthetic and recreational aspects elevating the score.

Ecology (rivers)

This zone consists of various tributaries to the middle reach of the Sabie River. The river reaches in this zone ranged between slightly/moderately modified (B/C) to largely modified (D). The river reaches in slightly/moderately modified condition include those with some of its catchment falling within nature conservation areas (Musutklu and upper Saringwa). The rest of the reaches in moderately modified state include the lower Saringa, Matsavana and White Waters. The reaches on largely modified condition (PES=C/D to D) include the Sabani, Noord-Sand and Bejani. The primary impacts in this zone are non-flow related (agriculture, high and low density rural and urban settlements) and to some extent water quality deterioration (increased nutrients).

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale

All tributaries of the Sabie outside the KNP which do not form part of the IUAs above have been grouped together in one IUA. Most of the land uses are non-flow related and linked to high and low density settlements, agriculture and water quality deterioration. The operation of this IUA will therefore be based on non-flow related aspects rather than management of abstractions and operation of Inyaka Dam.

9.4.5 IUA X3-5 (Sabie River downstream of the Sand confluence to the RSA border)

Water resources: Surface water

This IUA consists of the main stem of the Sabie River downstream of the confluence with Sand River. There are no dams in the IUA. The landscape is flat and is exclusively a wilderness area, contained within the KNP.Water use within this IUA is for game watering and domestic use at the camps within the park.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite and the volcanic rocks of the Lebombo Group. These weathered and fractured aquifers are generally not of high water bearing capacity. Alluvial aquifers are present in the IUA along the Sabie River. Within the IUA a close inter-dependence exists between groundwater and surface water is expected. Groundwater is limited to rural domestic supplies, as well as for game and livestock watering.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The IUA is entirely within the KNP and tourism is the only economic activity that takes place.

Ecosystem Services

Entire IUA is located in the KNP. Tourism and recreational aspects elevate the Ecosystem Services.

Ecology (rivers)

The entire main stem of the Sabie River in this IUA is protected in the KNP and only impacted by upstream influences or less significant tourist facility pressure. This places the river in a PES that varies between PES of A/B and B, except for the reach that includes the Lower Sabie Rest Camp where the impacts of the instream dam and associated influences cause the PES to be a lower B/C.

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale

Downstream of the Sand confluence the Sabie River flows through the KNP. Landuse is therefore all similar and the only aspect impacting on the Sabie River (apart from small localised impacts due to tourism infrastructure) is the upstream catchment influences in the Sand River and the operation of Inyaka Dam and abstractions in the Sabie River. The main Sabie River therefore warrants an IUA as operation of the Sabie River will be different than its tributaries in this area.

9.4.6 IUA X3-6 (Southern and northern tributaries of the Sabie in the KNP downstream of the Sand confluence including the Phabeni)

Water resources: Surface water

This IUA consist of the tributaries of the Sabie River downstream of the confluence with the Sand River located within the KNP. There are no dams in this IUA. The landscape is very flat and the land is all wilderness area. Water use is for game watering.

Water resources: Ground water

The geology underlying the IUA is characterised predominantly by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite. Alluvial aquifers are only present in the IUA to a very limited extent. The IUA is almost entirely within the KNP and the minimal groundwater use is mainly for domestic supplies, as well as for game watering.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The IUA is entirely within the KNP and tourism is the only economic activity that takes place.

Ecosystem Services

Entire IUA is located in or adjacent to the KNP. Tourism and recreational aspects elevate the Ecosystem Services.

Ecology (rivers)

The Pabeni River flows in the KNP but close to the border, with mostly small non-flow impacts such as grazing and flooding, bank erosion due to the bridge and roads, thus it has a B PES. All the other rivers fall within the KNP and have no or limited impacts, i.e. in an A PES.

Ecology (wetlands)

The Nwatimhiri inside KNP has a few pans and small dams which highlight as priority due to their conservation status.

IUA rationale:

These Sabie tributaries all fall in the KNP in their entirety and are therefore grouped together in one IUA.

9.4.7 IUA X3-7 (Mutlumuvi catchment)

Water resources: Surface water

This IUA consists of the Mutlumuvi River, a major tributary of the Sand River. There are no dams on this river although the failed Zoeknog Dam was located on this river. The Mutlumuvi River rises on escarpment and drops rapidly to the Lowveld plains. Land use consists of forestry on the mountain slopes, numerous villages, grazing, limited irrigation and subsistence dry-land agriculture.Water use in this IUA is domestic water use supplied mostly from the Inyaka Dam but still supplemented from run-of-river abstractions. There is also limited supply to irrigation via the New Forest canal which diverts water out of the river at the New Forest weir.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite and the Cunning Moor Tonalites. These Basement aquifers have no primary porosity and have a low groundwater potential. However, deeply weathered and fracture zones may yield boreholes that sustain small scale irrigation and rural domestic supplies. Groundwater use occurs throughout the area and is largely for rural domestic supplies of which many is entirely dependent on groundwater (i.e. Bushbuckridge area).

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X32E-00639	Ndlobesuthu	Serious (4)	Urban runoff and effluent discharge, so high algal levels.

Economy

The main economic activities in the IUA are forestry and agriculture (both commercial and subsistence farming). Forestry includes pine and gum plantations with saw milling activities, while the agriculture includes subsistence dry land agriculture and limited irrigation of crops from the new forest canal. There are a number of settlements in the IUA with a significant demand for domestic water.

Ecosystem Services

Although the IUA includes some areas of low population density and some forestry there are also very dense settlements of Zoeknog, Orinoco, Shatale, Dwarsloop, New Forest, MarijaneThulamahase, Saselani and Arthurstone. Along with subsistence and informal agriculture are pockets of high value greenhouse/tunnel development and commercial agriculture. Resource dependence aspects of Ecosystem Services are high.

Ecology (rivers)

This IUA is situated in an area dominated by rural agriculture and urbanization, and the main influence on the rivers is non-flow issues, such as agricultural fields, vegetation removal, overgrazing and trampling, sedimentation, bed and channel disturbance. However, additional smaller flow and water quality impacts also cause the SQs in the IUA to vary in PES levels between C/D and D/E.

Ecology (wetlands)

The Mutlumuvi (X32D-00605) was highlighted for extensive channelled valley-bottom wetlands with a PES of D and an integrated EIS of High. The main impacts are vegetation removal and overgrazing.

IUA rationale

Although not significantly different than the rest of the catchment, the Mutlumuvi and its tributaries were grouped into one IUA. The catchment is characterised by extensive dense settlements and associated impacts. There is also a transfer from Inyaka Dam to this catchment, although nowadays the transfer does not flow directly into the river.

9.4.8 IUA X3-8 (Sand catchment to the Khokhovela (included) confluence)

Water resources: Surface water

This IUA consists of the northern tributaries of the Sand River, i.e. the Klein-sand and Thulandziteka Rivers. There are several small dams in the IUA, namely, the Kasteel, Acornhoek, Orinoco and Edinburgh dams. The terrain is the same as the IUA Sab7 with the rivers rising on the escarpment and falling rapidly to the Lowveld plains. Landuse is forestry, grazing, villages, irrigation and dry-land subsistence agriculture.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite, the Cunning Moor Tonalites and the Makhutswi gneiss. These Basement aquifers have no primary porosity and have a low groundwater potential. However, deeply weathered and fracture zones may yield boreholes that sustain small scale irrigation and rural domestic supplies. Alluvial aquifers are only present in the IUA to a very limited extent. Groundwater use is largely for rural domestic supplies of which many is dependent on groundwater. Groundwater also sustains some small irrigation schemes.

Water resources: Water quality hotspots

SQ reach	River name	Water quality impact (rating)	Water quality issues
X32A-00583	Thulandziteka	Large (3)	Elevated nutrients, toxics and turbidity.

Economy

The main economic activities in the IUA are forestry and agriculture (both commercial and subsistence farming). Forestry includes pine and gum plantations with saw milling activities, while the agriculture includes subsistence dry land agriculture and grazing with limited irrigation of crops. There are a number of settlements in the IUA with a significant demand for domestic water.

Ecosystem Services

The upper reaches IUA extends through the Blyde River Canyon. The IUA then descends onto plains of open terrain and the large townships of Casteel, Craigisburn, and Dingleydale. Some commercial farmland is noted in this part of the IUA as is the Dingleydale Dam. IUA population densities increase with the presence of Edinburgh,Mbumber, Khokovela, Clare, Rolle, and Athole. Cattle grazing and some subsistence agriculture are notable features of this part of the IUA. Some portion of the IUA is given over to Game Park. Resource dependence aspects of Ecosystem Services are high as are the aesthetic features of the Blyde River Canyon and recreational aspects of the Game Park areas.

Ecology (rivers)

Most of the impacts on the rivers in IUA X3_8 are related to rural agriculture and urbanization such as agricultural fields, vegetation removal, overgrazing and trampling, sedimentation, bed and channel disturbance. This put all the SQs in a C PES, except Thulandziteka which is a D PES.

Ecology (wetlands)

Both the Thulandziteka and Motlamogatsana Rivers were highlighted for extensive channelled valley-bottom wetlands with a PES of D and an integrated EIS of High. Many of the wetlands are associated with the tributaries. The main impacts are vegetation removal and overgrazing.

IUA rationale

The similar landuse which is dominated by settlements, overgrazing and sedimentation problems are grouped into one IUA. The downstream border of the IUA is dictated by the change in landuse due to the presence of conservation areas.

9.4.9 IUA X3-9 (Sand catchment downstream of the Khokovela confluence)

Water resources: Surface water

This IUA consist of the Sand River catchment downstream of the Kholovela River, which is approximately at the border with the Sabi Sand Game Reserve. There are no dams in this IUA. The terrain is flat and the area falls entirely within wilderness area, either the Sabi Sand Park or the KNP.Water use is for game watering and camps within these parks.

Water resources: Groundwater

The geology underlying the IUA is characterised by the crystalline igneous and metamorphic basement rocks of the Nelspruit Suite, the Cunning Moor Tonalites and the Makhutswi gneiss. Alluvial aquifers are present in the IUA along the Sabie River. These weathered and fractured aquifers are generally not of high water bearing capacity. Along these alluvial systems a close inter-dependence exists between groundwater and surface water. Groundwater for domestic use or irrigation in this IUA is minimal.

Water resources: Water quality

There are no hotspots in this IUA.

Economy

The area of the IUA falls within the KNP as well as private game reserves along the border of the park. The main economic activity is thus tourism and nature conservation.

Ecosystem Services

Virtually all of the IUA is Game Park but it also includes the settlement of Phungwe and Utlha. Tourism and recreational aspects elevate the Ecosystem Services importance.

Ecology (rivers)

All of these rivers are situated in conservation areas and thus fairly well protected. These rivers are thus without the burden of local impacts, therefore the good PES levels that varies between PES of A and B. However, the Sand which forms the upstream link to the IUA is still under pressure owing to high levels of sedimentation that has washed in from upstream, putting the reach in a PES of a C.

Ecology (wetlands)

There were no priority wetlands highlighted for this IUA.

IUA rationale

The presence of the conservation areas has resulted in the main Sand River and a tributary to form its own IUA.

9.5 DESCRIPTION OF STATUS QUO PER IUA IN X4 (NWANEDZI AND NWASWITSONTSO)

There are 24 SQs in this IUA which consists of all the SQs in X4 (Figure 9.5). Of the 24 SQs, 22 are in an A or A/B PES and 2 in a B PES. Twenty-threeof theSQs are situated completely within the KNP. One SQ is situated for 70 % of its length in the KNP. As such, these SQs will not be impacted by any future scenarios and the Management Class will be a Class I.

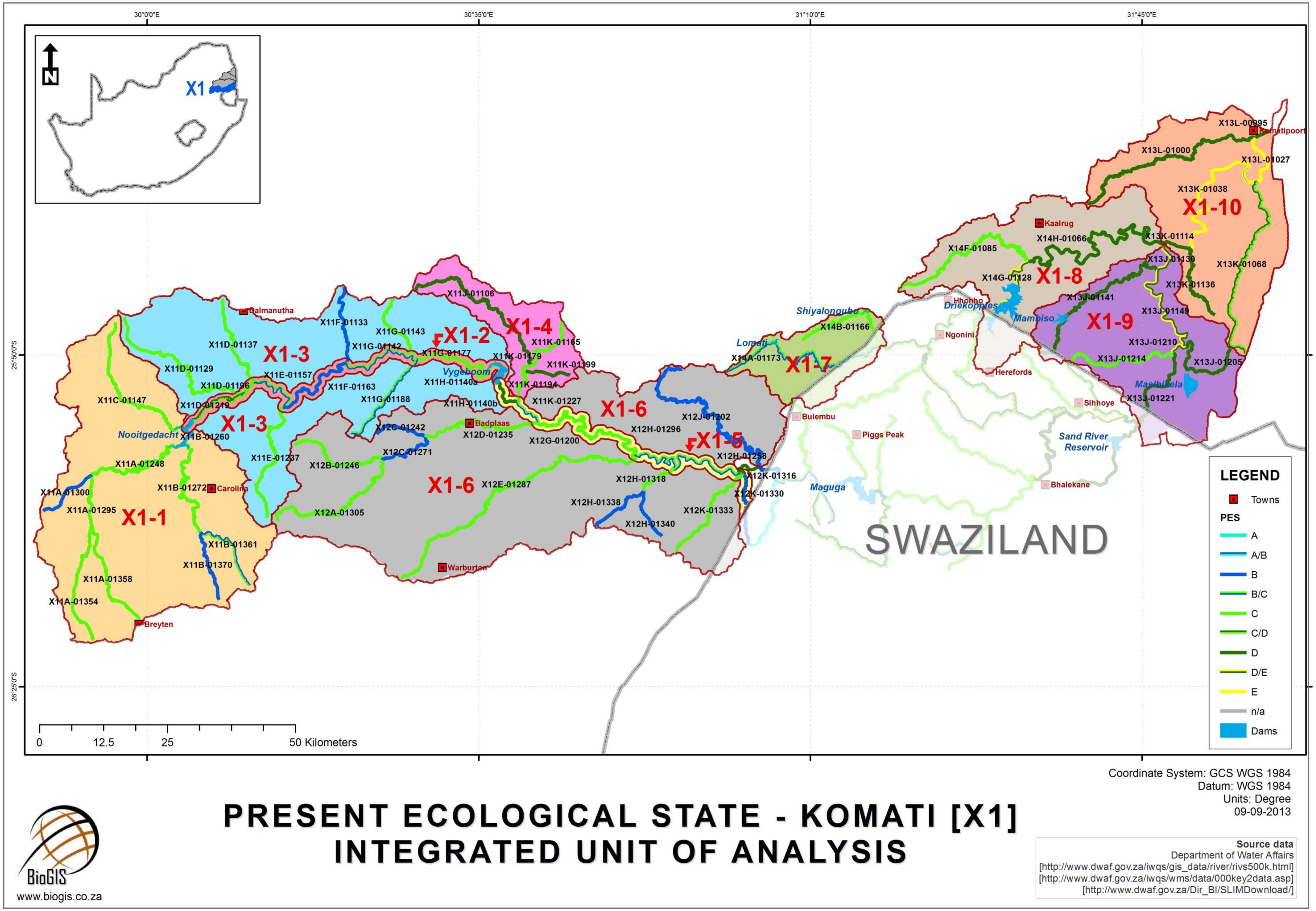

Figure 9.2 IUA and PES in the Komati catchment (X1)

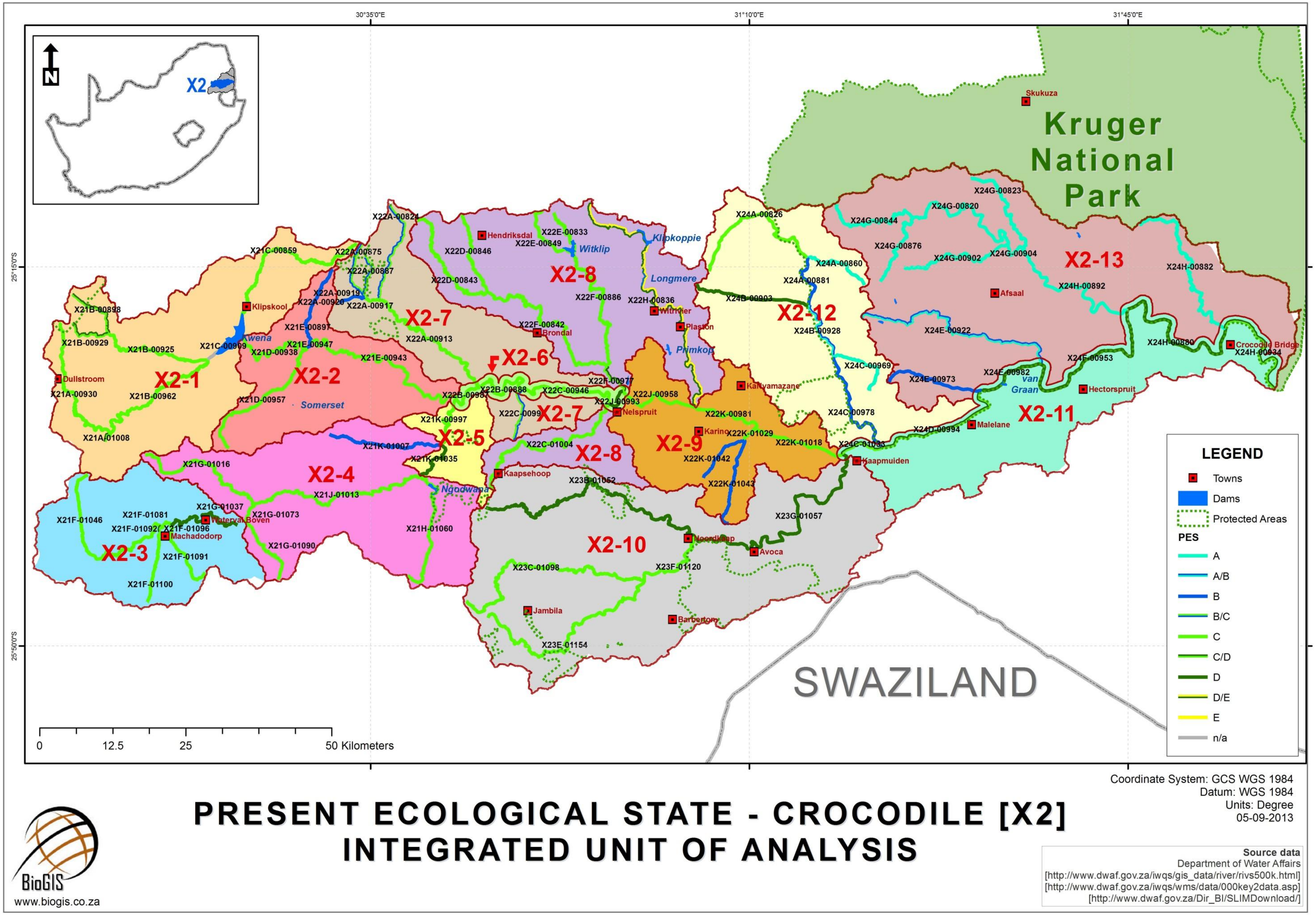

Figure 9.3 IUA and PES in the Crocodile catchment (X2)

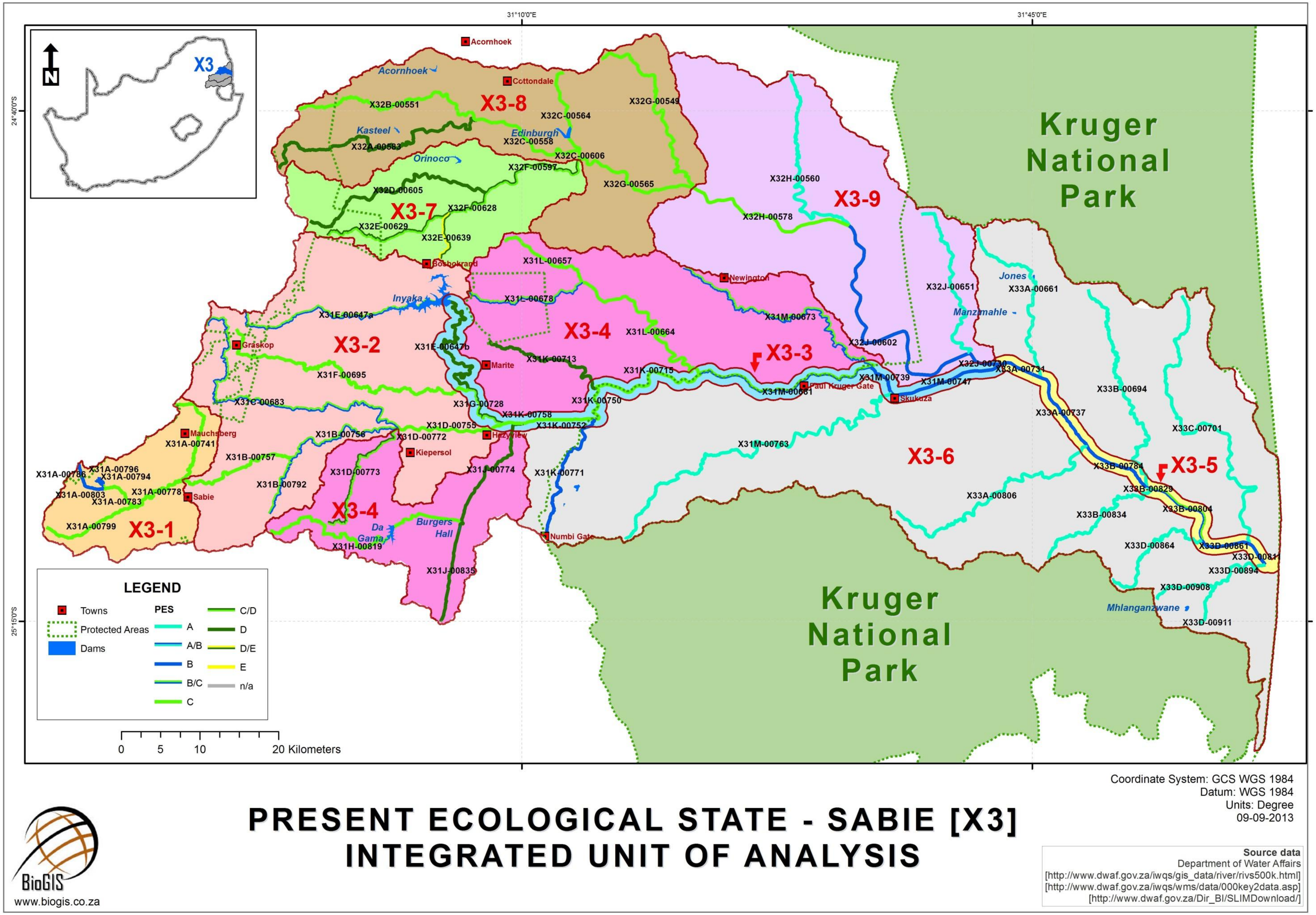

Figure 9.4 IUA and PES in the Sabie-Sand catchment (X3)

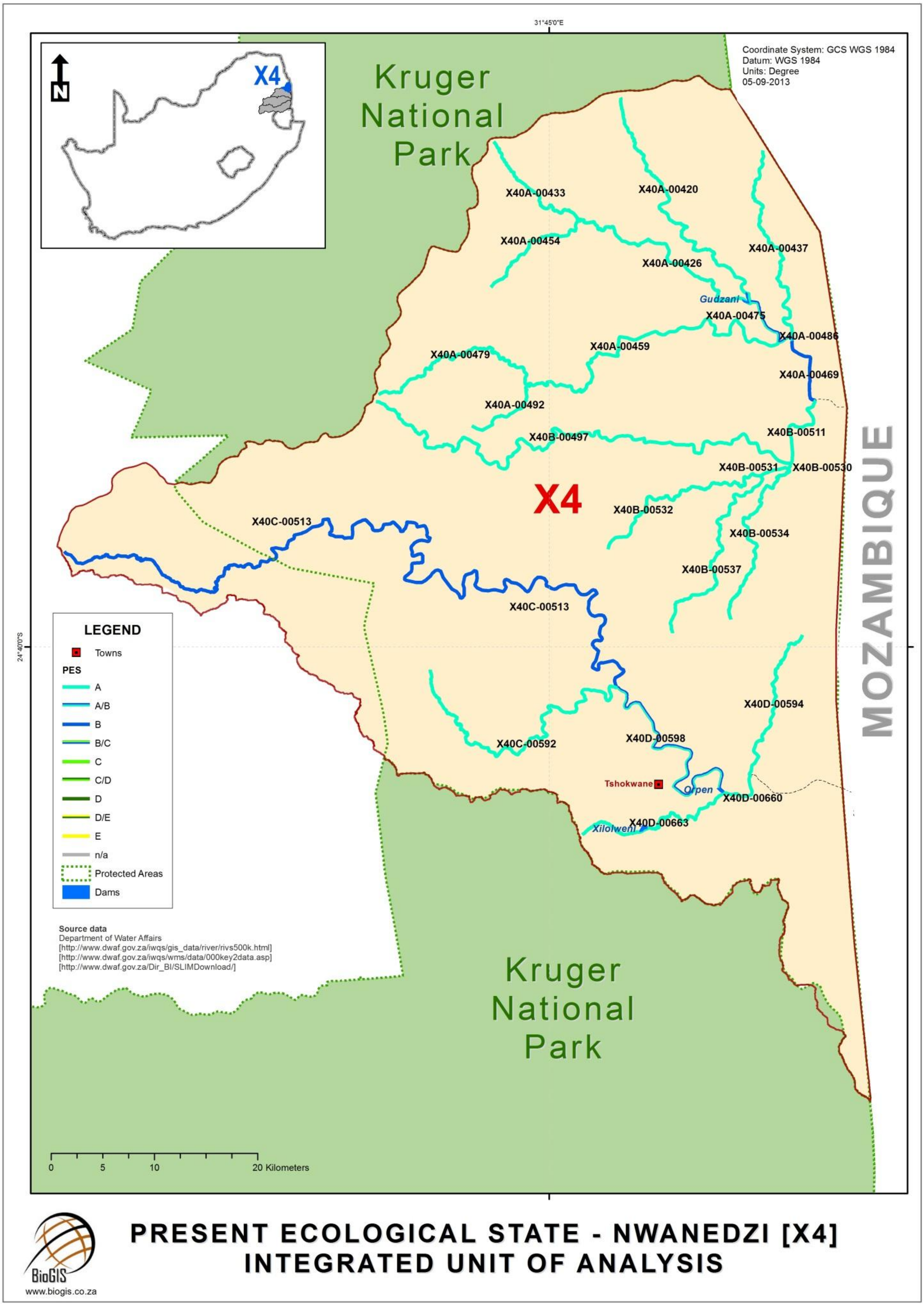

Figure 9.5 IUA and PES in X4

10 METHOD TO IDENTIFY HOTSPOTS (RIVERS)

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.

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 select river reaches where new EWR sites should be selected.
- To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the National Water Resource Classification System (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 10.1 and relied on the results (with modifications during this study) of the PESEIS study. The total number of SQ reaches is 288 which therefore require 288 river biophysical nodes. Some of these biophysical nodes will be replaced by estuary nodes. It was proposed that all the nodes were considered in terms of ecological requirements, but that less desktop biophysical nodes should be selected for EWR estimation. Nodes that were excluded from the estimation process were those with:

- its source in the Drakensberg mountains and conservation areas;
- 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 WRUI was undertaken as well as the SCI. These were undertaken on a SQ scale but grouped where similar.

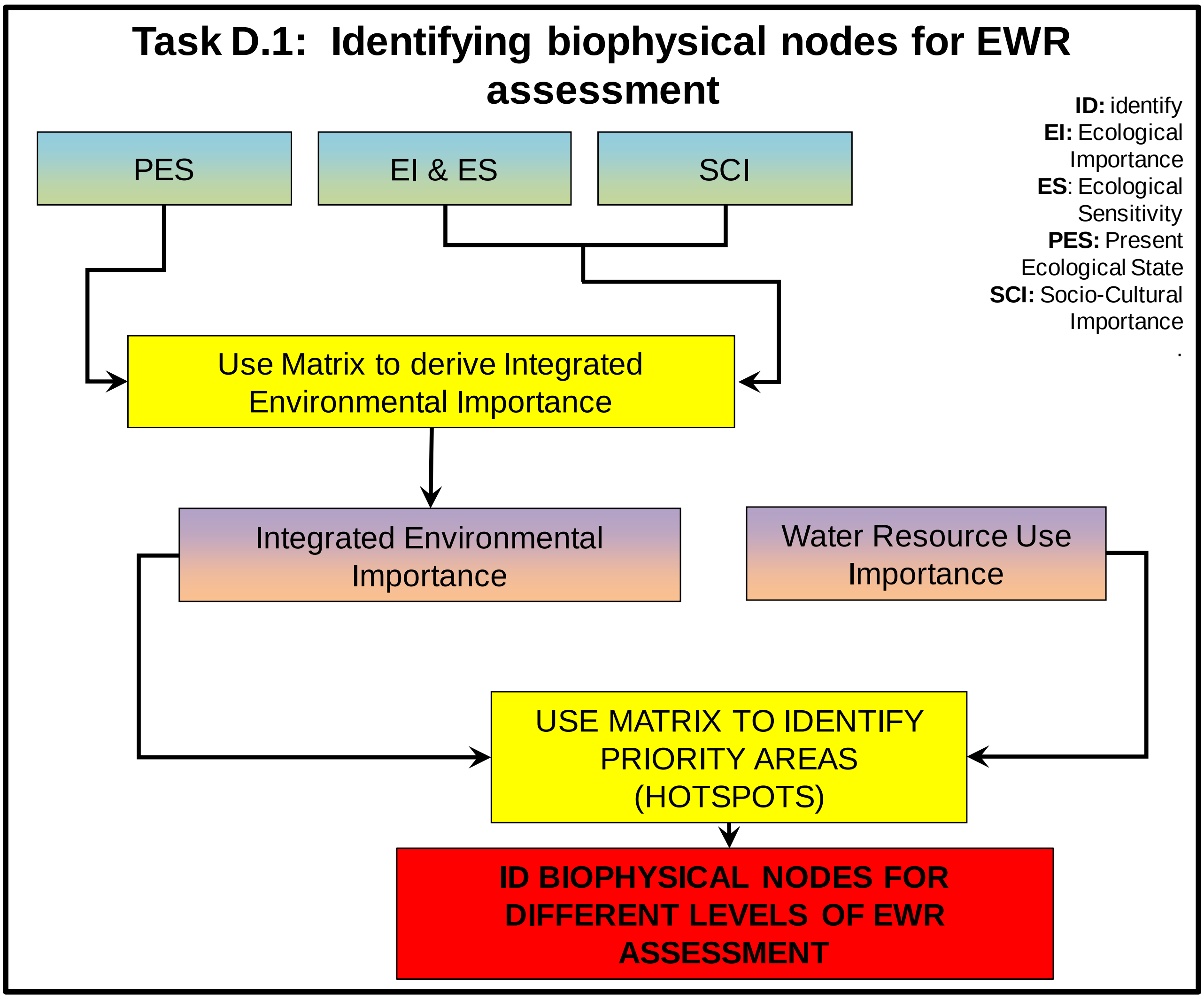

Figure 10.1 Summary of the process to identify biophysical nodes for EWR assessment

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

- Desktop EcoClassification which included the determination of the EIS; SCI and PES.
- Determination of the IEI by integrating the EIS, SCI and the PES. Significant wetlands (if present) were also identified and rated in terms of its 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.

10.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

10.1.1 Present Ecological State

The PES approach is described in Section 8.2.

10.1.2 River Ecological Importance and Sensitivity

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) (Reshet *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, D:RQS, DWA. 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 (DWA 2013e). Further explanations of the functions of the model must be referred to D: RQS.

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 was 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 (DWA, 2013e)provided a higher confidence PES assessment as that on which the NFEPA study was based (which was largely Kleynhans (2000) data based as well as some localised and expert data). The PESEIS study (DWA, 2013e) included a Google Earth™assessment by various 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 (DWA, 2013e) 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 (DWA, 2013e).
- 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 was verified using the information from the PESEIS study (DWA, 2013e).
- If the FEPA was in a B or higher PES, but not fish information was provided to support this, a tick for yes with a **?**was indicated.

There are 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 Recommended Ecological Category (REC) to be lower than the PES.

10.1.3 Wetland River Ecological Importance and Sensitivity

The integrated ecological importance and sensitivity for the Inkomati system is shown in Appendix C – Section 16.3. The methodology used to derive this is described in Section 7.2.

10.1.4 Socio-cultural importance

The SCI was generated by scoring each quaternary catchment based on the following features (Huggins *et al*., 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 adoptedIntensity 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 MzimvubuRiver 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 inTable 10.1 below.

Table 10.1 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.

10.1.5 Integrated Environmental Importance assessment

As described above, the Ecological and SCI were assessed separately and were then integrated with the PES to determine the IEI. The PES forms part of the Integrated Environmental Importance as rivers (or wetlands) 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 IEI 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 SCI, but is in bad condition, the restoration potential is often low and that will result in a low IEI.

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 10.2) 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 10.2 Matrix used to determine a combined EIS/SCI and PES value which provides an IEI value

EIS &SCI (max)	Very high	4-5	3	3	3	4	5	5	5	5
	High	3-3.99	2	3	3	3	4	5	5	5
	Moderate	2-2.99	2	2	2	3	3	4	5	5
	Low	1-1.99	1	1	2	2	3	4	4	4
	Very low	0-0.99	1	1	1	2	2	3	4	4
			D/E to F	D	C/D	C	B/C	B	A/B	A
			>3.2	2.7-3.2	2.3-2.6	1.7-2.2	1.3-1.6	0.7-1.2	0.3-0.6	<0.3
			PES							

10.2 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 10.3.

Table 10.3 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.

10.3 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 10.4). The Y-axis is based on the Integrated Environmental Importance value derived from the first matrix (Table 10.2). 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 IEI of 3 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 10.4 Matrix used in assessing hotspots

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 Use Importance								

11 IDENTIFICATION OF HOTSPOTS

11.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

11.1.1 PESresults

The PES results are provided in Chapter 8.

11.1.2 River Ecological Importance and Sensitivity results

The results are available from the PESEIS study (DWA, 2013e). No review or adjustments have been made to these results during this study and they have been taken as is. The number of HIGH or VERY HIGH (>3) Ecological Important areas is provided per IUA (Table 11.1). The green shading shows any IUA with 70% or higher HIGH EI SQs.

Table 11.1 Number of High EI SQs per IUA

IUA	Number of SQs	Number of HIGH (>3) SQs	% of HIGH (>3) SQs
X1-1	9	0	0
X1-2	6	3	50
X1-3	7	2	29
X1-4	5	0	0
X1-5	5	4	80
X1-6	12	9	75
X1-7	2	2	100
X1-8	3	2	67
X1-9	7	0	0
X1-10	7	0	0
X2-1	7	4	57
X2-2	5	3	60
X2-3	7	0	0
X2-4	6	2	33
X2-5	2	0	0
X2-6	4	1	25
X2-7	8	3	38
X2-8	9	2	22
X2-9	6	3	50
X2-10	5	4	80
X2-11	6	4	67
X2-12	7	5	72
X2-13	10	10	100
X3-1	8	1	13
X3-2	8	3	38
X3-3	9	6	67
X3-4	9	1	11
X3-5	7	7	100
X3-6	11	9	82
X3-7	5	0	0
X3-8	7	2	29
X3-9	5	5	100
X4	24	20	83

11.1.3 River NFEPA results

The SQs with associated NFEPAsare listed and verified in Table 11.2. Note, that the SQs with a B/C evaluation was taken as verified due to the uncertainty whether it falls in a B or C PES.

Table 11.2 FEPA verification based on PES data and fish information

SQ	River	EI	PES	Veri-fication	FEPA comment
KOMATI (X1)					
X11A-01354		Moderate	C	✗	Unlikely to be in present ecological status of A or B.
X11A-01358	Vaalwaterspruit	Moderate	C	✗	Unlikely to be in present ecological status of A or B.
X11A-01295	Vaalwaterspruit	Moderate	C	✗	Unlikely to be in present ecological status of A or B.
X11B-01361		Moderate	B/C	?	*Barbus anoplus* present in this reach, but this species is not threatened. Uncertainty regarding the justification for use of this species in selecting FEPAs (no rationale provided in FEPA documentation).
X11B-01260	Komati			✗	Entire SQ in Nooitgedacht Dam.
X11C-01147	Witkloofspruit	Moderate	C	✗	Unlikely to be in present ecological status of A or B.
X11D-01129	Klein-Komati	Moderate	C	✗	Unlikely to be in present ecological status of A or B.
X11E-01237	Swartspruit	High	B/C	✗	Unlikely to be in present ecological status of A or B.
X11F-01133	Bankspruit	High	B	?	*B. anoplus* present in this reach, but this species is not threatened. Uncertainty regarding the justification for use of this species in selecting FEPAs (no rationale provided in FEPA documentation).
X12J-01202	Mtsoli	High	B	✓	PES in B and both species expected to be present. *Chiloglanis bifurcus* threatened but uncertain about *B. anoplus* rationale for inclusion.
X12K-01332	Mhlangampepa	High	B	?	Uncertain about the presence of this species in this SQ (low probability of occurrence).
X12K-01330	Komati			✗	Very short reach completely inundated by downstream weir.
X14A-01173	Lomati	High	B/C	✓	PES probably in low B. All mentioned species except *Barbusbrevipinus*, *C. bifurcus* and *Opsaridium peringueyi* expected to be present.
X14B-01166	Ugutugulo	High	C	?	Low probability of PES still being in A or B. All mentioned species except *B. brevipinus*, *C. bifurcus* and *O. peringueyi* expected to be present.
CROCODILE (X2)					
X21A-01008		Low	C/D	✗	Unlikely to still be in present ecological status of A or B. Ephemeral system (short drainage line). None of the mentioned species expected in this reach.
X21A-00930	Crocodile	High	C	✗	Unlikely to still be in present ecological status of A or B. None of the mentioned species expected in this reach.
X21B-00925	Lunsklip	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Kneria*sp.and

SQ	River	EI	PES	Veri-fication	FEPA comment
					Opsaridium sp.likely to be present).
X21B-00962	Crocodile	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X21C-00859	Alexander-spruit	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X21D-00957	Buffelskloof-spruit	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X21G-01090	Weltevrede-spruit	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Kneria* sp. and *Opsaridium* sp. likely to be present).
X21H-01060	Ngodwana	Moderate	C	✗	Unlikely to still be in present ecological status of A or B. (All fish species except *Opsaridium* sp. likely to be present).
X21J-01013	Elands	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X21K-01035	Elands	Moderate	D	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X21K-00997	Elands	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X22A-00917	Houtbosloop	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X22A-00913	Houtbosloop	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X22B-00987	Crocodile	High	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X22B-00888	Crocodile	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (all fish species except *Opsaridium* sp. likely to be present).
X22D-00843	Nels	Moderate	C	✗	Unlikely to still be in present ecological status of A or B (*C. bifrenatus* and *Opsaridium* sp.unlikely to be present).
X22K-01042	Mbuzulwane	Moderate	B	✓	PES in B. *H. vittatus* highly unlikely to be present, but *O. peringuyi* low probability of occurrence.
X22K-01043	Blinkwater	High	B	✓	PES in B. *H. vittatus* highly unlikely to be present, but *O. peringuyi* low probability of occurrence.
X24E-00973	Matjulu	High	B	✗	PES in B (low probability that *H. vittatus* is present and *C. brevis* actually introduced into the Crocodile System).
X24E-00922	Mlambeni	High	A/B	✗	PES in A/B (low probability that *H. vittatus* is present and *C. brevis* actually introduced into the Crocodile System).
X24G-00902	Mitomeni	High	A	✗	PES in A. Agree based on ecosystem type. Very low probability that *H. vittatus* is present due to ephemeral nature of stream).
X24G-00823	Muhlam-	High	A	?	PES in A. Agree based on ecosystem

SQ	River	EI	PES	Verification	FEPA comment
	bamadubo				type.Very low probability that *H. vittatus* is present due to ephemeral nature of stream.
X24G-00904	Mbyamiti	High	A	?	PES in A. Agree based on ecosystem type and low probability that *H. vittatus* is present at times in lower reaches.
X24H-00882	Vurhami	High	A	✗	PES in A. Agree based on ecosystem type. Very low probability that *H. vittatus* is present due to ephemeral nature of stream.
X24H-00892	Mbyamiti	High	A	?	PES in A. Agree based on ecosystem type and moderate probability that *H. vittatus* is present at times in lower reaches.
Sabie Sand catchment (X3)					
X31A-00778	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except *Serranochromismeridianus* and *O. peringueyi* expected to be present.
X31A-00783		Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except *S.meridianus* and *O. peringueyi* expected to be present.
X31A-00786		High	B	✓	PES estimated to still fall in B. *A. natalensis* most probably only of listed fish species present in this reach.
X31A-00799	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except *S. meridianus*and *O. peringueyi* expected to be present.
X31B-00756	Sabie	Moderate	B/C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except *S.meridianus*and *O. peringueyi* expected to be present.
X31B-00757	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except S. *meridianus, O. peringueyi* and *H. vittatus* expected to be present.
X31B-00792	Goudstroom	Moderate	B/C	✓	PES estimated to fall in a low B. All mentioned species except *S. meridianus and O. peringueyi* expected to be present.
X31C-00683	Mac-Mac	High	B/C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except *S.meridianus*expected to be present.
X31D-00755	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except S. *meridianus*and *H. vittatus* expected to be present.
X31F-00695	Motitsi	High	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species except S. *meridianus*expected to be present.
X31K-00715	Sabie	High	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species expected to be present.
X31K-00750	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species expected to be present.
X31K-00752	Sabie	Moderate	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species expected to be present.

SQ	River	EI	PES	Veri-fication	FEPA comment
X31K-00758	Sabie	High	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species expected to be present.
X31M-00681	Sabie	High	B/C	✓	PES estimated to still fall in low B. All mentioned species expected to be present.
X31M-00739	Sabie	High	B	✓	PES estimated to still fall in B. All mentioned species expected to be present.
X31M-00747	Sabie	High	B	✓	PES estimated to still fall in B. All mentioned species expected to be present.
X31M-00763	Nwaswitshaka	High	A	✓	PES estimated to still fall in A. All mentioned species expected to be present.
X32A-00583	Thulandziteka	High	D	✗	Highly unlikely to be in present ecological status of A or B. All mentioned species expected to be present.
X32B-00551	Motlamogat-sana	High	C	✗	Unlikely to be in present ecological status of A or B. All mentioned species expected to be present.
X32H-00560	Phungwe	High	A	✓	PES estimated to still fall in A. Low probability of *S meridianus* to be present.
X32J-00602	Sand	High	B	✓	PES estimated to still fall in A or B. All mentioned species expected to be present.
X32J-00651	Mutlumuvi	High	A	✗	PES estimated to still fall in A or B. Low probability of *H. vittatus* being present due to ephemeral nature of reach.
X32J-00730	Sand	High	B	✓	PES estimated to still fall in A or B. All mentioned species expected to be present.
X33A-00661	Nwatindlopfu	High	A	✗	PES estimated to still fall in A or B. Low probability of *H. vittatus* being present due to ephemeral nature of reach.
X33A-00731	Sabie	High	B	✓	PES estimated to still fall in B. All mentioned species expected to be present.
X33A-00737	Sabie	High	B	✓	PES estimated to still fall in B. All mentioned species expected to be present.
X33A-00806	Nwatimhiri	High	A	✗	PES estimated to still fall in A or B. Low probability of *H. vittatus* being present due to ephemeral nature of reach.
X33B-00694	Salitje	High	A	✗	PES estimated to still fall in A or B. Low probability of *H. vittatus* being present due to ephemeral nature of reach.
X33B-00784	Sabie	High	B	✓	PES estimated to still fall in B. All mentioned species expected to be present.
X33B-00804	Sabie	High	B/C	✓	PES estimated to still fall in low B. All mentioned species expected to be present.
X33B-00829	Sabie	High	A/B	✓	PES estimated to still fall in A or B. All mentioned species expected to be present.
X33C-00701	Mnondozi	High	A	✗	PES estimated to still fall in A or B. Low probability of *H. vittatus* being present due to ephemeral nature of reach.
X33D-00811	Sabie	High	B	✓	PES estimated to still fall in A or B. All mentioned species expected to be present.
X4					
X40D-00594	Metsimetsi	High	A	?	PES estimated to still fall in A. Agree based on river ecosystem type.
X40D-00660	Nwaswitsontso	High	A	?	PES estimated to still fall in A. Agree based on river ecosystem type.

11.1.4 Priority river-linked wetlands in the Inkomati WMA

Twenty nine moderate, high and very high priority sub-quaternary catchments were identified from the NFEPA database of wetlands within the study area that are likely to be important wetland systems linked to main rivers or large tributaries (Table 11.3).

Table 11.3 Priority wetlands and NFEPA verification based on PES data, vegetation information and integrated EIS

SQ	SQ name	PES	Primary PES Driver	NFEPA Check	Integrated EIS
X11A-01248	Vaalwaterspruit	C	Flow modification and landuse activities.	Some artificial but mostly true.	Moderate
X11A-01354		C	Flow reduction and landuse activities.	Many are small dams, but some pans and channelled valley-bottom wetlands.	Moderate
X11B-01272	Boesmanspruit	C	Landuse activities.	Both natural and artificial channelled valley-bottom wetlands.	High
X11C-01147	Witkloofspruit	C	Flow modification.	Many pans, but most wetlands associated with channel are dams.	High
X11D-01129	Klein-Komati	C	Flow reduction activities.	Many pans, but most wetlands associated with channel are dams.	Moderate
X11E-01237	Swartspruit	B/C	Landuse activities, water quality.	Extensive channel valley-bottom wetlands.	High
X11G-01143	Gemakstroom	B/C	Flow. Non-flow and water quality aspects.	Yes, mostly flat areas and seeps in headwaters.	Moderate
X11H-01140	Komati	C	Flow modification and overgrazing.	Extensive channel valley-bottom wetlands, but also some artificial wetlands associated with large dam.	High
X11K-01194	Gladdespruit	B/C	Landuse activities.	Mostly channelled valley-bottom wetlands associated with tributaries.	Moderate
X12A-01305	Buffelspruit	B/C	Forestry and Invasive vegetation.	Mostly natural seeps and channelled valley-bottom wetlands.	High
X12C-01271	Buffelspruit	B	Landuse activities, overgrazing.	Natural channelled valley-bottom wetlands.	Moderate
X12D-01235	Seekoeispruit	C	Urbanisation and landuse activities.	Natural channelled valley-bottom wetlands.	Moderate
X12E-01287	Teespruit	B/C	Flow and non-flow related impacts.	Extensive channelled valley-bottom wetlands.	High
X13J-01149	Komati	D/E	Flow modification and agriculture.	Extensive floodplain wetlands.	Moderate
X13J-01205	Mbiteni	D	Flow, non-flow and water quality impacts.	Natural floodplain wetlands, but artificial channelled valley-bottom wetlands associated with dam.	Moderate
X13J-01221	Komati	D	Flow modification, agricultural encroachment.	Extensive floodplain wetlands, mostly riparian.	Moderate
X13K-01068	Nkwakwa	D	Flow modification and reduction.	Mostly artificial channelled valley-bottom wetlands associated with dams.	Low
X13L-01000	Ngweti	D/E	Flow modification	Mostly dams.	Low

SQ	SQ name	PES	Primary PES Driver	NFEPA Check	Integrated EIS
			andreduction, dams.		
X14G-01128	Lomati	E	Dams, flow modification and reduction.	Artificial and associated with dam.	Moderate
X21A-00930	Crocodile	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.	Ramsar (VerlorenValei Nature Reserve), NFEPA mostly natural seeps.	Very High
X21A-01008		C/D	Flow reduction and small dams.	Short SQ with small area of natural seeps but all end in small dams.	Low
X21B-00898	Lunsklip	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.	Ramsar (VerlorenValei Nature Reserve), NFEPA mostly natural seeps.	Very High
X21B-00929	Gemsbokspruit	C	Small dams and pockets of forestry.	Ramsar (small portion of VerlorenValei Nature Reserve), NFEPA mostly natural seeps and some flat areas.	Very High
X21C-00859	Alexanderspruit	C/D	Dams, irrigation, forestry.	Both natural and artificial channelled valley-bottom wetlands, several associated with Kwena Dam backup.	High
X21F-01046	Elands	C	Many small dams and agricultural encroachment.	Extensive natural seeps and flat areas in tributaries some channelled valley-bottom wetlands, mostly natural.	High
X22C-01004	Gladdespruit	C	Afforestation/Invasive plants, landuse encroachment.	Extensive channelled valley-bottom wetlands and seeps.	High
X22H-00836	Wit	E	Flow modification, Dams.	Mostly dams or associated with dams but some channelled valley bottom wetlands around White River.	High
X23E-01154	Queens	C	Afforestation/Invasive plants.	Seep wetlands in upper reaches.	Low
X31F-00695	Motitsi	C	Forestry.	Channelled valley-bottom wetlands.	Moderate
X32A-00583	Tlulandziteka	D	Vegetation removal and overgrazing.	Extensive channelled valley-bottom wetlands.	High
X32B-00551	Motlamogatsana	D	Vegetation removal and overgrazing.	Extensive channelled valley-bottom wetlands.	High
X32D-00605	Mutlumuvi	D	Vegetation removal and overgrazing.	Extensive channelled valley-bottom wetlands.	High
X33A-00806	Nwatimhiri	A/B	In KNP.	NFEPAs are pans in KNP.	High
X40A-00469	Nwanedzi	C	Weirs.	Channelled valley-bottom wetlands, but partly Dumbana dam and other weirs, prominent pools.	Low

11.1.5 Socio-cultural importance

The following SQs, as set out in Table 11.4below, 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 Drakensberg or the high dependence on resources associated with poor and vulnerable communities located within the SQ.

Table 11.4 SCI that cored HIGH

SQ number	River	Comment
X13B-01347		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X13B-01348		River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive so social value is considered to be high.
X14C-01212	Phophonyane	Upper reaches (upper 50%) comprised solely of commercial agriculture (sugar cane) with no presence of human habitation. River extends past the Piggs peak area so elevated tourism/recreational value. Lower reaches (lower 50%) extends into the Komati township which has extensive rural homestead and informal agriculture along the river. High social value.
X14C-01203	Phophonyane	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river. High social value.
X14D-01174	Lomati	River section extends into the Lomati township which has extensive rural homesteads and informal agriculture along the river. High social value.
X14E-01172	Mlilambi	The upper reaches of the river section is located in Swaziland, and an area comprised of scattered rural homesteads, informal agricultural plots and open terrain. The lower reaches of the river extends into an area of higher population density (linked to the Hlohlo township) and extensive informal subsistence farm plots. Social value is high.
X13B-01270	Umlambongwenya	Upper reaches of the river section extends through plantation forestry, and a large farm dam. The river then passes the rural village of Ndzingeni (which contains both households and industrial features). The lower half of the river section extends through a mosaic of rural homesteads with informal agriculture, open terrain. Social value is moderate to high.
X13C-01364	Mbuyane	The river section headwaters are located in Malolotja Nature Reserve in Swaziland. Much of the river extent is, however, a mosaic of rural homesteads, informal agriculture and open terrain. Social value is considered to be high.
X13D-01323	Komati	Much of the river extent is a mosaic of rural homesteads, informal agriculture and open terrain. Formal small-holdings noted. Social value is considered to be moderate to high.
X13E-01389	Nyonyane	River section extends largely through a mosaic of open terrain and formal smallholdings (small-scale agriculture). Rural homesteads noted but not extensive. Social value is moderate.
X13E-01346	Komati	Upper reaches of the river section comprised of open terrain. Mid-reaches extend north of a large rural settlement of Bhalekane and extensive informal agricultural fields. Commercial agriculture also present on the lower reaches. Social value Is high.
X13F-01252	Mzimnene	Upper portions of the river section comprised of plantation forestry. Upper and mid-section of the river extend through a mosaic of open terrain, and rural homestead with extensive informal agriculture. Lower reaches extend into moderate density township (Bhalekane) with commercial agriculture on the river banks. Social value is considered to be high.
X13G-01261	Mphofu	Upper reaches of the river extends through a mosaic of plantation forestry and natural forests. Lower reaches extend through rural settlement (low density homesteads) with extensive informal agricultural plots.
X13G-01216	Mbulatana	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high. Social value is considered to be moderate to high.
X13G-01259	Mphofu	River section extends through a mosaic of open terrain, rural homesteads and informal agriculture. The latter two are extensive along much of the river extent so social value is considered to be high. Social value is considered to be moderate to high.
X13G-01282	Komati	River section is flanked on both banks by extensive commercial agriculture. Beyond the agricultural fields, is extensive rural settlement (low-density homestead) which flanks the river on certain sections. Social value is considered to be moderate to high.
X13H-01197	Mhlangatane	River section extends through a mosaic of low-density, rural homesteads with

SQ number	River	Comment
		extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river. Social value is considered to be high.
X13H-01226		River section extends through a mosaic of low-density, rural homesteads with extensive informal agricultural plots present and open terrain. Commercial agriculture is present on the lower reaches of the river. Social value is considered to be high.
X13H-01299		Upper reaches of the river section extends through rural settlements (rural homesteads) and extensive informal agricultural fields. Mid-reaches of the river section extend into open terrain/natural terrain with no human presence before discharging into the Sand River Reservoir. Lower reaches extend below the dam wall and cross commercial agricultural land. Social value is considered to be high.
X13H-01281	Komati	Small section of river which extends through commercial agricultural land, with rural homesteads found on the north bank. Social value is considered high.
X13J-01214	Mgobode	River section extends through open terrain and informal agricultural plots, of which the plots are linked to the MgodobeTownship located further down the river. The mid-reaches of the river extend through open terrain. The lower reaches of the river extend through the Madadeni Township, with some informal agricultural plots noted. Social value is considered to be moderate to high.
X13J-01141	Mzinti	River section is extends through extensive informal agricultural plots on it upper reaches, which are linked to the large Magogeni township located further down the river. The river extends through two additional large townships (Skoonplaas and Boschfontein). The lower reaches of the river include open terrain and an additional township (Mzinti). Social value is considered to be moderate to high.
X13K-01068	Nkwakwa	River section extends through a mosaic of open terrain, rural townships and limited informal agricultural plots. Lower-reaches of the river extend through commercial agriculture. Social value is considered to be moderate to high
X14E-01151	Lomati	The river section is located in Swaziland and extends through extensive commercial agriculture (sugar cane). The river extends into the Hlohlo township before discharging into the Driekoppies Dam in South Africa. Social value is considered to be high.
X24A-00826	Nsikazi	Upper reaches of the river section extends through Legogote Township and Manzini. Mid-reaches are comprised of open terrain and passes the Makoko Township.
X24C-00978	Nsikazi	Upper reaches of the river section passes the Ehlanzeni township, and then extends through open/natural terrain, associated with a nature reserve. Lower reaches of the river passes the Matsulu township.
X31K-00713	Bejani	River extends through open terrain. Marongwana township located on the north bank on the upper reaches of the river. Much of the mid and lower-reaches extend through extensive rural townships.
X31M-00673	Musutlu	River extends through open terrain. Three large townships located on the banks of the river.
X32E-00629	Nwarhele	Upper section low population density some forestry then very dense settlement of Shatale and Dwarsloop.
X32E-00639	Ndlobesuthu	Short river section with very dense settlement of Marijane and Dwarsloop.

11.1.6 IntegratedEnvironmental Importance results

The results are illustrated in Figure 11.1 to Figure 11.3. These results are similar to the Ecological Importance results provided in Table 11.1.

11.2 WATER RESOURCE USE IMPORTANCE

The 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 9.2. 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 are provided in Table 11.5.

Table 11.5 Number of High EI SQs per IUA

SQ	River	Comment
X11A-01300	Unnamed	AMD from coal mines.
X11A-01354	Unnamed	AMD from coal mines.
X11A-01358	Vaalwaterspruit	AMD from coal mines.
X11A-01295	Vaalwaterspruit	AMD from coal mines.
X11A-01248	Vaalwaterspruit	AMD from coal mines.
X11B-01370	Boesmanspruit	AMD from coal mines.
X11B-01361	Unnamed	AMD from coal mines.
X11B-01272	Boesmanspruit	AMD from coal mines.
X11B-01260	Komati	AMD from coal mines.
X11K-01179	Gladdespruit	High water useand transfers.
X11K-01194	Gladdespruit	High water use and transfers.
X11K-01227	Komati	High water use and transfers.
X12G-01200	Komati	High water use and transfers.
X13G-01282	Komati	High water use.
X13H-01299		High water use.
X13H-01281	Komati	High water use.
X13H-01277	Komati	High water use.
X13H-01280	Komati	High water use.
X13J-01221	Komati	High water use.
X13J-01210	Komati	High water use.
X13J-01149	Komati	High water use.
X13J-01130	Komati	High water use.
X13K-01114	Komati	High water use.
X13K-01038	Komati	High water use.
X13L-01000	Ngweti	High water use.
X13L-01027	Komati	High water use.
X13L-0995	Komati	High water use.
X14G-01128	Lomati	High water use.
X22H-00836	Wit	High water use.
X22J-00993	Crocodile	High water use.
X22J-00958	Crocodile	High water use.
X22K-00981	Crocodile	High water use.
X22K-01018	Crocodile	High water use.
X23G-01057	Kaap	High water use.
X24C-01033	Crocodile	High water use.
X24D-00994	Crocodile	High water use.
X24E-00982	Crocodile	High water use.
X24F-00953	Crocodile	High water use.
X24H-00880	Crocodile	High water use.
X24H-00934	Crocodile	High water use.
X31D-00755	Sabie	High water use.
X31D-00773	Sabani	High water use.
X31E-00647	Marite	High water use.

11.3 PRIORITYAREAS – HOTSPOTS

The identified hotspots are illustrated in Table 11.6and the mapsin Figure 11.1 to Figure 11.3. Only hotspots with the maximum evaluation, i.e. a 4 scoring, has been provided.

Table 11.6 Hotspot results

SQ	River	IEI (0-5)	WRUI (0-4)	Hotspot
KOMATI (X1)				
X11A-01300	Unnamed	4	4	4
X11A-01354	Unnamed	3	4	4
X11A-01358	Vaalwaterspruit	3	4	4
X11A-01295	Vaalwaterspruit	3	4	4
X11A-01248	Vaalwaterspruit	3	4	4
X11B-01370	Boesmanspruit	4	4	4
X11B-01361	Unnamed	3	4	4
X11B-01272	Boesmanspruit	3	4	4
X11F-01163	Komati	5	3	4
X11G-01142	Komati	4	3	4
X11K-01179	Gladdespruit	3	4	4
X11K-01194	Gladdespruit	3	4	4
X11K-01227	Komati	4	4	4
X12G-01200	Komati	3	4	4
X12H-01296	Komati	4	3	4
X12H-01258	Komati	4	3	4
X14H-01066	Lomati	3	4	4
CROCODILE (X2)				
X22J-00993	Crocodile	3	4	4
X22J-00958	Crocodile	3	4	4
X22K-00981	Crocodile	3	4	4
X22K-01018	Crocodile	3	4	4
X23G-01057	Kaap	3	4	4
X24C-01033	Crocodile	3	4	4
X24D-00994	Crocodile	3	4	4
X24E-00982	Crocodile	3	4	4
X24F-00953	Crocodile	3	4	4
X24H-00880	Crocodile	3	4	4
X24H-00934	Crocodile	3	4	4
SABIE-SAND (X3)				
X31D-00755	Sabie	3	4	4
X31E-00647	Marite (US of dam)	4	4	4
X31M-00681	Sabie	4	3	4
X31M-00739	Sabie	5	3	4
X32J-00602	Sand	5	3	4
X32J-00730	Sand	5	3	4
X33A-00731	Sabie	5	3	4
X33A-00737	Sabie	5	3	4
X33B-00784	Sabie	5	3	4
X33B-00804	Sabie	4	3	4
X33B-00829	Sabie	5	3	4
X33D-00811	Sabie	5	3	4
X33D-00861	Sabie	5	3	4
X31E-00647	Marite (ds of Inyaka Dam)	3	4	4

The rivers where hotspots dominate are mostly on the main stems of the rivers. This can largely be attributed to the cumulative impact of water use and deteriorating water quality relating to industrial and urban development and well as mining.

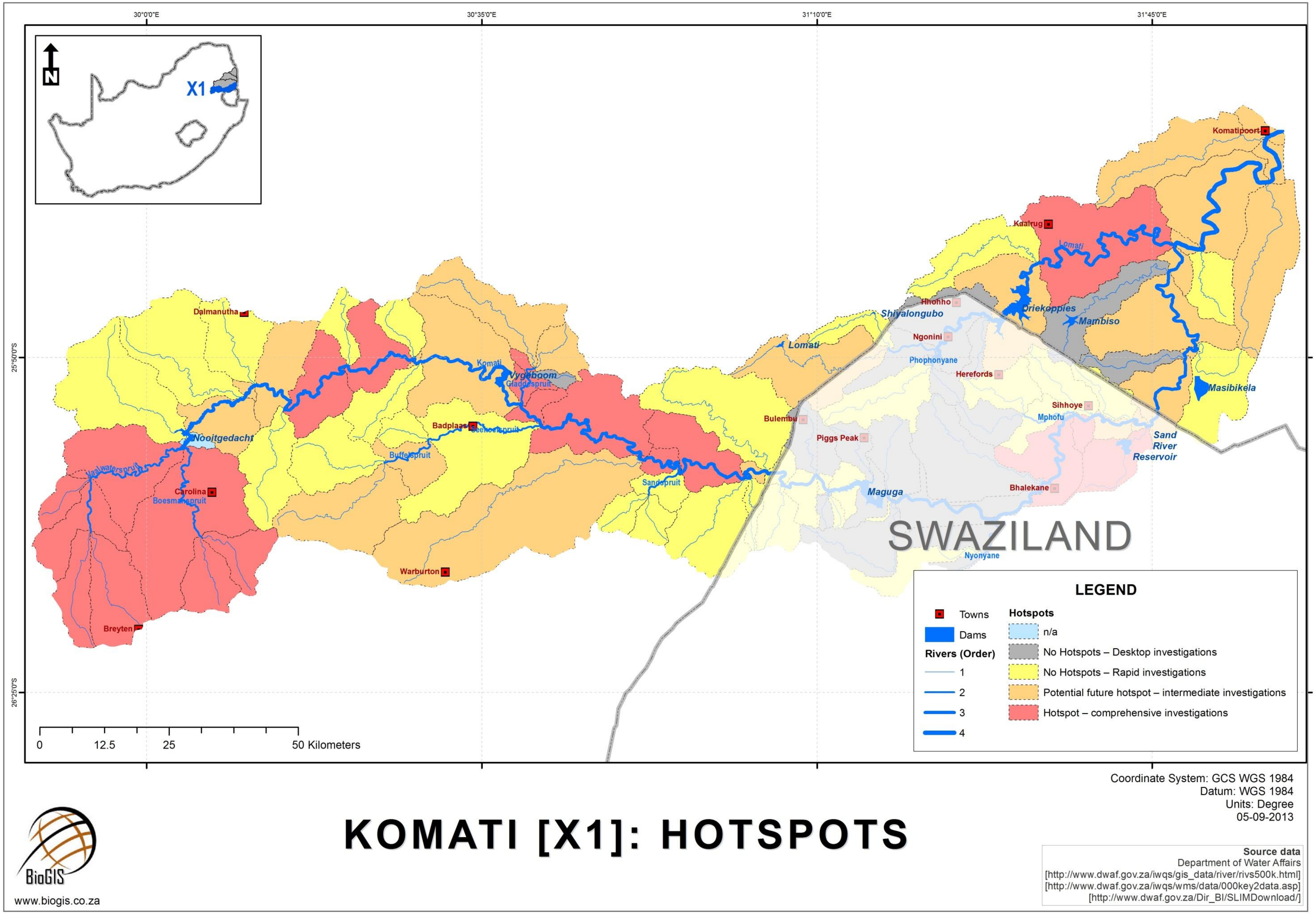

Figure 11.1 Hotspots in the Komati (X1)

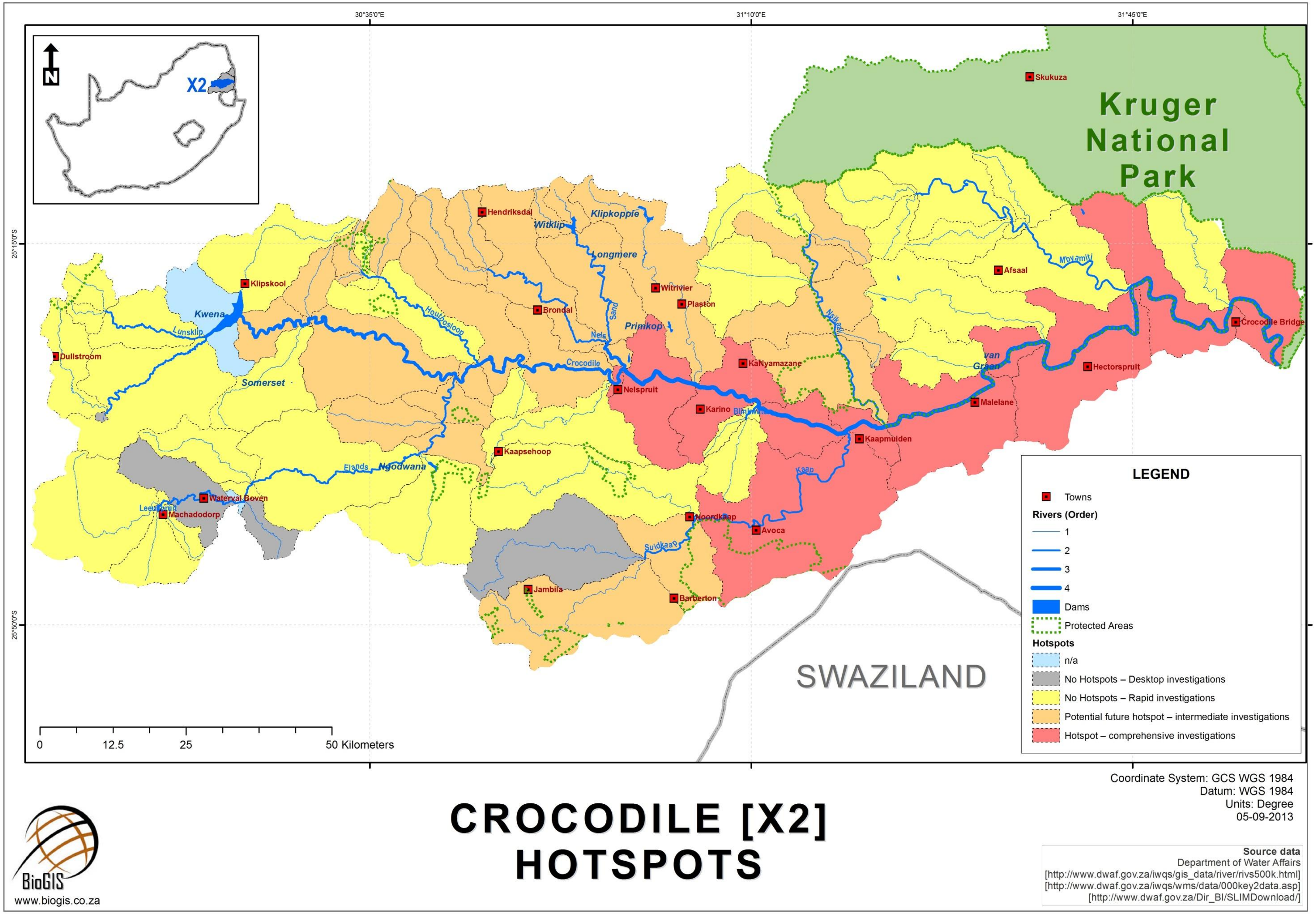

Figure 11.2 Hotspots in the Crocodile (X2)

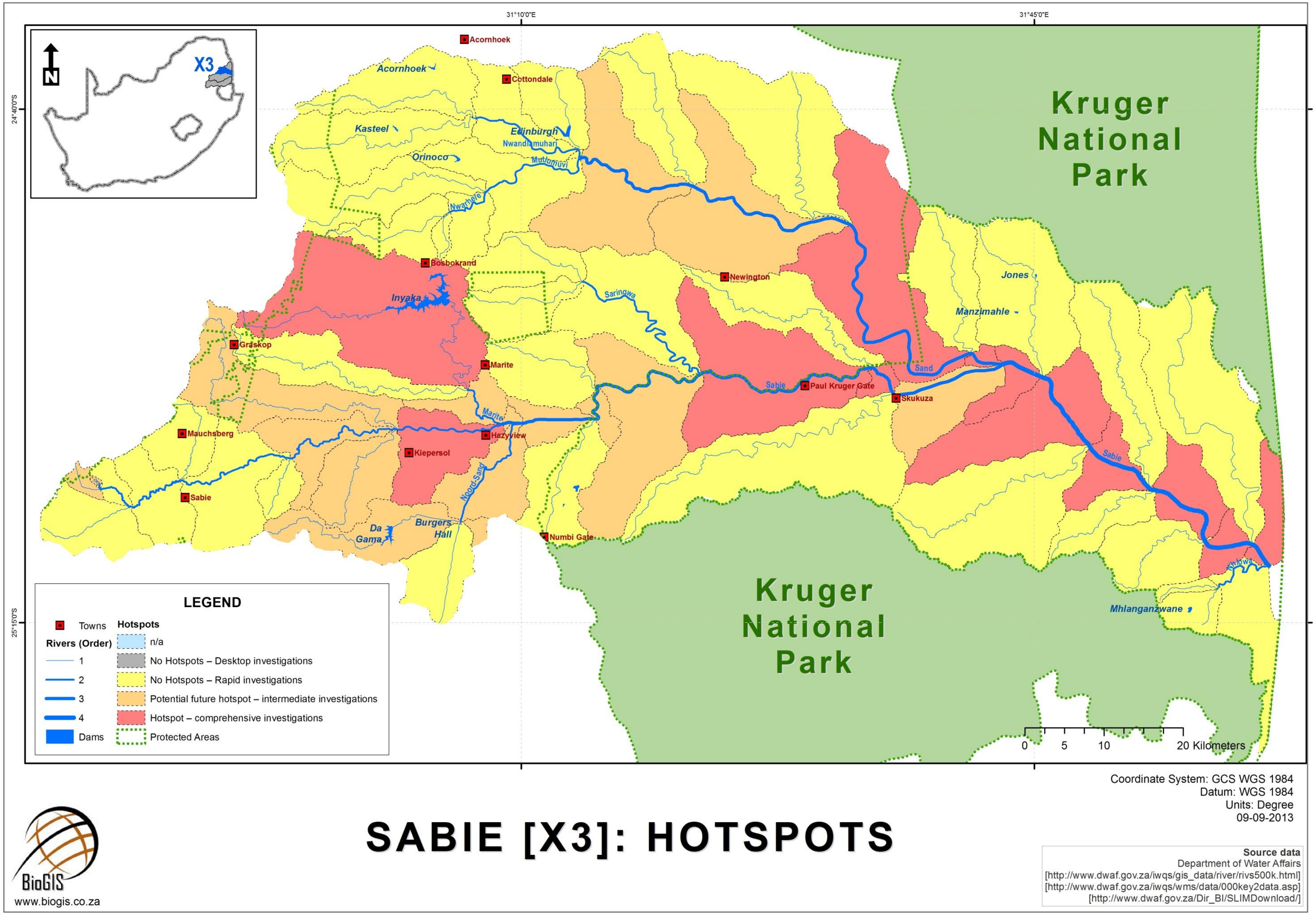

Figure 11.3 Hotspots in the Sabie-Sand (X3)

12 BIOPHYSICAL NODES AND LEVEL OF EWR ASSESSMENT

12.1 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 aretherefore nested within the IUAs (DWAF, 2007b) and represents flow requirements and ecological state relevant for the RU (SQ). This is illustrated in Figure 12.1.

- IUA represented by the salmon coloured catchment.
- RUs or SQ reaches represented by 9 river reaches each identified by a code e.g. X11A-01354.
- Each SQ is represented by a node - the 7 black circles within the IUA.

Figure 12.1 Illustration of biophysical nodes and RU (SQ reaches) nested within an IUA

12.2 BIOPHYSICAL NODES

Each SQ unit is a surrogate for a desktop RU and must be represented by a desktop biophysical node. As there are 238 SQs, this implies that there 238 biophysical nodes. These nodes were plotted at the end of each SQ (Figure 12.2 to Figure 12.4).

There are21 EWR sites, i.e. key biophysical nodes (Figure 12.2 to Figure 12.4). The key biophysical sites replaced 21 of the desktop biophysical nodes and therefore there are217 desktop biophysical nodes and 21 key biophysical nodes.

The list of nodes and the coordinates are provided in Tables in Appendix B and Figure 12.2 to Figure 12.4.

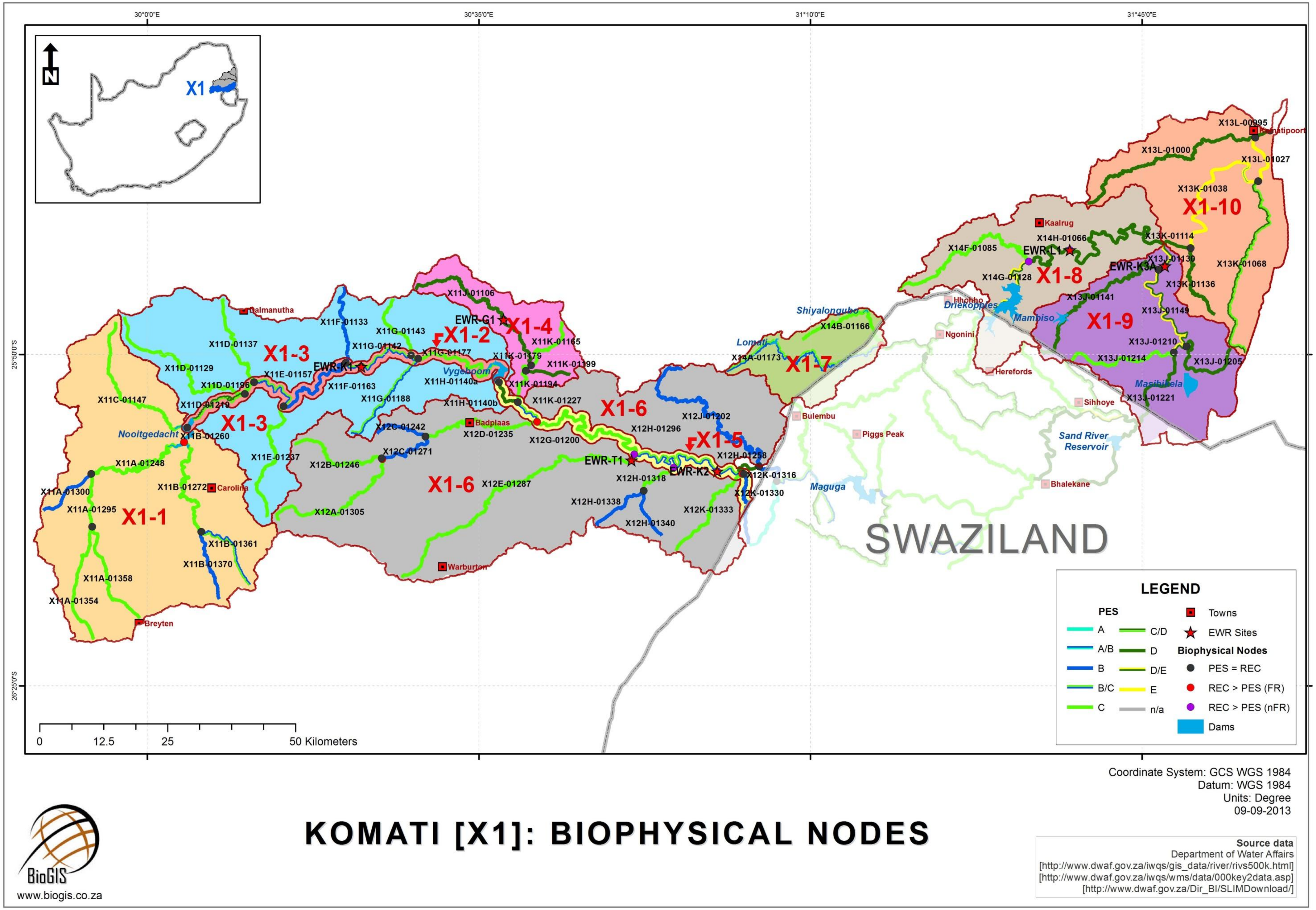

Figure 12.2 Biophysical nodes in Komati (X1)

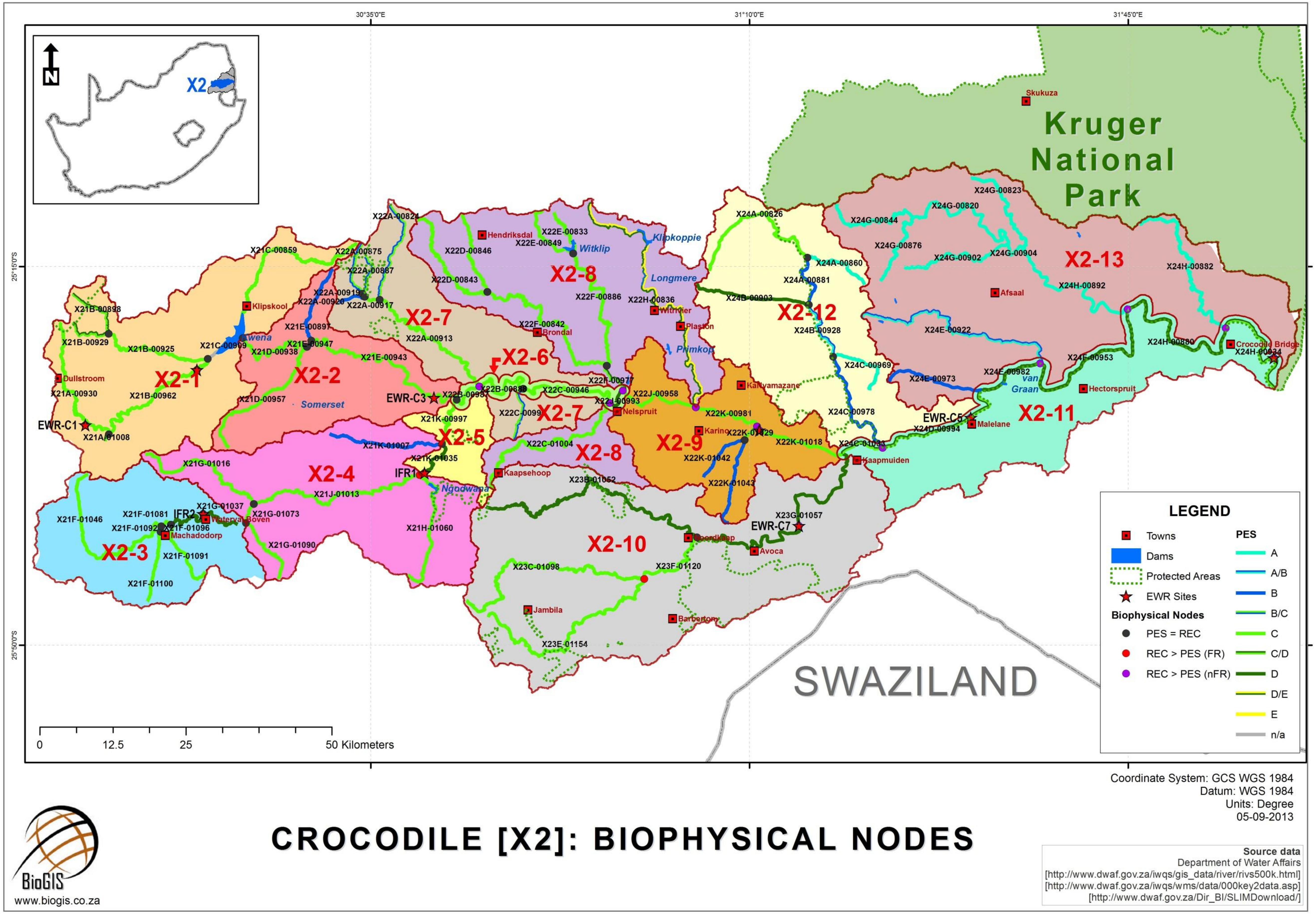

Figure 12.3 Biophysical nodes in Crocodile (X2)

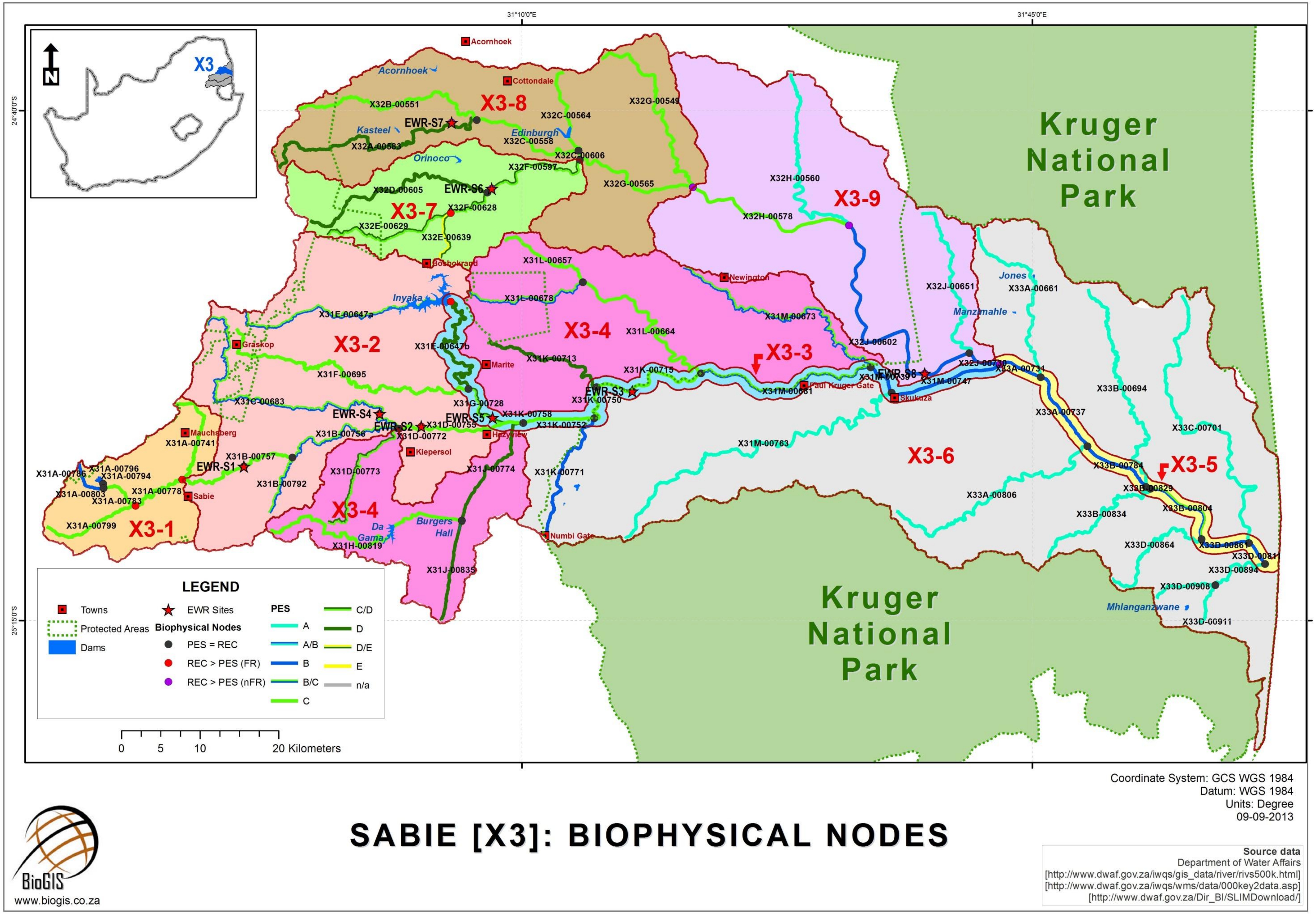

Figure 12.4 Biophysical nodes in Sabie (X3)

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14 APPENDIX A: GROUNDWATER INFORMATION

14.1 SUMMARY OF THE AVERAGE GROUNDWATER QUALITY ESTIMATES FOR EACH OF THE INKOMATI GUAS (IN MG/L)

GUAs	Parameter	pH	EC (ms/m)	Total Dissolved Solids	Alkalinity as $CaCO_3$	Ca	Mg	Na	K	Cl	SO_4	Nitrate as N	Ammonia as N	PO_4 as P	F	Fe	Mn	Al
GUA1-1	N	6	6	5	6	6	6	5	5	6	5	6	5	5	6	1	1	1
	Mean	7.6	34.0	251.4	135.1	28.6	8.5	23.9	3.6	10.7	9.1	2.3	0.03	0.02	0.3	0.011	0.002	0.021
GUA1-2	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3			
	Mean	8.0	23.0	188.7	111.8	20.2	10.2	11.0	0.6	3.4	2.8	0.5	0.05	0.07	0.3			
GUA1-3	N	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
	Mean	7.4	11.7	111.0	45.8	7.7	4.2	6.5	1.2	28.1	4.8	0.4	0.03	0.01	0.6	0.003	0.001	0.026
GUA1-4	N	4	4	4	4	4	4	4	4	4	4	4	4	4	4			
	Mean	7.2	16.7	115.8	58.6	8.7	8.4	6.8	0.5	5.4	3.0	2.2	0.11	0.02	0.1			
GUA1-5	N	29	29	29	29	29	29	29	29	29	29	29	29	29	29	2	2	2
	Mean	7.8	57.3	448.3	202.9	27.5	27.6	53.6	3.1	58.9	11.6	3.9	0.05	0.02	0.8	0.065	0.002	0.041
GUA1-6	N	52	52	52	52	52	52	52	52	52	52	52	52	52	52	1	1	1
	Mean	8.3	155.4	1058.8	299.7	63.3	54.3	193.2	4.9	340.0	17.2	4.4	0.17	0.03	0.5	0.006	0.815	0.035
GUA1-7	N	10	10	10	10	10	10	10	10	10	10	10	10	10	10			
	Mean	8.0	149.7	1098.6	343.9	65.5	51.9	183.8	2.5	285.8	42.7	10.5	0.04	0.03	0.6			
GUA2-1	N	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Mean	7.6	22.9	183.1	107.3	19.0	13.3	5.8	0.7	4.1	4.2	1.0	0.04	0.02	0.2	0.039	0.006	0.040
GUA2-2	N	3	3	2	3	3	3	2	3	2	3	3	3	3	3	1	1	1
	Mean	8.2	30.6	186.5	107.2	17.3	11.5	4.4	2.4	3.8	6.5	0.3	0.03	0.03	1.2	0.017	0.019	0.014
GUA2-3	N	11	11	10	11	11	11	10	10	11	10	11	10	10	11			
	Mean	7.7	47.9	351.9	108.5	36.1	22.3	28.6	1.0	68.9	40.7	1.0	0.02	0.01	0.2			
GUA2-4	N	24	24	22	24	24	24	23	23	24	22	23	23	23	23	6	6	4
	Mean	7.9	52.2	451.9	204.9	28.1	18.7	63.8	3.1	37.1	14.0	2.4	0.07	0.02	1.1	0.008	0.024	0.029
GUA2-5	N	34	34	34	34	34	34	34	34	34	34	34	34	34	34			
	Mean	8.0	58.6	479.5	246.9	27.6	34.8	50.4	1.6	25.0	25.9	2.8	0.03	0.03	0.5			
GUA2-6	N	41	41	39	40	40	40	40	40	40	40	39	39	39	39	3	3	3
	Mean	8.5	108.0	887.3	420.8	35.7	37.8	162.9	1.6	128.4	9.5	0.8	0.06	0.02	1.0	0.074	0.004	0.173
GUA3-1	N	22	22	22	22	22	22	22	22	22	22	22	22	22	22	3	3	3
	Mean	7.5	20.1	161.6	76.1	14.0	9.1	12.5	2.9	12.0	11.3	1.5	0.03	0.03	0.4	0.037	0.004	0.011

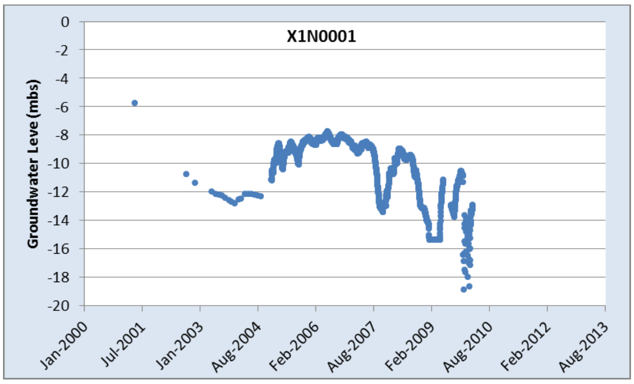
GUAs	Parameter	pH	EC (ms/m)	Total Dissolved Solids	Alkalinity as $CaCO_3$	Ca	Mg	Na	K	Cl	SO_4	Nitrate as N	Ammonia as N	PO_4 as P	F	Fe	Mn	Al
GUA3-2	N	143	143	143	143	143	143	143	143	143	143	143	143	143	143	41	41	41
	Mean	7.8	72.0	492.3	189.3	34.0	26.1	70.2	2.1	83.9	9.5	7.9	0.03	0.03	0.6	0.024	0.012	0.043
GUA3-3	N	300	300	299	300	300	300	299	299	300	299	300	299	299	300	74	75	76
	Mean	7.9	72.7	529.5	213.0	35.2	23.2	82.3	2.7	80.9	12.4	7.2	0.05	0.04	0.7	0.025	0.036	0.055
GUA3-4	N	124	124	123	124	124	124	124	124	124	124	123	123	123	124	29	30	30
	Mean	8.2	197.0	1447.0	536.5	58.7	76.5	270.4	4.2	332.5	25.3	5.1	0.10	0.02	0.8	0.037	0.027	0.059
GUA3-5	N	11	11	11	11	11	11	11	11	11	11	11	11	11	11	3	3	3
	Mean	8.6	221.5	1559.8	516.8	75.9	65.4	325.6	1.6	445.4	12.6	0.2	0.22	0.02	1.3	3.607	0.017	0.500
GUA4-1	N	70	70	63	70	70	70	69	69	70	69	64	63	63	70	10	10	11
	Mean	8.5	235.3	1743.2	560.8	65.8	84.7	341.1	4.2	450.8	30.9	6.5	0.07	0.03	1.1	0.489	0.004	0.370
Drinking Water Quality Limits - DWAF, 1996																		
Class 1		5-6 or 9-9.5	70-150	450-1000		80-150	30-70	100-200	25-50	100-200	200-400	6-10			0.7-1	0.1-0.2	0.05-0.1	0-0.15
Class 2		4-5 or 9.5-10	150-370	1000-2400		150-300	70-100	200-600	50-100	200-600	400-600	10-20			1-1.5	0.2-2	0.1-1	0.15-0.5
Class 3		3.5-4 or 10-10.5	370-520	2400-3400		>300	100-200	600-1200	100-500	600-1200	600-1000	20-40			1.5-3.5	2-10	1-5	>0.5

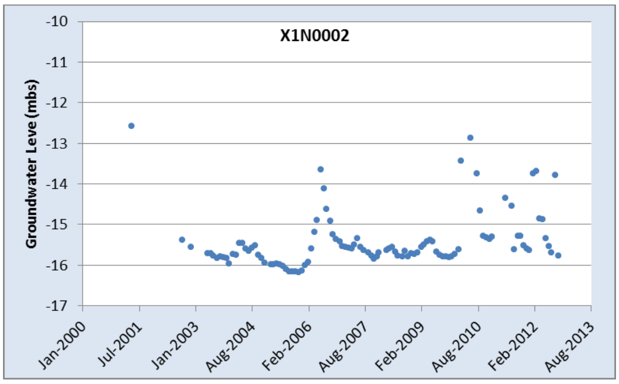
14.2 WATER LEVEL MONITORING STATIONS FOR THEKOMATI SUB-CATCHMENT

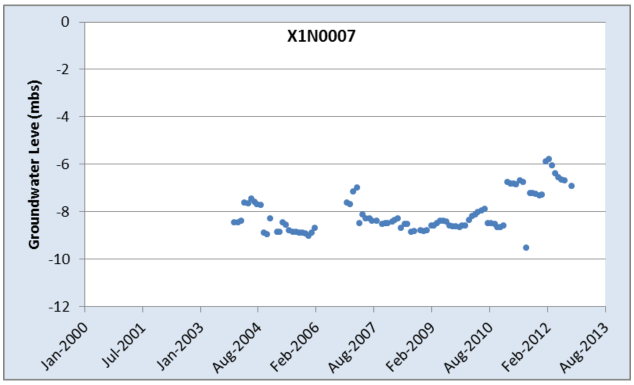
GUA	Station	Range Start	Range End	Comment
GUA1-5	X1N0001	May-01	Mar-10	Seasonal fluctuation approx. 2m (Decreasing trend)*
	X1N0002	May-01	Sep-12	Seasonal fluctuation approx. 1m
	X1N0003	May-01	Mar-10	Seasonal fluctuation approx. 2m (Decreasing trend)*
	X1N0004	May-01	Mar-10	Seasonal fluctuation approx. 2m (Decreasing trend)*
	X1N0005	Dec-04	Mar-10	Seasonal fluctuation approx. 3m (Decreasing trend)*
	X1N0006	May-01	Sep-12	Seasonal fluctuation approx. 1.5m
GUA1-6	X1N0007	Dec-03	Sep-12	Seasonal fluctuation approx. 2m
	X1N0008	Blocked		
	X1N0009	Nov-03	Sep-08	Poor dataset
	X1N0011	Nov-03	Sep-08	Poor dataset
	X1N0013	May-01	Mar-10	Seasonal fluctuation approx. 3m (Decreasing trend)*

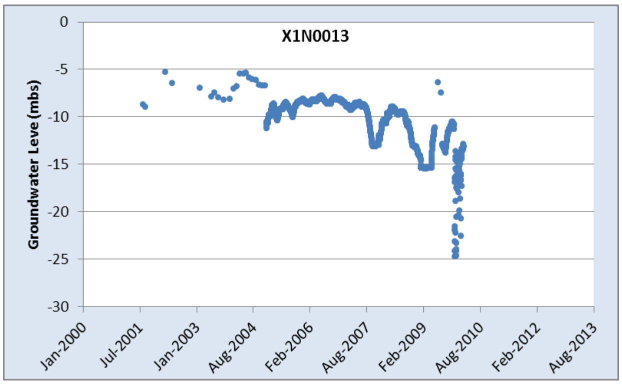
* - Datasets needs to be re-checked with DWA (appear to have faulty readings).

14.3 SELECTED WATER LEVEL MONITORING TRENDS FOR THE KOMATI SUB-CATCHMENT

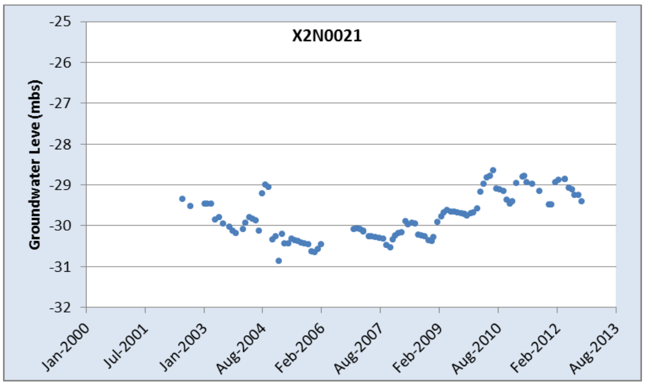


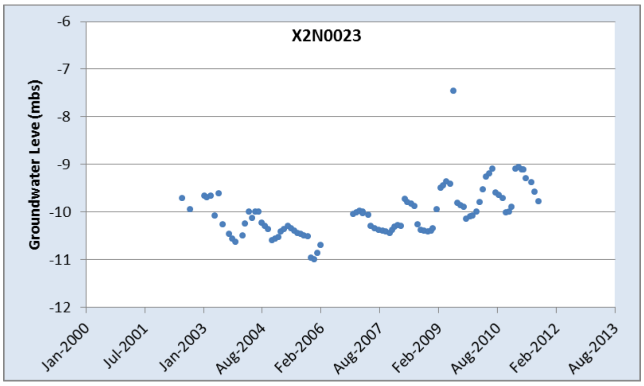


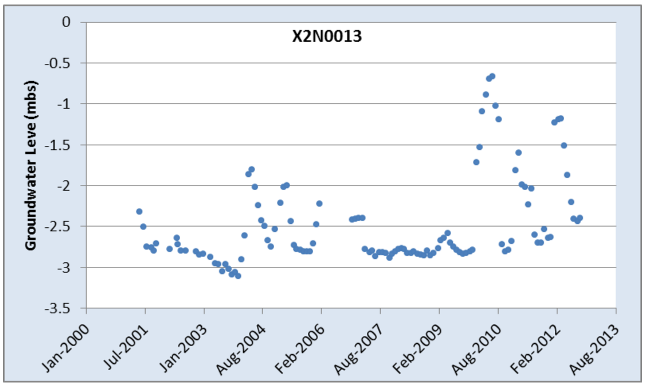


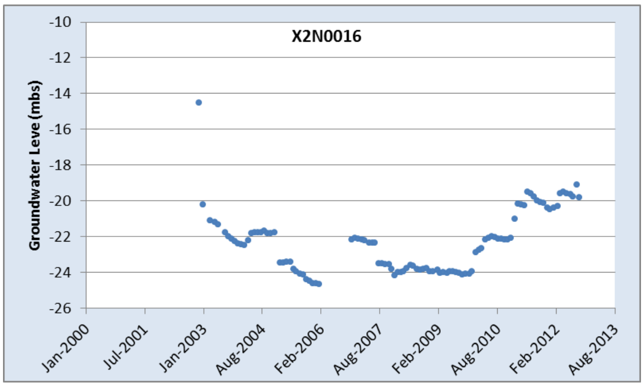


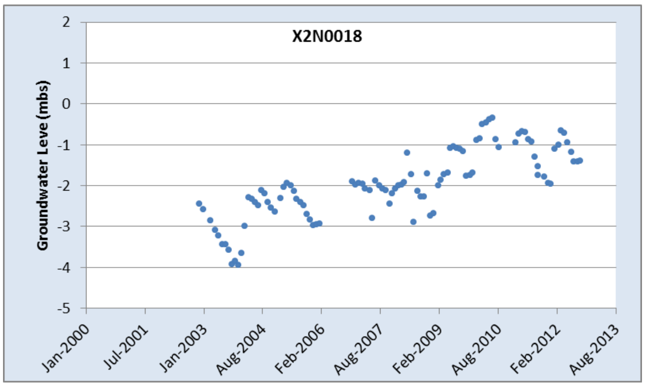
14.4 SELECTED WATER LEVEL MONITORING TRENDS FOR THE CROCODILE SUB-CATCHMENT

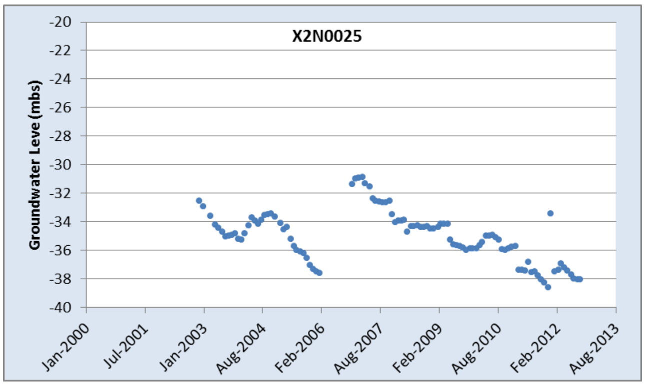


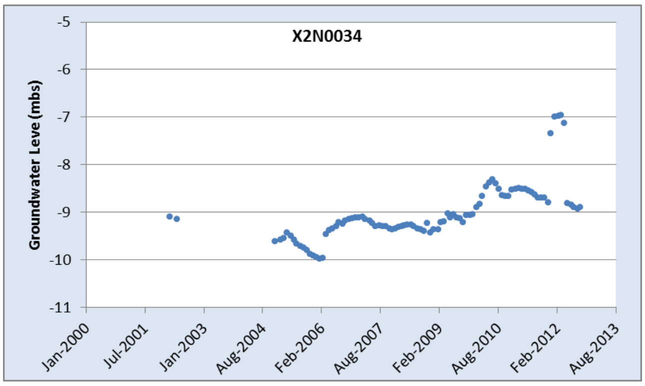


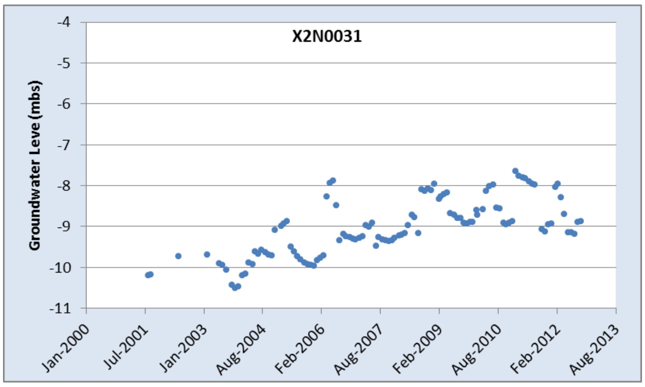




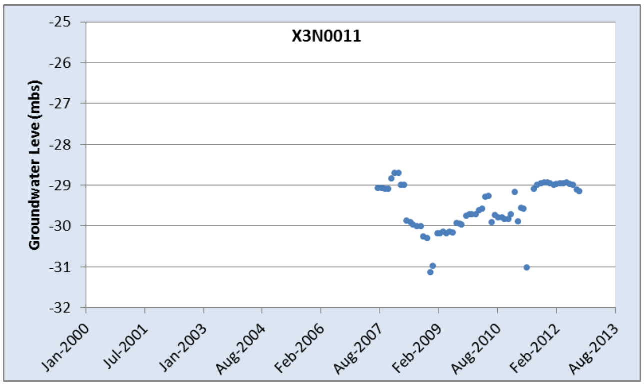


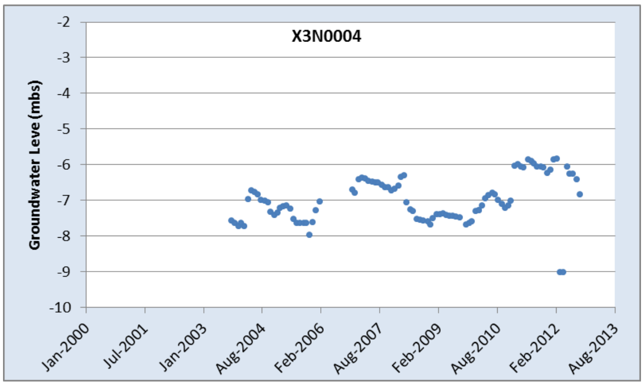


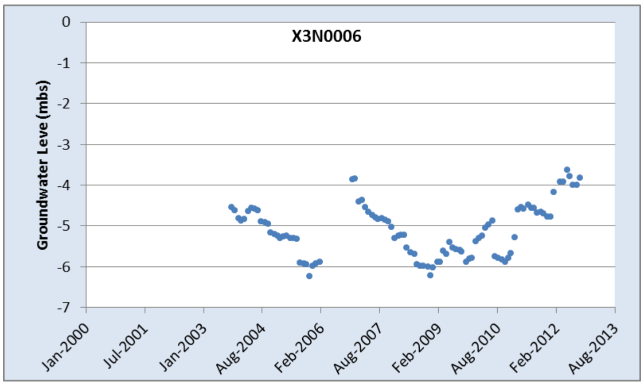


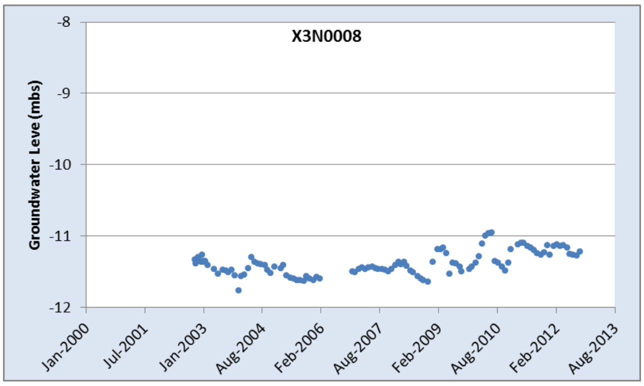


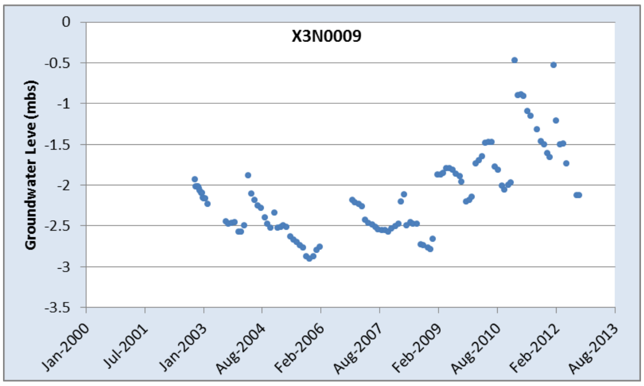
14.5 SELECTED WATER LEVEL MONITORING TRENDS FOR THE SABIE-SAND SUB-CATCHMENT

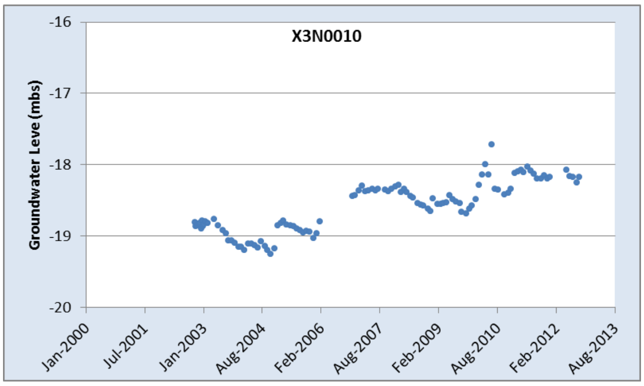












15 APPENDIX B: LIST OF BIOPHYSICAL NODES

15.1 NODES IN KOMATI SUB-CATCHMENT (X1)

Node name	River	Latitude	longitude
X11A-01300		29.901619	-26.043195
X11A-01354		29.903282	-26.136537
X11A-01358	Vaalwaterspruit	29.903282	-26.136537
X11A-01295	Vaalwaterspruit	29.901619	-26.043195
X11A-01248	Vaalwaterspruit	30.064878	-25.987793
X11B-01370	Boesmanspruit	30.095085	-26.145410
X11B-01361		30.095085	-26.145410
X11B-01272	Boesmanspruit	30.064878	-25.987793
X11C-01147	Witkloofspruit	30.070526	-25.961761
X11D-01129	Klein-Komati	30.171723	-25.902315
X11D-01137	Waarkraalloop	30.188055	-25.881858
X11D-01219	Komati	30.171723	-25.902315
X11D-01196	Komati	30.188055	-25.881858
X11E-01237	Swartspruit	30.239969	-25.924258
X11E-01157	Komati	30.239969	-25.924258
X11F-01133	Bankspruit	30.349398	-25.847839
X11F-01163	Komati	30.349398	-25.847839
X11G-01188	Ndubazi	30.476752	-25.840409
X11G-01143	Gemakstroom	30.464371	-25.834540
EWR K1	Komati	30.376917	-25.854333
X11G-01177	Komati	30.476752	-25.840409
X11H-01140a	Komati	30.619260	-25.882054
EWR G1	Mngubhudle	30.627167	-25.771722
X11K-01165	Poponyane	30.675658	-25.852089
X11K-01199		30.666182	-25.861636
X11K-01179	Gladdespruit	30.666182	-25.861636
X11K-01194	Gladdespruit	30.652178	-25.917194
X11K-01227	Komati	30.686115	-25.951856
X12A-01305	Buffelspruit	30.413796	-26.017430
X12B-01246	Hlatjiwe	30.412570	-26.015757
X12C-01242	Phophenyane	30.489833	-25.977363
X12C-01271	Buffelspruit	30.489833	-25.977363
X12D-01235	Seekoeispruit	30.686115	-25.951856
EWR T1	Teespruit	30.852028	-26.019306
X12G-01200	Komati	30.857172	-26.008955
X12H-01338	Sandspruit	30.873505	-26.072969
X12H-01340		30.873505	-26.072969
X12H-01318	Sandspruit	30.926179	-26.032450
X12H-01296	Komati	30.926179	-26.032450
EWR K2	Komati	31.003139	-26.038806
X12J-01202	Mtsoli	31.076913	-26.030391
X12K-01333	Mlondozi	31.046929	-26.043396
X12K-01332	Mhlangampepa	31.049691	-26.043312
X13J-01214	Mgobode	31.806151	-25.829605
X13J-01141	Mzinti	31.779227	-25.683896
X13J-01205	Mbiteni	31.828514	-25.819159
X13J-01221	Komati	31.806151	-25.829605

Node name	River	Latitude	longitude
X13J-01210	Komati	31.828514	-25.819159
X13J-01149	Komati	31.779227	-25.683896
EWR K3A	Komati	31.790556	-25.677639
X13K-01136	Mambane	31.835547	-25.645813
X13K-01068	Nkwakwa	31.954807	-25.527723
X13K-01114	Komati	31.835547	-25.645813
X13K-01038	Komati	31.954807	-25.527723
X13L-01000	Ngweti	31.949442	-25.451165
X13L-01027	Komati	31.949442	-25.451165
X13L-00995	Komati	31.975633	-25.438925
X14A-01173	Lomati	31.291161	-25.816625
X14B-01166	Ugutugulo	31.291161	-25.816625
X14G-01128	Lomati	31.551168	-25.669340
EWR L1	Lomati	31.623194	-25.649444
X11H-01140b	Komati	30.652178	-25.917194

15.2 NODES IN CROCODILE SUB-CATCHMENT (X2)

Node name	River	Latitude	longitude
X21A-01008		30.180424	-25.508425
EWR C1	Crocodile	30.144267	-25.494117
X21B-00929	Gemsbokspruit	30.179772	-25.353381
X21B-00898	Lunsklip	30.179772	-25.353381
X21B-00925	Lunsklip	30.332546	-25.392130
EWR C2	Crocodile	30.315917	-25.409250
X21C-00859	Alexanderspruit	30.386504	-25.360259
X21D-00957	Buffelskloofspruit	30.485462	-25.373669
X21D-00938	Crocodile	30.485462	-25.373669
X21E-00897	Buffelskloofspruit	30.492217	-25.364207
X21E-00947	Crocodile	30.492217	-25.364207
EWR C3	Crocodile	30.681083	-25.452117
X21F-01046	Elands	30.261029	-25.650038
X21F-01100	Leeuspruit	30.260027	-25.658560
X21F-01096	Dawsonsspruit	30.260027	-25.658560
X21F-01091	Rietvleispruit	30.275882	-25.647559
X21F-01092	Leeuspruit	30.261029	-25.650038
X21F-01081	Elands	30.275882	-25.647559
X21G-01090	Weltevredespruit	30.391423	-25.644958
X21G-01016	Swartkoppiespruit	30.403514	-25.615848
EWR E2	Elands	30.325700	-25.631000
X21G-01073	Elands	30.403514	-25.615848
X21H-01060	Ngodwana	30.659034	-25.571118
X21J-01013	Elands	30.659034	-25.571118
X21K-01007	Lupelule	30.693240	-25.523112
EWR E1	Elands	30.666600	-25.567970
X21K-00997	Elands	30.716140	-25.455119
X22A-00875	Houtbosloop	30.570615	-25.291982
X22A-00887	Beestekraalspruit	30.570615	-25.291982
X22A-00824	Blystaanspruit	30.597237	-25.301118
X22A-00920		30.574348	-25.296581
X22A-00919	Houtbosloop	30.574348	-25.296581

Node name	River	Latitude	longitude
X22A-00917	Houtbosloop	30.597237	-25.301118
X22A-00913	Houtbosloop	30.750933	-25.434752
X22B-00987	Crocodile	30.750933	-25.434752
X22B-00888	Crocodile	30.818499	-25.438256
X22C-00990	Visspruit	30.818499	-25.438256
X22C-01004	Gladdespruit	30.951838	-25.460160
X22C-00946	Crocodile	30.951838	-25.460160
X22D-00843	Nels	30.763034	-25.289088
X22D-00846		30.763034	-25.289088
X22E-00849	Sand	30.895318	-25.229733
X22E-00833	Kruisfonteinspruit	30.895318	-25.229733
X22F-00842	Nels	30.946953	-25.402865
X22F-00886	Sand	30.946953	-25.402865
X22F-00977	Nels	30.971776	-25.440951
X22H-00836	Wit	31.084151	-25.466807
X22J-00993	Crocodile	30.971776	-25.440951
X22J-00958	Crocodile	31.084151	-25.466807
X22K-01042	Mbuzulwane	31.159293	-25.517065
X22K-01043	Blinkwater	31.159293	-25.517065
X22K-01029	Blinkwater	31.178499	-25.496232
X22K-00981	Crocodile	31.178499	-25.496232
EWR C4	Crocodile	31.181983	-25.502433
X23B-01052	Noordkaap	31.085839	-25.666957
X23C-01098	Suidkaap	31.004886	-25.731028
X23E-01154	Queens	31.004886	-25.731028
X23F-01120	Suidkaap	31.085839	-25.666957
EWR C7	Kaap	31.242867	-25.649467
X24A-00826	Nsikazi	31.256131	-25.236111
X24A-00860	Sithungwane	31.256131	-25.236111
X24A-00881	Nsikazi	31.258286	-25.308924
X24B-00903	Gutshwa	31.258286	-25.308924
X24B-00928	Nsikazi	31.295574	-25.388972
X24C-00969	Mnyeleni	31.295574	-25.388972
X24C-00978	Nsikazi	31.371761	-25.529119
X24C-01033	Crocodile	31.371761	-25.529119
EWR C5	Crocodile	31.507733	-25.482867
X24E-00973	Matjulu	31.525035	-25.441064
X24E-00922	Mlambeni	31.614235	-25.399149
X24E-00982	Crocodile	31.614235	-25.399149
X24F-00953	Crocodile	31.749136	-25.315390
X24G-00902	Mitomeni	31.565255	-25.215165
X24G-00876	Komapiti	31.419149	-25.173662
X24G-00844	Mbyamiti	31.419149	-25.173662
X24G-00823	Muhlambamadubo	31.588910	-25.225746
X24G-00820	Mbyamiti	31.565255	-25.215165
X24G-00904	Mbyamiti	31.588910	-25.225746
X24H-00882	Vurhami	31.900315	-25.344798
X24H-00892	Mbyamiti	31.749136	-25.315390
X24H-00880	Crocodile	31.900315	-25.344798
EWR C6	Crocodile	31.974450	-25.390500

15.3 NODES IN SABIE-SAND SUB-CATCHMENT (X3)

Node name	River	Latitude	Longitude
X31A-00741	Klein Sabie	30.778273	-25.088558
X31A-00778	Sabie	30.778273	-25.088558
X31A-00783		30.724951	-25.118765
X31A-00786		30.688401	-25.098420
X31A-00794		30.687692	-25.093399
X31A-00796		30.687692	-25.093399
X31A-00799	Sabie	30.724951	-25.118765
X31A-00803		30.688401	-25.098420
X31B-00756	Sabie	31.024965	-25.030371
EWR S1	Sabie	30.848733	-25.073733
X31B-00792	Goudstroom	30.904354	-25.063381
EWR S4	Mac-Mac	31.004050	-25.013333
EWR S2	Sabie	31.051650	-25.027917
X31D-00772	Sabie	31.026430	-25.030545
X31D-00773	Sabani	31.024965	-25.030371
X31E-00647a	Marite (US of dam)	31.085425	-24.885110
X31F-00695	Motitsi	31.105664	-24.984968
EWR S5	Marite	31.133283	-25.017950
X31H-00819	White Waters	31.097900	-25.135438
X31J-00774	Noord-Sand	31.168160	-25.023881
X31J-00835	Noord-Sand	31.097900	-25.135438
X31K-00713	Bejani	31.252151	-24.982929
EWR S3	Sabie	31.292867	-24.987600
X31K-00750	Sabie	31.252151	-24.982929
X31K-00752	Sabie	31.249431	-25.018560
X31K-00758	Sabie	31.168160	-25.023881
X31K-00771	Phabeni	31.249431	-25.018560
X31L-00657	Matsavana	31.236268	-24.862835
X31L-00664	Saringwa	31.371648	-24.967105
X31L-00678	Saringwa	31.236268	-24.862835
X31M-00673	Musutlu	31.565360	-24.960396
X31M-00681	Sabie	31.565360	-24.960396
X31M-00739	Sabie	31.589296	-24.989273
X31M-00747	Sabie	31.713623	-24.956582
X31M-00763	Nwaswitshaka	31.589296	-24.989273
EWR S7	Tlulandziteka	31.086467	-24.680483
X32B-00551	Motlamogatsana	31.115045	-24.677367
X32C-00558	Nwandlamuhari	31.231231	-24.712592
X32C-00564	Mphyanyana	31.231231	-24.712592
X32C-00606	Nwandlamuhari	31.232947	-24.722944
X32D-00605	Mutlumuvi	31.127077	-24.760297
X32E-00629	Nwarhele	31.085209	-24.783758
X32E-00639	Ndlobesuthu	31.085209	-24.783758
EWR S6	Mutlumuvi	31.132050	-24.755867
X32F-00628	Nwarhele	31.127077	-24.760297
X32G-00549	Khokhovela	31.362012	-24.754170
X32G-00565	Sand	31.362012	-24.754170
X32H-00560	Phungwe	31.540747	-24.797912
X32H-00578	Sand	31.540747	-24.797912

Node name	River	Latitude	Longitude
EWR S8	Sand	31.627350	-24.967417
X32J-00651	Mutlumuvi	31.678425	-24.944025
X32J-00730	Sand	31.713623	-24.956582
X33A-00661	Nwatindlopfu	31.759761	-24.971639
X33A-00731	Sabie	31.759761	-24.971639
X33A-00737	Sabie	31.813267	-25.050528
X33A-00806	Nwatimhiri	31.813267	-25.050528
X33B-00694	Salitje	31.880364	-25.097013
X33B-00784	Sabie	31.880364	-25.097013
X33B-00804	Sabie	31.943619	-25.156946
X33B-00829	Sabie	31.885354	-25.099254
X33B-00834	Lubyelubye	31.885354	-25.099254
X33C-00701	Mnondozi	31.997889	-25.161332

16 APPENDIX C: WETLANDS

16.1 EXPECTED WETLAND POTENTIAL PER QUATERNARY CATCHMENT

Quat	NFEPA Wetland Type								Wetland FEPA		Tot Wetland Area (km^2)		RAMSAR	Wetland 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 (occurs in quat)	(NFEPA, 2013)	% Quat comprising wetland		Potential Wetland Importance (0-3)
X11A	215	72	78		66	20		451	Y	Y	24.24	3.61		3
X11B	87	49	43		38	17	6	240	Y	Y	19.55	3.28		3
X11C	42	65	23		41	7	3	181	Y	Y	26.99	8.47		3
X11D	31	62	39		89	14	1	236	Y	Y	7.95	1.35		3
X11E	8	15	41		30	3		97	Y	Y	11.10	4.60		1
X11F			12		11			23			1.15	0.63		1
X11G	8	1	31		8	3		51		Y	2.43	0.92		1
X11H	31		18		1	18	14	82			12.36	4.66		1
X11J	6		7		8			21			1.82	0.98		1
X11K	36		55		37	4	51	183	Y	Y	23.72	11.26		3
X12A	22	2	74		30	3		131	Y	Y	16.08	6.58		2
X12B	7	4	11		18			40	Y	Y	3.61	2.33		1
X12C	42		18		3	8		71		Y	6.20	3.33		1
X12D	36		54		4	9	36	139	Y	Y	19.81	8.88		3
X12E	23	4	30		17	1		75	Y	Y	11.41	3.43		1
X12F	25		36		7	3	10	81	Y	Y	13.77	4.40		1
X12G	6		13		1		27	47	Y	Y	6.94	2.91		1
X12H	11		4			5		20			0.34	0.12		1
X12J					1			1			0.00	0.00		1
X12K	14		5		1	15		35			0.65	0.23		1
X13A	3		1		3			7			1.49	0.61		1
X13B	6		3				1	10			17.18	7.26		2
X13C								0			0.00	0.00		1
X13D								0			0.00	0.00		1
X13E								0			0.00	0.00		1
X13F					1		1	2			0.02	0.01		1
X13G	8			4				12			2.11	0.63		1
X13H	4		4	10	2	1	6	27			15.02	4.92		2
X13J	76	13	14	10	27	14	16	170	Y	Y	23.53	2.98		3
X13K	180	10	84		27	35	12	348			15.03	2.42		3

Quat	NFEPA Wetland Type								Wetland FEPA		Tot Wetland Area (km^2)		RAMSAR	Wetland 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 (occurs in quat)	(NFEPA, 2013)	% Quat comprising wetland		Potential Wetland Importance (0-3)
X13L	71	2	28		64	5	1	171			9.14	3.19		**2**
X14A	5					1		6			0.96	0.68		**1**
X14B					1			1			0.33	0.18		**1**
X14C	3	1	1					5			0.08	0.05		**1**
X14D	4							4			0.04	0.03		**1**
X14E	7		4			2	5	18			22.01	12.42		**3**
X14F								0			0.00	0.00		**1**
X14G	38		34			6	107	185			24.70	12.10		**3**
X14H	124		59	2	17	16	8	226			8.65	2.40		**3**
X21A	25		114		201	13		353	Y	Y	33.20	12.53	Y	**3**
X21B	20		46		162	19		247	Y	Y	25.54	6.75	Y	**3**
X21C	66		25		13	53	23	180		Y	23.65	7.60		**3**
X21D	12		1		8	5		26			10.81	4.93		**1**
X21E	7		1		1	20		29			0.16	0.05		**1**
X21F	76	4	122		125	17		344	Y	Y	16.38	4.13		**3**
X21G	16		14		48	3		81	Y	Y	1.71	0.49		**1**
X21H	11		5		1		4	21			2.50	1.09		**1**
X21J	6		3		4	6		19			1.71	0.48		**1**
X21K			2					2			0.02	0.01		**1**
X22A	7		1		2	1		11			0.07	0.03		**1**
X22B	3		5		2	11		21			0.23	0.10		**1**
X22C	281		70		83	61	6	502	Y	Y	8.23	2.25		**3**
X22D	9		2		1	1		13			0.10	0.04		**1**
X22E	13		5				15	33			3.36	2.20		**1**
X22F	10		18		6	11		45	Y		0.21	0.10		**1**
X22G	9		1		1		3	14		Y	3.71	3.45		**1**
X22H	147		24		46	14		231		Y	5.54	2.77		**3**
X22J	74		25		30	15		144	Y	Y	1.60	0.67		**2**
X22K	55		4		47	20		126			2.61	0.78		**2**
X23A	17		2					19			0.16	0.12		**1**
X23B	26		5			2		33	Y		0.43	0.19		**1**
X23C					5			5			0.27	0.33		**1**
X23D	72		25		2	1		100			0.87	0.48		**2**
X23E			13		9			22			4.97	2.76		**1**

Quat	NFEPA Wetland Type								Wetland FEPA		Tot Wetland Area (km^2)		RAMSAR	Wetland 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 (occurs in quat)	(NFEPA, 2013)	% Quat comprising wetland		Potential Wetland Importance (0-3)
X23F	43		21		1	37		102			0.80	0.26		2
X23G	12					7		19			0.32	0.14		1
X23H	29		3		10	48	1	91			0.90	0.29		1
X24A	10		1		2			13			0.37	0.15		1
X24B	27					8		35			1.32	0.39		1
X24C	35		2		1	7		45			1.94	0.68		1
X24D	55		5		7	23	1	91			3.66	1.21		1
X24E	60	3	21		2	7	4	97			5.49	1.04		1
X24F	67	1	9		17	7		101		Y	3.66	1.40		2
X24G	5				4	2		11			0.15	0.02		1
X24H	65	1	27		11	11	5	120			11.98	1.56		2
X31A	9				1	3		13			0.58	0.25		1
X31B	4				5	1		10			0.10	0.05		1
X31C	1		4		7			12		Y	0.62	0.40		1
X31D	102		49		119	2	2	274			4.50	2.35		3
X31E	20	1	8		31			60	Y	Y	8.39	3.92		1
X31F	8		14				5	27		Y	2.53	2.69		1
X31G	15				5	3		23			0.35	0.21		1
X31H			1		4			5			1.29	2.14		1
X31J	101		25		36	1		163			3.45	2.24		2
X31K	45		6		1	2		54			4.71	0.97		1
X31L	21				5	1		27			0.79	0.26		1
X31M	36		10		21	10		77			7.83	1.10		1
X32A	55		52			14	13	135	Y	Y	6.09	5.43		2
X32B	23		10		3	2		38	Y	Y	1.82	3.29		1
X32C	22		10	4	2	4		42	Y	Y	2.28	0.98		1
X32D	37		36		12	8	4	97	Y	Y	3.49	3.49		1
X32E					1			1	Y		0.06	0.08		1
X32F	27		11			4	1	43	Y	Y	0.81	0.52		1
X32G	43		9		13	8		73			1.17	0.35		1
X32H	70	1	12		25	11	3	122			1.96	0.40		2
X32J	33				2	4		39			1.80	0.51		1
X33A	16	1	1		1	2		21	Y	Y	5.36	0.89		1
X33B	17	4	1			1	1	24	Y	Y	3.19	1.03		1

Quat	NFEPA Wetland Type								Wetland FEPA		Tot Wetland Area (km^2)		RAMSAR	Wetland 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 (occurs in quat)	(NFEPA, 2013)	% Quat comprising wetland		Potential Wetland Importance (0-3)
X33C	8	2						10	Y		0.24	0.13		**1**
X33D	26		1			1	3	31			4.12	1.18		**1**
X40A	28	4	6		1	2		41	Y	Y	1.34	0.14		**1**
X40B	27	13	4		3			47	Y	Y	1.21	0.16		**1**
X40C	44	7	7		24			82			1.95	0.21		**1**
X40D	35	4	4		1	2		46			1.45	0.25		**1**
Total	**3422**	**346**	**1727**	**30**	**1728**	**726**	**399**	**8380**	**11**	**23**			**2**	**18 (High)**

16.2 EXPECTED WETLAND POTENTIAL PER SUB-QUATERNARY CATCHMENTS

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X11A-01300		5	0	0	0	0	1	0	6	1		FALSE
X11C-01147	Witkloofspruit	23	10	0	0	19	1	0	53	3	Y	TRUE
X14G-01128	Lomati	9	0	11	0	0	0	51	71	3		TRUE
X14H-01066	Lomati	7	0	7	2	0	0	3	19	2		FALSE
X11D-01129	Klein-Komati	0	5	4	0	15	1	0	25	2	Y	TRUE
X11D-01137	Waarkraalloop	0	0	1	0	3	0	0	4	1		FALSE
X11D-01219	Komati	4	0	0	0	0	0	0	4	1		FALSE
X11D-01196	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11E-01237	Swartspruit	0	2	2	0	11	0	0	15	2	Y	TRUE
X11E-01157	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11F-01133	Bankspruit	0	0	0	0	5	0	0	5	1		FALSE
X11F-01163	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11G-01188	Ndubazi	1	0	0	0	0	0	0	1	1		FALSE
X11A-01354		14	2	3	0	11	3	0	33	3		TRUE
X11G-01143	Gemakstroom	0	0	4	0	0	1	0	5	1	Y	TRUE
X11G-01142	Komati	2	0	0	0	0	0	0	2	1		FALSE
X11G-01177	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11H-01140	Komati	13	0	5	0	0	6	7	31	3		TRUE
X11J-01106	Mngubhudle	2	0	7	0	4	0	0	13	1		FALSE
X11K-01165	Poponyane	4	0	0	0	2	0	0	6	1		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X11K-01199		3	0	0	0	6	0	0	9	1		FALSE
X11K-01179	Gladdespruit	0	0	0	0	0	0	0	0	0		FALSE
X11K-01194	Gladdespruit	3	0	0	0	0	0	0	3	1	Y	TRUE
X11K-01227	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11A-01358	Vaalwaterspruit	14	0	2	0	1	1	0	18	2		FALSE
X12A-01305	Buffelspruit	6	0	15	0	4	2	0	27	2	Y	TRUE
X12B-01246	Hlatjiwe	1	0	0	0	5	0	0	6	1		FALSE
X12C-01242	Phophenyane	1	0	0	0	0	0	0	1	1		FALSE
X12C-01271	Buffelspruit	9	0	0	0	0	0	0	9	1	Y	TRUE
X12D-01235	Seekoeispruit	6	0	2	0	0	5	0	13	1	Y	TRUE
X12E-01287	Teespruit	31	0	8	0	1	1	5	46	3	Y	TRUE
X12G-01200	Komati	1	0	0	0	0	0	0	1	1		FALSE
X12H-01338	Sandspruit	0	0	0	0	0	0	0	0	0		FALSE
X12H-01340		0	0	0	0	0	0	0	0	0		FALSE
X12H-01318	Sandspruit	1	0	0	0	0	1	0	2	1		FALSE
X11A-01295	Vaalwaterspruit	11	0	0	0	0	0	0	11	1		FALSE
X12H-01296	Komati	2	0	0	0	0	0	0	2	1		FALSE
X12H-01258	Komati	6	0	0	0	0	1	0	7	1		FALSE
X12J-01202	Mtsoli	0	0	0	0	1	0	0	1	1		FALSE
X12K-01333	Mlondozi	1	0	0	0	0	0	0	1	1		FALSE
X12K-01332	Mhlangampepa	0	0	0	0	0	0	0	0	0		FALSE
X12K-01330	Komati	0	0	0	0	0	0	0	0	0		FALSE
X12K-01316	Komati	4	0	0	0	0	1	0	5	1		FALSE
X13A-01337	Maloloja	0	0	0	0	0	0	0	0	0		FALSE
X13A-01255	Nkomazana	1	0	0	0	0	0	0	1	1		FALSE
X13A-01302	Komati	2	0	0	0	0	0	0	2	1		FALSE
X11A-01248	Vaalwaterspruit	0	1	1	0	0	1	0	3	1	Y	TRUE
X13A-01324	Komati	3	0	0	0	0	0	0	3	1		FALSE
X13A-01328	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13B-01347		0	0	0	0	0	0	0	0	0		FALSE
X13B-01348		0	0	0	0	0	0	0	0	0		FALSE
X13B-01276	Mkhomazane	3	0	0	0	0	0	0	3	1		FALSE
X13B-01270	Umlambongwenya	1	0	0	0	0	0	0	1	1		FALSE
X13B-01345		3	0	0	0	0	0	0	3	1		FALSE
X13B-01319	Komati	2	0	0	0	0	0	0	2	1		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X13B-01317	Komati	3	0	0	0	0	0	0	3	1		FALSE
X13B-01351	Komati	0	0	0	0	0	0	0	0	0		FALSE
X11B-01370	Boesmanspruit	0	0	0	0	0	0	0	0	0		FALSE
X13C-01364	Mbuyane	1	0	0	0	0	0	0	1	1		FALSE
X13D-01323	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13E-01415		0	0	0	0	0	0	0	0	0		FALSE
X13E-01429	Nyonyane	0	0	0	0	0	0	0	0	0		FALSE
X13E-01389	Nyonyane	0	0	0	0	0	0	0	0	0		FALSE
X13E-01346	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13F-01252	Mzimnene	0	0	0	0	0	0	0	0	0		FALSE
X13G-01261	Mphofu	0	0	0	0	0	0	0	0	0		FALSE
X13G-01216	Mbulatana	0	0	0	0	0	0	0	0	0		FALSE
X13G-01259	Mphofu	0	0	0	2	0	0	0	2	1		FALSE
X11B-01361		1	0	0	0	0	0	0	1	1		FALSE
X13G-01282	Komati	0	0	0	1	0	0	0	1	1		FALSE
X13H-01197	Mhlangatane	1	0	0	2	0	0	0	3	1		FALSE
X13H-01226		0	0	0	2	0	0	0	2	1		FALSE
X13H-01299		1	0	0	3	1	0	0	5	1		FALSE
X13H-01281	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13H-01277	Komati	0	0	0	8	0	0	0	8	1		FALSE
X13H-01280	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13J-01214	Mgobode	0	0	0	1	0	0	0	1	1		FALSE
X13J-01141	Mzinti	9	0	0	0	7	0	0	16	2		FALSE
X13J-01205	Mbiteni	0	2	0	2	0	1	2	7	1	Y	TRUE
X11B-01272	Boesmanspruit	5	0	0	0	0	1	0	6	1	Y	TRUE
X13J-01221	Komati	1	0	0	10	0	0	6	17	2	Y	TRUE
X13J-01210	Komati	0	0	0	2	0	0	2	4	1		FALSE
X13J-01149	Komati	14	0	0	1	0	1	0	16	2	Y	TRUE
X13J-01130	Komati	0	0	0	0	0	0	0	0	0		FALSE
X13K-01136	Mambane	2	0	0	0	0	0	0	2	1		FALSE
X13K-01068	Nkwakwa	21	2	2	0	6	0	1	32	3		TRUE
X13K-01114	Komati	9	0	3	0	0	1	0	13	1		FALSE
X13K-01038	Komati	5	0	2	0	0	9	0	16	2		FALSE
X13L-01000	Ngweti	43	0	5	0	18	0	0	66	3		TRUE
X13L-01027	Komati	14	1	4	0	0	3	0	22	2		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X11B-01260	Komati	5	0	3	0	0	0	3	11	1		FALSE
X13L-0995	Komati	0	0	0	0	0	0	0	0	0		FALSE
X14A-01173	Lomati	3	0	0	0	0	1	0	4	1		FALSE
X14B-01166	Ugutugulo	0	0	0	0	1	0	0	1	1		FALSE
X14C-01212	Phophonyane	0	0	0	0	0	0	0	0	0		FALSE
X14C-01220	Mgobode	0	0	0	0	0	0	0	0	0		FALSE
X14C-01203	Phophonyane	0	0	0	0	0	0	0	0	0		FALSE
X14D-01174	Lomati	0	0	0	0	0	0	0	0	0		FALSE
X14E-01172	Mlilambi	1	0	0	0	0	0	0	1	1		FALSE
X14E-01151	Lomati	4	0	0	0	0	0	0	4	1		FALSE
X14F-01085	Mhlambanyatsi	4	0	1	0	0	0	0	5	1		FALSE
X21A-01008		0	0	0	0	1	0	0	1	1	Y	TRUE
X21A-00930	Crocodile	2	0	31	0	77	0	0	110	3	Y	TRUE
X21B-00929	Gemsbokspruit	0	0	2	0	9	0	0	11	1		FALSE
X21B-00898	Lunsklip	0	0	1	0	17	0	0	18	2		FALSE
X21B-00925	Lunsklip	1	0	0	0	8	0	0	9	1		FALSE
X21B-00962	Crocodile	1	0	0	0	1	3	0	5	1		FALSE
X21C-00859	Alexanderspruit	18	0	1	0	11	11	0	41	3		TRUE
X21C-00909	Crocodile	4	0	0	0	0	0	0	4	1		FALSE
X21D-00957	Buffelskloofspruit	2	0	1	0	5	3	0	11	1		FALSE
X21D-00938	Crocodile	0	0	0	0	0	0	0	0	0		FALSE
X21E-00897	Buffelskloofspruit	0	0	0	0	0	0	0	0	0		FALSE
X21E-00947	Crocodile	0	0	0	0	0	0	0	0	0		FALSE
X21E-00943	Crocodile	2	0	0	0	0	7	0	9	1		FALSE
X21F-01046	Elands	28	0	23	0	44	4	0	99	3	Y	TRUE
X21F-01100	Leeuspruit	2	0	0	0	0	0	0	2	1		FALSE
X21F-01096	Dawsonsspruit	0	0	0	0	0	0	0	0	0		FALSE
X21F-01091	Rietvleispruit	1	0	0	0	0	1	0	2	1		FALSE
X21F-01092	Leeuspruit	0	0	0	0	0	0	0	0	0		FALSE
X21F-01081	Elands	0	0	0	0	0	0	0	0	0		FALSE
X21G-01090	Weltevredespruit	0	0	0	0	2	0	0	2	1		FALSE
X21G-01016	Swartkoppiespruit	0	0	1	0	8	0	0	9	1		FALSE
X21G-01037	Elands	0	0	0	0	0	0	0	0	0		FALSE
X21G-01073	Elands	0	0	0	0	0	0	0	0	0		FALSE
X21H-01060	Ngodwana	4	0	5	0	1	0	4	14	1		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X21J-01013	Elands	0	0	0	0	0	0	0	0	0		FALSE
X21K-01007	Lupelule	0	0	0	0	0	0	0	0	0		FALSE
X21K-01035	Elands	0	0	0	0	0	0	0	0	0		FALSE
X21K-00997	Elands	0	0	0	0	0	0	0	0	0		FALSE
X22A-00875	Houtbosloop	0	0	0	0	0	0	0	0	0		FALSE
X22A-00887	Beestekraalspruit	0	0	0	0	0	0	0	0	0		FALSE
X22A-00824	Blystaanspruit	0	0	0	0	0	0	0	0	0		FALSE
X22A-00920		0	0	0	0	0	0	0	0	0		FALSE
X22A-00919	Houtbosloop	0	0	0	0	0	0	0	0	0		FALSE
X22A-00917	Houtbosloop	0	0	0	0	0	0	0	0	0		FALSE
X22A-00913	Houtbosloop	2	0	0	0	0	1	0	3	1		FALSE
X22B-00987	Crocodile	0	0	0	0	0	0	0	0	0		FALSE
X22B-00888	Crocodile	5	0	0	0	0	3	0	8	1		FALSE
X22C-00990	Visspruit	1	0	0	0	0	0	0	1	1		FALSE
X22C-01004	Gladdespruit	9	0	6	0	9	4	0	28	2	Y	TRUE
X22C-00946	Crocodile	23	0	0	0	0	4	0	27	2		FALSE
X22D-00843	Nels	0	0	1	0	0	0	0	1	1		FALSE
X22D-00846		0	0	0	0	0	0	0	0	0		FALSE
X22E-00849	Sand	1	0	2	0	0	0	0	3	1		FALSE
X22E-00833	Kruisfonteinspruit	3	0	2	0	0	0	6	11	1		FALSE
X22F-00842	Nels	1	0	0	0	1	2	0	4	1		FALSE
X22F-00886	Sand	2	0	0	0	0	2	0	4	1		FALSE
X22F-00977	Nels	3	0	0	0	0	1	0	4	1		FALSE
X22H-00836	Wit	75	0	8	0	16	7	0	106	3	Y	TRUE
X22J-00993	Crocodile	7	0	0	0	0	1	0	8	1		FALSE
X22J-00958	Crocodile	0	0	0	0	0	0	0	0	0		FALSE
X22K-01042	Mbuzulwane	1	0	0	0	1	0	0	2	1		FALSE
X22K-01043	Blinkwater	0	0	0	0	0	1	0	1	1		FALSE
X22K-01029	Blinkwater	0	0	0	0	0	0	0	0	0		FALSE
X22K-00981	Crocodile	4	0	0	0	0	5	0	9	1		FALSE
X22K-01018	Crocodile	8	0	0	0	0	1	0	9	1		FALSE
X23B-01052	Noordkaap	25	0	3	0	0	1	0	29	2		FALSE
X23C-01098	Suidkaap	29	0	10	0	0	1	0	40	3		TRUE
X23E-01154	Queens	18	0	27	0	8	2	0	55	3		TRUE
X23F-01120	Suidkaap	1	0	0	0	0	3	0	4	1		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X23G-01057	Kaap	12	0	1	0	9	14	0	36	3		TRUE
X24A-00826	Nsikazi	8	0	0	0	1	0	0	9	1		FALSE
X24A-00860	Sithungwane	0	0	0	0	0	0	0	0	0		FALSE
X24A-00881	Nsikazi	1	0	0	0	0	0	0	1	1		FALSE
X24B-00903	Gutshwa	4	0	0	0	0	0	0	4	1		FALSE
X24B-00928	Nsikazi	7	0	0	0	0	0	0	7	1		FALSE
X24C-00969	Mnyeleni	6	0	0	0	0	0	0	6	1		FALSE
X24C-00978	Nsikazi	13	0	0	0	0	0	0	13	1		FALSE
X24C-01033	Crocodile	3	0	0	0	0	0	0	3	1		FALSE
X24D-00994	Crocodile	10	0	0	0	0	0	0	10	1		FALSE
X24E-00973	Matjulu	3	0	0	0	0	1	0	4	1		FALSE
X24E-00922	Mlambeni	6	0	0	0	0	0	0	6	1		FALSE
X24E-00982	Crocodile	5	0	0	0	0	0	0	5	1		FALSE
X24F-00953	Crocodile	17	0	0	0	0	0	0	17	2		FALSE
X24G-00902	Mtomeni	0	0	0	0	0	0	0	0	0		FALSE
X24G-00876	Komapiti	0	0	0	0	0	0	0	0	0		FALSE
X24G-00844	Mbyamiti	0	0	0	0	0	0	0	0	0		FALSE
X24G-00823	Muhlambamadubo	0	0	0	0	0	0	0	0	0		FALSE
X24G-00820	Mbyamiti	1	0	0	0	0	1	0	2	1		FALSE
X24G-00904	Mbyamiti	0	0	0	0	0	0	0	0	0		FALSE
X24H-00882	Vurhami	5	0	0	0	0	1	0	6	1		FALSE
X24H-00892	Mbyamiti	2	0	0	0	0	0	0	2	1		FALSE
X24H-00880	Crocodile	6	1	1	0	0	1	0	9	1		FALSE
X24H-00934	Crocodile	18	0	10	0	0	5	0	33	3		TRUE
X31A-00741	Klein Sabie	0	0	0	0	0	1	0	1	1		FALSE
X31A-00778	Sabie	1	0	0	0	0	0	0	1	1		FALSE
X31A-00783		3	0	0	0	0	0	0	3	1		FALSE
X31A-00786		0	0	0	0	0	0	0	0	0		FALSE
X31A-00794		0	0	0	0	0	0	0	0	0		FALSE
X31A-00796		0	0	0	0	0	0	0	0	0		FALSE
X31A-00799	Sabie	2	0	0	0	0	0	0	2	1		FALSE
X31A-00803		0	0	0	0	0	0	0	0	0		FALSE
X31B-00756	Sabie	0	0	0	0	0	0	0	0	0		FALSE
X31B-00757	Sabie	0	0	0	0	0	0	0	0	0		FALSE
X31B-00792	Goudstroom	0	0	0	0	0	0	0	0	0		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X31C-00683	Mac-Mac	2	0	0	0	7	0	0	9	1	Y	TRUE
X31D-00755	Sabie	1	0	0	0	0	0	0	1	1		FALSE
X31D-00772	Sabie	0	0	0	0	0	0	0	0	0		FALSE
X31D-00773	Sabani	18	0	0	0	0	0	0	18	2		FALSE
X31E-00647	Marite	19	1	0	0	14	1	0	35	3		TRUE
X31F-00695	Motitsi	5	0	9	0	0	0	5	19	2	Y	TRUE
X31G-00728	Marite	0	0	0	0	0	0	0	0	0		FALSE
X31H-00819	White Waters	0	0	1	0	4	0	0	5	1		FALSE
X31J-00774	Noord-Sand	8	0	0	0	0	0	0	8	1		FALSE
X31J-00835	Noord-Sand	9	0	0	0	0	0	0	9	1		FALSE
X31K-00713	Bejani	0	0	0	0	0	0	0	0	0		FALSE
X31K-00715	Sabie	6	0	0	0	0	0	0	6	1		FALSE
X31K-00750	Sabie	1	0	0	0	0	0	0	1	1		FALSE
X31K-00752	Sabie	5	0	0	0	0	0	0	5	1		FALSE
X31K-00758	Sabie	0	0	0	0	0	0	0	0	0		FALSE
X31K-00771	Phabeni	2	0	0	0	1	0	0	3	1		FALSE
X31L-00657	Matsavana	0	0	0	0	0	0	0	0	0		FALSE
X31L-00664	Saringwa	4	0	0	0	0	0	0	4	1		FALSE
X31L-00678	Saringwa	3	0	0	0	0	0	0	3	1		FALSE
X31M-00673	Musutlu	2	0	0	0	4	0	0	6	1		FALSE
X31M-00681	Sabie	14	0	5	0	0	0	0	19	2		FALSE
X31M-00739	Sabie	2	0	0	0	0	0	0	2	1		FALSE
X31M-00747	Sabie	3	0	0	0	0	0	0	3	1		FALSE
X31M-00763	Nwaswitshaka	0	0	0	0	0	0	0	0	0		FALSE
X32A-00583	Tlulandziteka	8	0	4	1	0	4	1	18	2	Y	TRUE
X32B-00551	Motlamogatsana	14	0	1	3	1	1	0	20	2	Y	TRUE
X32C-00558	Nwandlamuhari	0	0	0	3	0	0	0	3	1	Y	TRUE
X32C-00564	Mphyanyana	3	0	0	0	0	0	0	3	1		FALSE
X32C-00606	Nwandlamuhari	0	0	0	0	0	0	0	0	0		FALSE
X32D-00605	Mutlumuvi	14	0	6	0	0	2	1	23	2	Y	TRUE
X32E-00629	Nwarhele	0	0	0	0	1	0	0	1	1		FALSE
X32E-00639	Ndlobesuthu	0	0	0	0	0	0	0	0	0		FALSE
X32F-00597	Mutlumuvi	4	0	0	0	0	3	0	7	1	Y	TRUE
X32F-00628	Nwarhele	2	0	0	0	0	0	0	2	1		FALSE
X32G-00549	Khokhovela	13	0	1	0	5	0	0	19	2		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X32G-00565	Sand	13	0	0	0	0	3	0	16	2		FALSE
X32H-00560	Phungwe	11	0	0	0	0	1	1	13	1		FALSE
X32H-00578	Sand	13	0	3	0	0	0	1	17	2		FALSE
X32J-00602	Sand	22	0	0	0	0	2	0	24	2		FALSE
X32J-00651	Mutlumuvi	2	0	0	0	0	0	0	2	1		FALSE
X32J-00730	Sand	4	0	0	0	0	0	0	4	1		FALSE
X33A-00661	Nwatindlopfu	6	0	0	0	0	0	0	6	1		FALSE
X33A-00731	Sabie	3	0	0	0	0	0	0	3	1		FALSE
X33A-00737	Sabie	3	0	0	0	0	0	0	3	1		FALSE
X33A-00806	Nwatimhiri	5	1	0	0	1	1	0	8	1	Y	TRUE
X33B-00694	Salitje	5	0	0	0	0	0	0	5	1		FALSE
X33B-00784	Sabie	5	0	0	0	0	0	0	5	1		FALSE
X33B-00804	Sabie	10	0	0	0	0	0	1	11	1		FALSE
X33B-00829	Sabie	2	0	0	0	0	0	0	2	1		FALSE
X33B-00834	Lubyelubye	4	0	0	0	0	1	0	5	1		FALSE
X33C-00701	Mnondozi	11	0	0	0	0	0	0	11	1		FALSE
X33D-00811	Sabie	4	0	0	0	0	0	0	4	1		FALSE
X33D-00861	Sabie	4	0	0	0	0	0	0	4	1		FALSE
X33D-00864	Mosehla	1	0	0	0	0	0	0	1	1		FALSE
X33D-00894	Nhlowa	5	0	0	0	0	0	0	5	1		FALSE
X33D-00908	Shimangwana	0	0	0	0	0	0	0	0	0		FALSE
X33D-00911	Nhlowa	0	0	0	0	0	0	0	0	0		FALSE
X40A-00437	Shinkelengane	0	0	0	0	0	0	0	0	0		FALSE
X40A-00454	Mmondzo	0	0	0	0	0	0	0	0	0		FALSE
X40A-00479	Nwanedzi	0	0	0	0	0	0	0	0	0		FALSE
X40A-00492	Rihlazeni	0	0	0	0	0	0	0	0	0		FALSE
X40A-00433	Mtomeni	0	0	0	0	0	0	0	0	0		FALSE
X40A-00420	Gudzani	9	0	0	0	0	1	0	10	1		FALSE
X40A-00426	Mavumbye	0	0	0	0	0	0	0	0	0		FALSE
X40A-00475	Mavumbye	1	0	0	0	0	0	0	1	1		FALSE
X40A-00459	Nwanedzi	0	0	0	0	0	0	0	0	0		FALSE
X40A-00486	Nwanedzi	0	0	0	0	0	0	0	0	0		FALSE
X40A-00469	Nwanedzi	8	0	3	0	0	0	0	11	1	Y	TRUE
X40B-00534	Nungwini	0	0	0	0	0	0	0	0	0		FALSE
X40B-00537	Gwini	1	0	0	0	0	0	0	1	1		FALSE

SQ	Name	NFEPA Wetland Type							Total	Wetland Screening		Assess PES, EI and ES based on Wetland Screening
		Channelled valley-bottom wetland	Depression	Flat	Floodplain wetland	Seep	Unchannelled valley-bottom wetland	Valleyhead seep		Potential wetland importance (0-3)	Wetland FEPA	
X40B-00532	Mrunzuluku	0	0	0	0	0	0	0	0	0		FALSE
X40B-00497	Sweni	0	0	0	0	0	0	0	0	0		FALSE
X40B-00531	Mrunzuluku	0	0	0	0	0	0	0	0	0		FALSE
X40B-00530	Mrunzuluku	0	0	0	0	0	0	0	0	0		FALSE
X40B-00511	Sweni	9	0	1	0	0	0	0	10	1		FALSE
X40C-00592	Ripape	3	1	0	0	0	0	0	4	1		FALSE
X40C-00513	Nwaswitsontso	27	2	2	0	0	0	0	31	3		TRUE
X40D-00663	Shilolweni	3	0	0	0	0	0	0	3	1		FALSE
X40D-00594	Metsimetsi	0	0	0	0	0	0	0	0	0		FALSE
X40D-00598	Nwaswitsontso	7	0	0	0	0	1	0	8	1		FALSE
X40D-00660	Nwaswitsontso	6	0	0	0	0	0	0	6	1		FALSE
Total		1131	31	264	43	388	156	100	2130	17 (High)	28	40

16.3 INTEGRATED EIS SCORE FOR EACH SUB-QUATERNARY CATCHMENT

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X11A-01248	2	1	4	4	1	2.5	3	2	Moderate
X11A-01295	1	1	1				0		Low
X11A-01300	2	1	1				0		Low
X11A-01354	3	1	1	4		2.5	1.6	2	Moderate
X11A-01358	3	1	1		0.5		0		Low
X11B-01260	2	2	1				0		Low
X11B-01272	2	1	3	4		2.5	3	2	High
X11B-01361	1	1	1		0.5		0		Low
X11B-01370	1	1	1		0.5		3		Low
X11C-01147	3	2	4	4	0.5	3	3	1	High
X11D-01129	3	1	4	4	0.5	2	0.4	1	Low
X11D-01137	2	1	1				0		Low
X11D-01196	1	1	1				0		Low
X11D-01219	1	1	1				0		Low
X11E-01157	1	1	1		2		0		Low
X11E-01237	2	2	4	4	3	3	3	2	High
X11F-01133	1	1	1		3		0		Low
X11F-01163	1	1	1		4		0		Low
X11G-01142	1	1	1				0		Low
X11G-01143	2	1	3	3	1	1	3.6	1	Low
X11G-01177	1	1	1				0		Low
X11G-01188	1	1	1		1		0		Low
X11H-01140	3	3	1	3		2.5	3	2	High
X11J-01106	2	1	1		0.5		0		Low
X11K-01165	2	1	1		1		0		Low
X11K-01179	1	1	1				3		Low
X11K-01194	1	1	3	3		1.5	0.4	2	Low
X11K-01199	2	1	1				3		Low
X11K-01227	1	1	1				0		Low
X12A-01305	3	2	4	4		3	1.6	2	High
X12B-01246	2	1	1				0		Low
X12C-01242	1	1	1		1		0		Low
X12C-01271	1	1	3	4		1.5	1.2	1.5	Low
X12D-01235	2	1	4	3		1.5	1.2	1.5	Low
X12E-01287	3	2	3	3	1	3	1.2	2	High
X12G-01200	1	1	1		2		0		Low
X12H-01258	2	1	1		4		0		Low
X12H-01296	1	1	1		5		0		Low
X12H-01318	2	1	1		1		0		Low
X12H-01338	1	1	1		1		0		Low
X12H-01340	1	1	1		2		0		Low
X12J-01202	1	1	1		3		0		Low
X12K-01316	2	1	1				0		Low
X12K-01330	1	1	1				0		Low
X12K-01332	1	1	1		4		0		Low
X12K-01333	1	1	1				0		Low
X13A-01255	1	1	1		1		0		Low
X13A-01302	1	1	1		4.5		0		Low
X13A-01324	1	1	1		3		0		Low
X13A-01328	1	1	1				0		Low
X13A-01337	1	1	1		5		0		Low
X13B-01270	1	1	1		0.5		0		Low

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X13B-01276	1	4	1				0		Low
X13B-01317	1	4	1		1		0		Low
X13B-01319	1	2	1				0		Low
X13B-01345	1	2	1				0		Low
X13B-01347	1	1	1				0		Low
X13B-01348	1	1	1		1		0		Low
X13B-01351	1	1	1				0		Low
X13C-01364	1	2	1				0		Low
X13D-01323	1	1	1		1		0		Low
X13E-01346	1	1	1				0		Low
X13E-01389	1	1	1				0		Low
X13E-01415	1	1	1		1		0		Low
X13E-01429	1	1	1				0		Low
X13F-01252	1	1	1				0		Low
X13G-01216	1	1	1				0		Low
X13G-01259	1	1	1				0		Low
X13G-01261	1	1	1		0.5		0		Low
X13G-01282	1	1	1				3		Low
X13H-01197	2	1	1				0		Low
X13H-01226	1	1	1				3		Low
X13H-01277	1	2	1				3		Low
X13H-01280	1	1	1				3		Low
X13H-01281	1	1	1				0		Low
X13H-01299	2	2	1				0		Low
X13J-01130	1	1	1				0		Low
X13J-01141	2	1	1		1		0		Low
X13J-01149	2	1	3	4		3	1.2	1	Moderate
X13J-01205	3	1	3	2		1.5	3	1.5	Moderate
X13J-01210	2	1	1				0		Low
X13J-01214	1	1	1				0		Low
X13J-01221	2	2	3	3		2	3	1	Moderate
X13K-01038	2	1	1				0		Low
X13K-01068	3	1	1	2		1	3	1	Low
X13K-01114	2	1	1				0		Low
X13K-01136	1	1	1				0		Low
X13L-01000	2	1	1	2	1	1	1.6	1	Low
X13L-01027	3	2	1				0		Low
X13L-0995	1	1	1				0		Low
X14A-01173	2	1	1		2		0		Low
X14B-01166	1	1	1		2		0		Low
X14C-01203	1	1	1				0		Low
X14C-01212	1	1	1		1		0		Low
X14C-01220	1	1	1				0		Low
X14D-01174	1	1	1				0		Low
X14E-01151	1	1	1				3		Low
X14E-01172	1	1	1				0		Low
X14F-01085	2	1	1		0.5		0		Low
X14G-01128	2	4	1	2		1	3.2	1	Moderate
X14H-01066	3	1	1				0		Low
X21A-00930	2	4	4	4	4		4		Very High
X21A-01008	1	1	4	4			3.6		Very High
X21B-00898	2	1	4	4	4		3.6		Very High
X21B-00925	2	1	1				0		Low
X21B-00929	2	1	4	4	4		3.6		Very High
X21B-00962	2	1	3				0		Low

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X21C-00859	3	3	1	3			4		High
X21C-00909	1	3	1				0		Low
X21D-00938	1	1	1		3		0		Low
X21D-00957	3	1	1				0		Low
X21E-00897	1	1	1		3		0		Low
X21E-00943	2	1	1				0		Low
X21E-00947	1	1	1		2		0		Low
X21F-01046	3	2	4	3			4		High
X21F-01081	1	1	1				0		Low
X21F-01091	2	1	1				0		Low
X21F-01092	1	1	1				0		Low
X21F-01096	1	1	1				0		Low
X21F-01100	1	1	1				0		Low
X21G-01016	2	1	1				0		Low
X21G-01037	1	1	1				0		Low
X21G-01073	1	1	1				0		Low
X21G-01090	1	1	1				0		Low
X21H-01060	3	1	1				0		Low
X21J-01013	1	1	1				0		Low
X21K-00997	1	1	1				0		Low
X21K-01007	1	1	1				0		Low
X21K-01035	1	1	1				0		Low
X22A-00824	1	1	1		2		0		Low
X22A-00875	1	1	1		2		0		Low
X22A-00887	1	1	1		2.5		0		Low
X22A-00913	2	1	1				0		Low
X22A-00917	1	1	1				0		Low
X22A-00919	1	1	1				0		Low
X22A-00920	1	1	1				0		Low
X22B-00888	2	1	1				0		Low
X22B-00987	1	1	1		2		0		Low
X22C-00946	2	1	3				0		Low
X22C-00990	1	1	1				0		Low
X22C-01004	3	1	3	3	0.5		4		High
X22D-00843	1	1	1		0.5		0		Low
X22D-00846	1	1	1				0		Low
X22E-00833	2	1	1				0		Low
X22E-00849	2	1	1		0.5		0		Low
X22F-00842	2	1	1				0		Low
X22F-00886	2	1	1				0		Low
X22F-00977	2	1	1		1		0		Low
X22H-00836	3	2	3	3			4		High
X22J-00958	1	1	1		1		0		Low
X22J-00993	2	1	1		0.5		0		Low
X22K-00981	2	1	1				0		Low
X22K-01018	2	1	1		3		0		Low
X22K-01029	1	1	1		2		0		Low
X22K-01042	2	1	1		3		0		Low
X22K-01043	1	1	1		2.5		0		Low
X23B-01052	2	1	1		1		0		Low
X23C-01098	2	1	1	2			4		Moderate
X23E-01154	3	2	1	2	1		4		Moderate
X23F-01120	2	1	1				0		Low
X23G-01057	3	1	1	2			4		Moderate
X24A-00826	2	1	1		1.5		0		Low

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X24A-00860	1	1	1		5		0		Low
X24A-00881	1	1	1		5		0		Low
X24B-00903	1	1	1				0		Low
X24B-00928	1	1	1		5		0		Low
X24C-00969	1	1	1		5		0		Low
X24C-00978	1	1	1		5		0		Low
X24C-01033	1	1	1				0		Low
X24D-00994	1	1	1		5		0		Low
X24E-00922	1	1	1		5		0		Low
X24E-00973	2	1	1		5		0		Low
X24E-00982	1	1	1		5		0		Low
X24F-00953	1	2	1		5		0		Low
X24G-00820	2	1	1		5		0		Low
X24G-00823	1	1	1		5		0		Low
X24G-00844	1	1	1		5		0		Low
X24G-00876	1	1	1		5		0		Low
X24G-00902	1	1	1		5		0		Low
X24G-00904	1	1	1		5		0		Low
X24H-00880	3	1	1		5		0		Low
X24H-00882	2	1	1		5		0		Low
X24H-00892	1	1	1		5		0		Low
X24H-00934	2	3	1	2	5		0.8		Moderate
X31A-00741	1	1	1				0		Low
X31A-00778	1	1	1				0		Low
X31A-00783	1	1	1				0		Low
X31A-00786	1	1	1		3		0		Low
X31A-00794	1	1	1		3		0		Low
X31A-00796	1	1	1		2		0		Low
X31A-00799	1	1	1				0		Low
X31A-00803	1	1	1				0		Low
X31B-00756	1	1	1		2		0		Low
X31B-00757	1	1	1		0.5		0		Low
X31B-00792	1	1	1				0		Low
X31C-00683	2	1	3	3	3		4		High
X31D-00755	1	1	1		1		0		Low
X31D-00772	1	1	1				0		Low
X31D-00773	1	1	1				0		Low
X31E-00647	3	2	1	2	1		4		Moderate
X31F-00695	2	1	3	2	1		4		Moderate
X31G-00728	1	1	1		1		0		Low
X31H-00819	2	1	1		0.5		0		Low
X31J-00774	1	1	1				0		Low
X31J-00835	1	1	1				0		Low
X31K-00713	1	1	1				0		Low
X31K-00715	1	1	1		3		0		Low
X31K-00750	1	1	1		3		0		Low
X31K-00752	1	1	1				0		Low
X31K-00758	1	1	1				0		Low
X31K-00771	2	1	1		5		0		Low
X31L-00657	1	1	1				0		Low
X31L-00664	1	1	1				0		Low
X31L-00678	1	1	1		1		0		Low
X31M-00673	2	1	1		3		0		Low
X31M-00681	2	1	1		5		0		Low
X31M-00739	1	1	1		5		0		Low

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X31M-00747	1	1	1		5		0		Low
X31M-00763	1	1	1		5		0		Low
X32A-00583	3	1	4	2	0.5		4		High
X32B-00551	3	1	4	2	0.5		4		High
X32C-00558	1	1	3	2			1.2		Low
X32C-00564	1	1	1				0		Low
X32C-00606	1	1	1				0		Low
X32D-00605	3	1	4	2	0.5		4		High
X32E-00629	1	1	1		0.5		0		Low
X32E-00639	1	1	1				0		Low
X32F-00597	2	1	4	2			2		Moderate
X32F-00628	1	1	1				0		Low
X32G-00549	2	1	1		1		0		Low
X32G-00565	2	1	1		1.5		0		Low
X32H-00560	2	1	1		4.5		0		Low
X32H-00578	2	1	1		5		0		Low
X32J-00602	2	1	1		5		0		Low
X32J-00651	1	1	1		5		0		Low
X32J-00730	1	1	1		5		0		Low
X33A-00661	1	1	1		5		0		Low
X33A-00731	1	1	1		5		0		Low
X33A-00737	1	1	1		5		0		Low
X33A-00806	3	1	4	2	5		1.6		High
X33B-00694	1	1	1		5		0		Low
X33B-00784	1	1	1		5		0		Low
X33B-00804	2	1	1		5		0		Low
X33B-00829	1	1	1		5		0		Low
X33B-00834	2	1	1		5		0		Low
X33C-00701	1	1	1		5		0		Low
X33D-00811	1	1	1		5		0		Low
X33D-00861	1	1	1		5		0		Low
X33D-00864	1	1	1		5		0		Low
X33D-00894	1	1	1		5		0		Low
X33D-00908	1	1	1		5		0		Low
X33D-00911	1	1	1		5		0		Low
X40A-00420	2	1	1		5		0		Low
X40A-00426	1	1	1		5		0		Low
X40A-00433	1	1	1		5		0		Low
X40A-00437	1	1	1		5		0		Low
X40A-00454	1	1	1		5		0		Low
X40A-00459	1	1	1		5		0		Low
X40A-00469	2	1	3	3	5		0		High
X40A-00475	1	1	1		5		0		Low
X40A-00479	1	1	1		5		0		Low
X40A-00486	1	1	1		5		0		Low
X40A-00492	1	1	1		5		0		Low
X40B-00497	1	1	1		5		0		Low
X40B-00511	2	1	1		5		0		Low
X40B-00530	1	1	1		5		0		Low
X40B-00531	1	1	1		5		0		Low
X40B-00532	1	1	1		5		0		Low
X40B-00534	1	1	1		5		0		Low
X40B-00537	1	1	1		5		0		Low
X40C-00513	2	1	1	1	4		0		Low
X40C-00592	2	1	1		5		0		Low

SQ	Wetland EIS Criteria								Integrated EIS
	Diversity of wetland types	Density of wetlands	Unique wetlands (size; type etc.)	Species richness	Importance of conservation and natural areas	Migration route/corridor/ links to other systems	Rare/en-dangered/ unique popula-tions/spp	Sensitivity to upstream flow changes	
X40D-00594	1	1	1		5		0		Low
X40D-00598	2	1	1				0		Low
X40D-00660	1	1	1		5		0		Low
X40D-00663	1	1	1		5		0		Low

16.4 PRELIMINARY PES SCORES FOR EACH SQ IN THE INKOMATI SYSTEM

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X11A-01248	1	3	0	3	3	2	2	2	2	2	C
X11A-01295	2	1	0	4	3	1	1	2	1	2	B/C
X11A-01300	0.5	1	0	3	1	2	1	1	0	2	B
X11A-01354	2	4	0	4	1	2	1	2	1	2	C
X11A-01358	2	3	1	3	2	0	1	2	1	2	C
X11B-01260	0	0	0	0	0	0	0	0	0	0	A
X11B-01272	3	2	0	4	3	1	1	2	3	2	C
X11B-01361	2	1	0	4	1	1	2	2	3	2	C
X11B-01370	1	0.5	0	4	1	1	1	2	0	1	B
X11C-01147	2	3	0	2	4	2	1	2	1	2	C
X11D-01129	2	4	0	3	3	1	1	2	2	2	C
X11D-01137	2	2	0	4	2	1	0	1	1	2	B/C
X11D-01196	1	0	0	5	4	0	2	2	2	3	C
X11D-01219	2	4	0	4	4	1	2	2	2	2	C
X11E-01157	1	1	0	2	3	1	1	1	2	2	B
X11E-01237	1	1	0	2	1	0	1	2	2	1	B
X11F-01133	2	1	0	2	1	1	0	1	1	1	B
X11F-01163	1	1	0	1	3	0	1	1	1	1	B
X11G-01142	1	1	0	2	4	1	1	1	2	2	B
X11G-01143	2	2	0	2	1	0	0	2	1	2	B/C
X11G-01177	5	0	0	1	3	0	0	1	1	2	B
X11G-01188	4	0	0	0	2	0	1	1	1	2	B
X11H-01140	1	3	0	2	4	0	2	1	2	2	C
X11J-01106	4	1	0	2	3	1	2	3	2	2	C
X11K-01165	2	2	0	2	3	1	0	1	1	2	B/C
X11K-01179	1	0	0	5	4	0	0	2	1	1	B
X11K-01194	1	0	0	4	4	0	1	2	1	1	B
X11K-01199	3	4	0.5	2	3	0	0	1	2	2	C
X11K-01227	1	1	0	2	4	0	0	2	0	1	B
X12A-01305	4	1	0	2	2	0	1	1	1	2	B
X12B-01246	3	2	0	3	2	1	1	1	1	2	B/C
X12C-01242	1	0	0	3	0	1	0	1	1	1	B
X12C-01271	1	1	0	5	1	1	1	1	1	1	B
X12D-01235	2	2	3	3	2	1	2	2	2	2	C

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X12E-01287	2	1	1	2	2	0	2	1	1	2	B/C
X12G-01200	2	2	1	3	3	1	3	2	2	1	C
X12H-01258	1	1	1	1	3	0	2	2	0	1	B
X12H-01296	1	0	0	1	3	0	2	2	0	1	B
X12H-01318	1	0	0	3	1	1	2	2	3	2	B/C
X12H-01338	1	0	0	3	0	1	1	1	1	2	B
X12H-01340	1	0	1	3	0	0	0	1	2	2	B
X12J-01202	3	0	0	1	1	0	0	1	1	1	B
X12K-01316	2	3	0.5	4	4	2	2	3	0	4	C/D
X12K-01330	0	5	0	0	0	0	0	0	0	2	A
X12K-01332	1	0	0	2	0	1	1	1	0	1	B
X12K-01333	1.5	0	2	2	1	1	2	2	1	2	C
X13A-01255	3	0	0	2	2	0	1	2	2	2	C
X13A-01302	1	0.5	0	0.5	4	0	0	1	0	1	A/B
X13A-01324	2	0	0	3	4	0	2	1	3	3	C
X13A-01328	0	0	0	0	0	0	0	0	0	0	A
X13A-01337	1	0	0	0.5	0	0	0	0	0	1	A
X13B-01270	3	1	0	2	2	1	1	1	2	2	B/C
X13B-01276	3	0	0	2	2	1	2	2	3	2	C
X13B-01317	2	5	0	2	4	0	4	1	2	3	C
X13B-01319	0	0	0	0	0	0	0	0	0	0	A
X13B-01345	2	3	0	3	2	0	2	1	2	2	C
X13B-01347	2	0	0	4	2	0	3	1	3	3	C
X13B-01348	2	0	0	3	1	0	2	1	2	2	B/C
X13B-01351	1	0	0	4	4	0	0	1	0	1	A/B
X13C-01364	2	1	0	4	2	2	4	2	3	3	C
X13D-01323	2	0	0	3	4	0	2	2	2	2	C
X13E-01346	2	0	0	3	4	1	2	2	2	3	C
X13E-01389	2	0	0	3	2	1	3	2	2	2	C
X13E-01415	2	0	0	4	1	1	3	2	3	3	C
X13E-01429	2	0	0	4	1	2	3	2	1	3	C
X13F-01252	2	0	0	4	2	2	2	2	2	3	C
X13G-01216	2	0	1	4	1	2	3	2	3	3	C
X13G-01259	2	0	0	5	2	1	3	2	0	4	C
X13G-01261	2	0	0	3	1	1	3	2	3	3	C
X13G-01282	2	3	0	3	4	2	3	3	3	3	D
X13H-01197	2	1.5	0	4	2	1	3	2	3	3	C

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X13H-01226	2	1	0	4	2	2	3	1	3	4	C
X13H-01277	2	0	0	4	4	0	4	3	4	4	D/E
X13H-01280	2	0	0	4	4	0	3	3	3	4	D
X13H-01281	2	0	0	4	4	1	3	3	4	4	D
X13H-01299	2	2	0	4	4	2	2	3	1	3	C
X13J-01130	2	3	2	3	4	0	3	3	3	4	D
X13J-01141	2	1	3	3	2	2	2	3	2	3	C
X13J-01149	3	3	2	3	4	2	2	3	3	3	D
X13J-01205	2	1	3	3	3	3	3	3	3	3	D
X13J-01210	2	1	0	2	4	0	3	3	3	4	C/D
X13J-01214	2	0	2	3	1	2	2	2	3	3	C
X13J-01221	2	2	0	3	4	0	3	3	2	3	C/D
X13K-01038	3	4	0	4	4	0	0	4	5	4	E
X13K-01068	2	4	2	3	4	1	2	2	3	3	C/D
X13K-01114	2	2	0	3	4	0	0	3	4	4	C/D
X13K-01136	2	0	2	4	2	2	2	3	3	3	C
X13L-01000	2	4	0	2	4	0	0	2	2	2	C
X13L-01027	2	4	0	4	4	0	4	3	5	4	E
X13L-0995	2	0	3	0	4	0	2	3	3	2	C
X14A-01173	3	1	0	3	2	1	2	1	2	2	C
X14B-01166	3	1	0	1	2	0	1	2	0	1	B
X14C-01203	2	0	0	5	3	2	2	2	3	3	C
X14C-01212	3	0	0	3	2	1	3	2	2	3	C
X14C-01220	3	0	0	3	3	2	2	2	2	2.5	C
X14D-01174	2	0.5	0	4	2	2	2	2	2	3	C
X14E-01151	2	2	0	3	3	3	2	3	3	3	D
X14E-01172	2	0	0	4	2	2	2	2	2	3	C
X14F-01085	4	1	0	1	2	1	1	2	3	3	B/C
X14G-01128	2	5	1	3	4	2	4	3	4	3	D
X14H-01066	3	2	0	3	4	2	3	3	3	3	D
X21A-00930	1	3	1	3	2	1	1	2	2	2	C
X21A-01008	1	3	0	2	3	2	1	2	3	1	C
X21B-00898	2	3	0	2	2	1	1	3	1	2	C
X21B-00925	2	4	0	2	3	1	1	2	2	2	C
X21B-00929	1	4	0	2	2	0	1	3	2	1	B/C
X21B-00962	2	1	0	3	2	0	1	2	1	2	B/C
X21C-00859	2	4	0	3	2	1	0	2	1	2	C

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X21C-00909	0	0	0	0	0	0	0	0	0	0	A
X21D-00938	1	4	0	2	4	0	2	1	0	1	B
X21D-00957	1	1	0	2	2	1	1	2	1	1	B
X21E-00897	3	0	0	0	1	0	0	1	0	1	A
X21E-00943	2	0	0	3	4	0	1	2	2	2	C
X21E-00947	1	0	0	1	4	0	1	1	0	1	B
X21F-01046	2	3	1	3	2	0	1	2	1	2	C
X21F-01081	1	3	0	3	2	0	2	3	0	2	C
X21F-01091	1.5	3	0	3	1	0	1	3	2	2	C
X21F-01092	2	1	0	3	3	1	0	3	1	2	B/C
X21F-01096	2	0	0	0	0	0	0	0	0	2	A
X21F-01100	2	3	1	3	2	2	1	2	2	2	C
X21G-01016	2	3	0	1	2	0	1	2	1	1	B
X21G-01037	2	3	2	2	3	1	2	3	3	2	C
X21G-01073	2	1	0	1	3	1	2	2	3	3	C
X21G-01090	2	2	0	2	2	0	2	2	2	2	C
X21H-01060	2	3	0	2	2	0	2	2	1	2	C
X21J-01013	3	2	0	3	3	1	2	2	2	2	C
X21K-00997	2	2	0	1	3	0	1	2	2	2	C
X21K-01007	4	0	0	0	1	0.5	1	1	1	2	B
X21K-01035	4	2	0	0	3	0	2	3	1	3	C
X22A-00824	5	0.5	0	0	2	0	0	1	0.5	1	A/B
X22A-00875	5	0.5	0	0	2	0	0	1	0	1	A
X22A-00887	5	0	0	0	2	0	0	1	0	1	A
X22A-00913	2	2	0	2	3	0	0	2	2	2	C
X22A-00917	5	0	0	0	2	1	0	1	1	1.5	B
X22A-00919	5	0	0	0	2	0	0	1	0	1	A
X22A-00920	5	0	0	0	1	0	0	1	0	1	A
X22B-00888	2	1	0	2	4	0	1	2	0	2	B/C
X22B-00987	1	0	0	3	3	0	1	2	0	2	B
X22C-00946	2	0	1	2	3	0	1	2	1	2	B/C
X22C-00990	2	0	0	1	1	0	1	1	1	2	B
X22C-01004	3	1	1	1	3	0	2	2	2	1.5	C
X22D-00843	5	1	0	0	2	0	0	1	2	2.5	B
X22D-00846	5	1	0	0	2	0	0	1	2.5	2.5	B
X22E-00833	5	2	0	0	2	0	1	1	2	3	B/C
X22E-00849	5	2	0	0	2	1	1	1	2	2	B/C

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X22F-00842	4	1	0	0	2	0	1	2	2	2	B/C
X22F-00886	3	4	0	2	4	2	2	2	3	2	C
X22F-00977	2	2	2	2	4	0	1	3	0	1	C
X22H-00836	3	3	2	3	4	2	2	3	3	3	D
X22J-00958	2	1	2	0	3	0	1	3	1	1	B
X22J-00993	2	0.5	3	2	4	0	0	3	1	2	C
X22K-00981	2	3	1	2	4	0	0	3	2	3	C
X22K-01018	2	1	0	1	4	0	1	2	2	2	B/C
X22K-01029	2	0	0	2	2	0	0	2	1	1	B
X22K-01042	1	1.5	0	1	1	0	0	1	0.5	1	B
X22K-01043	1	2	0	2	2	0	0	1	0	1	B
X23B-01052	2	1	0	3	2	2	2	3	3	2.5	C
X23C-01098	3.5	1.5	0	2	2.5	1.5	2	2	2	2	C
X23E-01154	3	1	0	2	3	1	2	1	2	2	C
X23F-01120	2	2	0	2	3	0	2	2	2	2	C
X23G-01057	3	3	0	2	3	0	2	3	2	2	C
X24A-00826	2	1	2	3	2	1	2	2	2	2.5	C
X24A-00860	0	0	0	0	0	0	0	0	0	0.5	A
X24A-00881	0	0.5	0	0	1	0	0	1	0	0.5	A
X24B-00903	1	0	3	3	2	0	3	3	2	4	C/D
X24B-00928	0	0	0	0	2	0	0	1	0	0.5	A
X24C-00969	0	0	0	0	0	0	0	0	0	0.5	A
X24C-00978	0	0	0	1	1	0	1	1	0	1	A/B
X24C-01033	2	1	3	1	4	0	1	3	2	2	C
X24D-00994	1	0	2	2	4	0	1	3	3	3	C
X24E-00922	0	1	0	0	0	0	0	0	0	0.5	A
X24E-00973	0	0.5	1	0	1	0	0	1	1	0.5	A/B
X24E-00982	1	2	0	2	4	0	0	3	2	3	C
X24F-00953	1	2	0	1	4	0	1	3	2	2	B/C
X24G-00820	0	0.5	0	0.5	0	0	0	0	0	0.5	A
X24G-00823	0	0	0	0	0	0	0	0	0	0.5	A
X24G-00844	0	0	0	0	0	0	0	0	0	0	A
X24G-00876	0	0	0	0.5	0	0	0	0	0	0.5	A
X24G-00902	0	0	0	0	0	0	0	0	0	0.5	A
X24G-00904	0	0	0	0	0	0	0	0	0	0	A
X24H-00880	1	1	2	3	4	0	1	4	1	3	B/C
X24H-00882	0	0.5	0	0	0	0	0	0	0	0.5	A

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X24H-00892	0	0.5	0	0	0	0	0	0	0	0.5	A
X24H-00934	1	0	2	1	4	0	0	4	2	3	B/C
X31A-00741	4	1.5	1	1	2	1	1.5	2	1	2	B/C
X31A-00778	2	2	3	1	2	1	1	2	2	1	C
X31A-00783	5	2	0	1	2	0.5	0.5	1	2	1	B
X31A-00786	3	0	0	0	1	0.5	0.5	1	0	0.5	A/B
X31A-00794	2	0	0	0	0	0	0	1	1	0.5	A
X31A-00796	4	0	0	0	2	0.5	0	1	2	0.5	A/B
X31A-00799	5	1	0	0	2	2	1	1	3	2	B/C
X31A-00803	5	0	0	0	2	0	0	1	1	4	A/B
X31B-00756	2	0	0	0.5	2	0	1	1	0.5	1	B
X31B-00757	4	2	1	0	2	0	0	2	1	1	B
X31B-00792	5	0	1	0	1	1	1	1	1	2	B
X31C-00683	4	0.5	0.5	1	1	1	1	2	0	1	B
X31D-00755	2	1	0	3	2	1	1	2	2	3	C
X31D-00772	1	0	0	3	2	0	0	2	2	3	B/C
X31D-00773	2	3	0	3	4	1	1	2	2	2	C
X31E-00647	3	3	2	2	4	2	0	3	2	3	C/D
X31F-00695	4	1	1	1	3	1	2	2	2	3	C
X31G-00728	2	0.5	1	3	4	2	1	3	2	2	C
X31H-00819	4.5	2	0	0	2	0	0	2	2	2	C
X31J-00774	2	3	3	2	4	2	2	3	2	3	C/D
X31J-00835	2	3	1	2	3	2	2	3	2	2	C
X31K-00713	2	0	4	3	2	2	3	3	3	4	D
X31K-00715	0.5	0	0	3	3	1	2	2	1	3	B/C
X31K-00750	1	0	0	3	3	1	2	2	1	1	B
X31K-00752	1	2	0	4	3	1	2.5	2	2	3	C
X31K-00758	1	0	0.5	3	3	0	1	2	3	3	B/C
X31K-00771	1	1	0	0.5	1	1	1	1	1	2	B
X31L-00657	2	0	0	4	2	1	2	1	3	3	C
X31L-00664	2	0.5	3	4	2	1	3	2	3	3	C/D
X31L-00678	2	1	1	2	2	1	2	1	3	1	B/C
X31M-00673	1	1	2	3	1	1	0	1	2	2	B
X31M-00681	1	1	0	1	3	0	2	2	1	2	B
X31M-00739	1	2	0	0	3	0	1	1	0	2	B
X31M-00747	0.5	0	0.5	0	3	0	1	1	0.5	2	A/B
X31M-00763	0.5	0	0.5	0	0	0	0	0	1	0.5	A

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X32A-00583	1	2	2	4	4	2	3	2	3	3	C/D
X32B-00551	2	0	2	3	3	2	3	2	3	3	C/D
X32C-00558	2	1	3	3	3	2	3	2	2	3	C/D
X32C-00564	1	1	2	4	2	1	2	2	2	3	C
X32C-00606	1	0	2	3	3	0	0	2	0	3	B/C
X32D-00605	2	5	3	3	3	2	4	2	3	3	D
X32E-00629	3	1	3	2	2	3	3	2	3	3	D
X32E-00639	2	0	5	4	0	2	4	3	4	5	D/E
X32F-00597	1	1	2	3	4	2	2	2	4	4	C
X32F-00628	2	1	3	4	2	1	3	2	3	3	C/D
X32G-00549	1	1	2	4	3	2	3	2	1	2	C
X32G-00565	2	0	1	3	3	2	3	2	2	3	C
X32H-00560	0	0.5	0	0.5	0	0	0	0	0	0.5	A
X32H-00578	0	1	0	1	4	1	3	2	0	2	B
X32J-00602	0.5	0	0	0	4	0	0	1	0	0.5	A
X32J-00651	0	0	0	1	0	0	0	0	0	0.5	A
X32J-00730	0	0	0	0	4	0	0	1	0	0.5	A
X33A-00661	0	0.5	0	0.5	0	0	0	0	0	0.5	A
X33A-00731	0	0	0	0	3	0	0	1	0	1	A
X33A-00737	0	0	0	0	3	0	0	1	0	0.5	A
X33A-00806	0	0	0	0	0	0	0	0	0	0.5	A
X33B-00694	0	0	0	0	0	0	0	0	0	0.5	A
X33B-00784	0	0	0	0	3	0	0	1	0	1	A
X33B-00804	0	3	0	0	3	0	0	1	1	3	A/B
X33B-00829	0	0	0	0	3	0	0	1	0	0	A
X33B-00834	0	0	0	0	0	0	0	0	0	0.5	A
X33C-00701	0	0.5	0	0.5	0	0	0	0	0	0.5	A
X33D-00811	0	0	0	0	3	0	0	1	0	0	A
X33D-00861	0	0	0	0	3	0	0	1	0	0	A
X33D-00864	0	0	0	0	0	0	0	0	0	0.5	A
X33D-00894	0	0	0	0	0	0	0	0	0	0	A
X33D-00908	0	0	0	0	0	0	0	0	0	0	A
X33D-00911	0	0	0	0	0	0	0	0	0	0.5	A
X40A-00420	0	0.5	0	0	0	0	0	0	0	0	A
X40A-00426	0	0	0	0	0	0	0	0	0	0	A
X40A-00433	0	0	0	0	0	0	0	0	0	0	A
X40A-00437	0	0	0	0	0	0	0	0	0	0	A

SQ	Wetland Metrics										Prelim Wetland PES
	Afforestation /invasive plants	Dams, irrigation, other flow reduction activities	Extent of Urbanisation/ catchment hardening	Landuse activities (mining, agric., over grazing)	Flow mod	Erosion of wetlands	Sedimen-tation	Potential WQmod activities	Bed and channel disturbance	Vegetation removal	
X40A-00454	0	0	0	0	0	0	0	0	0	0	**A**
X40A-00459	0	0	0	0	0	0.5	0	0	0.5	0	**A**
X40A-00469	0	3	0	0	1	0	0	0.5	0	0	**A**
X40A-00475	0	0.5	0	0	1	0	0	0	0	0	**A**
X40A-00479	0	0	0	0	0.5	0	0	0	0	0	**A**
X40A-00486	0	0	0	0	0	0	0	0	0	0	**A**
X40A-00492	0	0	0	0	0	1	0	0	0	0	**A**
X40B-00497	0	0	0	0.5	0	0	0	0	0	0	**A**
X40B-00511	0	0	0	0	0	0	0	0	0.5	0.5	**A**
X40B-00530	0	0	0	0	0	0	0	0	0	0	**A**
X40B-00531	0	0	0	0	0	0	0	0	0	0	**A**
X40B-00532	0	0	0	0	0	0.5	0	0	0	0	**A**
X40B-00534	0	0	0	0	0	0	0	0	0	0	**A**
X40B-00537	0	0.5	0	0.5	0	0.5	0	0	0	0.5	**A**
X40C-00513	0.5	1	0	1	1	0.5	1	1	1	1	**B**
X40C-00592	0	0.5	0	0	0	0.5	0	0	0	0.5	**A**
X40D-00594	0	0.5	0	0	0	0	0	0	0	0	**A**
X40D-00598	0	0	0	0	0	0	0	0	0	0.5	**A**
X40D-00660	0	1	0	0	0	0	0	0	0	0.5	**A**
X40D-00663	0	0.5	0	1	0	0	0	0	0	0.5	**A**

17 APPENDIX D: REPORT COMMENTS

Page and/or section	Report Statement	Comments	Addressed in report?	Author Comment
Comments: Mohlapa Sekoele, received on 2 October 2103.				
All		General editing and formatting from comments received on 30/9/2013	Yes	
Page 4-4, section 4.3.2	The following are the main economic sectors in the catchment: • Irrigation Agriculture • Commercial forestry • Mining • Industry (Manufacturing)	What about eco-tourism.	Yes	Eco-tourism added as one of the main economic sectors.
Page 4-15, section 4.4.2	Section on AMD.	Source of information.	Yes	In the absence of the ICMA report (pending approval) the section on AMD was based on the personal knowledge of the authors.