ADOPT-A- RIVER PROGRAMME PHASE II: DEVELOPMENT OF AN IMPLEMENTATION PLAN WATER RESOURCE QUALITY SITUATION ASSESSMENT

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Republic of South Africa

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Department of Water Affairs
Resource Quality Services

October 2009

Directorate: Resource Quality Services, Department of Water Affairs

October 2009

Published by:

Department of Water Affairs
Resource Quality Services
Private Bag X313
PRETORIA 0001
Republic of South Africa
Tel: (012) 808 9500

Co-ordinated by:
Resource Quality Services

Project Number WP 9583

This document should be cited as:

Department of Water Affairs (DWA), 2009. Adopt-a-River Programme Phase II: Development of an Implementation Plan. Water Resource Quality Situation Assessment. Prepared by H. Hendriks and J.N. Rossouw for Department of Water Affairs, Pretoria, South Africa.

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Authors	Y. Burger, P. de Souza, J.N. Rossouw and L. Rossouw

DOCUMENT STATUS AND APPROVAL

WORKING TITLE:	Adopt-a-River Programme Phase II: Development of an Implementation Plan. Water Resource Quality Situation Assessment.
AUTHORS:	H. Hendriks and J.N. Rossouw
EXTERNAL REVIEWER:	None
REPORT STATUS:	Final report
PROJECT NUMBER:	WP 9583
REPORT NUMBER:	N000000RET0509
PROJECT TITLE:	Adopt-a-River Programme Phase II: Development of an Implementation Plan.
DATE:	**October 2009**

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ACKNOWLEDGEMENTS

The following project team members and officials of the Department of Water and Environmental Affairs are thanked for their inputs, comments and assistance towards the development of this document.

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EXECUTIVE SUMMARY

The Adopt-a-River programme is an initiative by the Department of Water Affairs (DWA) to create awareness amongst all South Africans of the need to care for our scarce water resources and to facilitate their participation in the protection and management of these resources. One of the objectives identified for the second phase of the Adopt-a-River programme was to conduct a water resource quality situation analysis based on available information for each of the catchments selected for pilot implementation in the nine DWA regions. The following catchments were identified for this purpose: The Vaal River, Pongola River, Mokolo River, Olifants River, Klip River and Wonderfonteinspruit, Modder and Riet Rivers, Mtata and Buffalo River, Olifants/Doring River, Hartz River, and the Crocodile (West) River. Water resource quality was defined as all aspects related to water quantity, water quality and aquatic ecosystem quality; the latter including the quality of in-stream and riparian habitats and aquatic biota. Only published information that was readily available was used for the assessment.

Each chapter in the report was dedicated to a pilot catchment identified by a regional office and included the following sections: A brief description of the pilot catchment, summary tables of water resource quality issues and concerns summarised for water resources issues (water balance in the catchment), water quality issues (related to concerns about salinity, nutrient enrichment, bacteriological quality, trace metals, pH, and other concerns) and aquatic ecosystem health issues (related to overall ecostatus, instream and riparian zone habitat, fish, macro-invertebrates, and ecosystem water quality) . Each chapter was concluded with a brief summary of problem areas in the catchment and possible Adopt-a-River activities that could be considered for them.

It was concluded that implementation of the Adopt-a-River programme will have a better chance of success if it is focused on rivers and/or river reaches where problems are experienced, and where the involvement of communities, different spheres of government, the agricultural sector, and the industrial sector can make a difference. This report attempted to highlight some of the problems and problems areas that occur in different regions of the country. These should be considered by the regional offices of DWA when looking for opportunities to launch Adopt-a-River initiatives.

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LIST OF ABBREVIATIONS

CMA	Catchment Management Area
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
ISP	Internal Strategic Perspective
RHP	River Health Programme
WMA	Water Management Area

1. INTRODUCTION

1.1 BACKGROUND TO THE ADOPT-A-RIVER PROGRAMME

The Adopt-a-River programme is an initiative by the Department of Water Affairs (DWA) to create awareness amongst all South Africans of the need to care for our scarce water resources and to facilitate their participation in the protection and management of these resources. The Adopt-a-River programme can play a vital role in encouraging citizens to learn about water resources and become involved in the protection and management of these resources in their particular area.

The main aim of the Adopt-a-River programme is to create an understanding among all water users and in particular the previously marginalised communities of the concepts of integrated water resource management, to encourage them to become actively involved in the protection and management of these resources (DWAF, 2007). Specific objectives include:

- Empowering all users of water to protect their water resources and participate in water resources management as captured in Key Focus Area, 9.5 of the DWA Strategic Plan.
- Facilitating the involvement of patrons and sponsors (influential individuals) in stakeholder empowerment and resource management strategies.
- Developing and making available the necessary tools for training and empowering local implementing agents and other role-players.
- Ensuring optimum effectiveness, through involvement and linkages with other existing programmes and initiatives aimed at water resource protection and management.
- Promoting a volunteerism ethic in South Africa to benefit all levels of society.

A phased approach is being followed to develop the programme. Phase 1 was the initiation and development of a Strategic Framework document (DWAF, 2007). Phase 2 of the project (this project) is the development of an Implementation Plan and the preparation for Phase 3 where pilot implementation on selected rivers will take place.

Specific objectives for Phase 2 of the Adopt-a-River programme include the following:

- Investigate models for volunteer monitoring programmes used in South Africa and elsewhere in the world and propose a suitable model for the Adopt-a-River Programme.
- Conduct a situation analysis of stakeholder involvement in resource protection management initiatives in South Africa and propose suitable links between these programmes and the Adopt-a-River programme.
- Develop a detail list of stakeholders.
- Determine the required institutional framework and governance structures.
- ***Conduct a water resource quality situation analysis based on available information for each of the catchments selected for pilot implementation (This report)***.
- Design the data acquisition component/s of the monitoring programme/s.

- Develop data management and reporting structures.
- Quantify resource requirements.
- Identify training requirements and develop appropriate training material.
- Record of decisions document summarising all the processes followed and decisions taken during the project.

1.2 INTRODUCTION TO THE WATER RESOURCE QUALITY SITUATION ASSESSMENT

The objective of this activity was to undertake an assessment of the current water resource quality situation in the river catchments that have been identified for pilot implementation in order to identify the key water resource quality issues of concern to stakeholders, and to match those to potential Adopt-a-River activities. The output of this activity will be used to inform Phase 3 of the Adopt-a-River Programme, namely “Pilot Implementation in Selected Rivers”.

In the Draft Strategic Framework for the Adopt-a-River Programme (DWAF, 2007) a number of catchments have been identified for pilot implementation of the Adopt-a-River Programme.

Table 1.1 Rivers and DWA Offices that are being targeted for pilot implementation of the Adopt-a-River programme

Responsible office	River
Director General: DWA	Vaal River
Kwa-Zulu Natal Regional office	Pongola River
Limpopo Regional office	Mokolo River
Mpumalanga Regional office	Olifants River
Gauteng Regional office	Klip River and Wonderfonteinspruit
Free State Regional office	Modder and Riet Rivers
Eastern Cape Regional office	Mtata and Buffalo River
Western Cape Regional office	Olifants/Doring River
Northern Cape Regional office	Hartz River
North West Regional office	Crocodile River

Water resource quality was defined in DWAF (2006) as all aspects of water quantity, water quality and aquatic ecosystem quality; the latter including the quality of in-stream and riparian habitats and aquatic biota.

1.3 METHODOLOGY

Only published information was used for this assessment. Information sources included the Water Resource Situation Assessment reports, Internal Strategic Perspective (ISP) reports, State-of-the-Rivers reports, reserve studies, basin study reports, and any other water quality reports that were readily available from the Department or its regional offices. Due to the limited budget for this task the spatial coverage and number of issues within each pilot catchment were quite comprehensive. Therefore, none of the issues were described in detail and the reader is referred to the detailed reports where specific issues have been identified.

The key issues were matched to activities that can be aligned to the objectives of the Adopt-a-River programme. Volunteers commonly monitor a combination of the following features: flow or water level, water temperature, dissolved oxygen, turbidity, pH, habitat, macroinvertebrates, aquatic plants, water transparency, phosphorus and nitrogen, bacteria, and land use.

1.4 LAYOUT OF THE REPORT

Each chapter is dedicated to a pilot catchment identified by a regional office and the chapter has a common layout which includes the following:

- Description – this is a brief description of the pilot catchment. These descriptions were taken from the ISP reports and slightly modified where required.
- Summary table of water resource quality issues and concerns – A table and/or description of key water resource quality concerns and issues were identified in the catchment. Specific locations were identified if a concern was limited to a geographic location. Water resource quality issues were summarised for:
    - water resources issues,
    - water quality issues, and
    - aquatic ecosystem health issues.
- Concluding remarks – A brief summary of problem areas in the catchment and possible Adopt-a-River activities that can be considered for them.
- References – A bibliography of reports consulted for the assessment. More detailed information can be sourced about a specific concern or issue by consulting these documents.

1.5 REFERENCES

Department of Water Affairs and Forestry (DWAF) (2007). Draft Strategic Framework for the development of the Adopt-a-River Programme (Caring for our scarce water resources). Prepared by Directorate: Resource Quality Services, April 2007.

2. VAAL RIVER CATCHMENT

Responsible office: Director General: DWA.

2.1 BRIEF OVERVIEW OF THE VAAL RIVER CATCHMENT

The water resources of the Vaal River System are an important asset to the country and its people, supporting major economic activities and a population of about 12 million people (DWAF, 2004a, b, c). The Vaal River System comprises the primary drainage region C within the water management drainage regions of South Africa and spans four water management areas (WMAs), *viz.* the Upper, Middle, part of Lower Vaal and part of the Upper Orange (Modder Riet catchment) WMAs. Due to the cascading orientation and associated inter-dependency of these WMAs, it is vital that the water resources of this river system are managed in an integrated manner. The objective is to achieve a balance between meeting specific water user and use requirements in each WMA as well as in fulfilling the transfer obligations between these WMAs, and the donating and receiving WMAs that form part of the larger integrated system (**Figure** 2.1). The Vaal River serves as a conduit to transfer water among the three Vaal WMAs and significant transfers out of the Upper Vaal WMA occur through the distribution system of Rand Water. The Vaal River System has extensive water resource infrastructure and is linked to other water resource systems (Thukela, Usutu, Lesotho) through substantial inter-basin transfers between them.

The Upper Vaal is highly modified by catchment development, with the Middle Vaal having a few major development centres with agriculture and mining being the main activities. The Lower Vaal WMA is less developed with agriculture being the predominant land use. The significant development within the system includes both formal and informal urbanisation, industrial growth, agricultural activities and widespread mining activities. These developments have led to a deterioration in the water quality of the water resources in the system, requiring that management interventions are sought to ensure that water of acceptable quality is available to all users in the system, especially as land use activities continue to grow and intensify. Salinisation and eutrophication of the water resources in the Vaal River System appear to be the two major water quality problems being experienced. If the system is going to sustain the envisaged growth and development, sound strategies and actions are needed to ensure that the water resources of the Vaal River System are managed to meet the needs of all water users while at the same time affording an adequate level of protection of in stream resource quality. The Vaal River is the major water resource within the system with a number of significant tributaries along its length. Rising at Sterkfontein Beacon near Breyten, in Mpumalanga province, the Vaal River flows 1 415 km southwest to its confluence with the Orange River near Douglas. In the middle Vaal River (especially between Kromdraai and Bloemhof Dam) the topography results in a flat slope with an average of about 0.28 m/km. The Vaal River forms the main tributary to the Orange River. The Vaal River catchment area stretches from Ermelo in the northeast to Vryburg in the northwest to Douglas in the southwest to Harrismith in the east. The catchment area covers approximately 197000 km^2 and is situated in the geographic centre of the country. The Vaal River is probably the most developed and regulated river in Southern

Africa – it has some 90 major man made impoundments situated on the main stem and its tributaries. A particular characteristic of the Vaal WMAs is the extensive inter-catchment transfer of water within the WMAs as well as inter-basin transfers between these and adjoining WMAs. In addition to the direct linkages through these transfers, the impacts of water resource management also indirectly extend to other WMAs within South Africa. The main interdependencies among the Vaal/Orange System (and other interlinked WMAs) relate to flow volume and flow regime in addition to water quality.

The Vaal River catchment area spans five provinces namely parts of Gauteng, Free State, Mpumalanga, North West and the Northern Cape. It also spans three water management areas namely the Upper Vaal WMA, the Middle Vaal WMA, and the Lower Vaal WMA. The Vaal catchment has some 23 tertiary sub-catchments (Table 2.1):

Table 2.1 List of secondary and tertiary catchments in the Vaal River catchment

Secondary sub-catchment	Tertiary sub-catchment	River(s)
C1	C11	Vaal River up to Grootdraai Dam
	C12	Vaal River from Grootdraai Dam to Vaal Dam, includes the Waterval River.
	C13	Klip River
C2	C21	Suikerbos River
	C22	Klip River and Vaal River Barrage
	C23	Mooi River and Middle Vaal River
	C24	Skoonspruit River and Middle Vaal River
	C25	Middle Vaal River and Bloemhof Dam
C3	C31	Upper Harts River
	C32	Dry Harts River
	C33	Harts River
C4	C41	Vet River
	C42	Sand River
	C43	Sand/Vet River
C5	C51	Riet River
	C52	Modder River
C6	C60	Vals River
C7	C70	Rhenoster River
C8	C81	Upper Wilge River and Sterkfontein dam
	C82	Lower Wilge River up to Vaal Dam
	B83	Liebenbergsvlei River
C9	C91	Lower Vaal River
	C92	Lower Vaal River

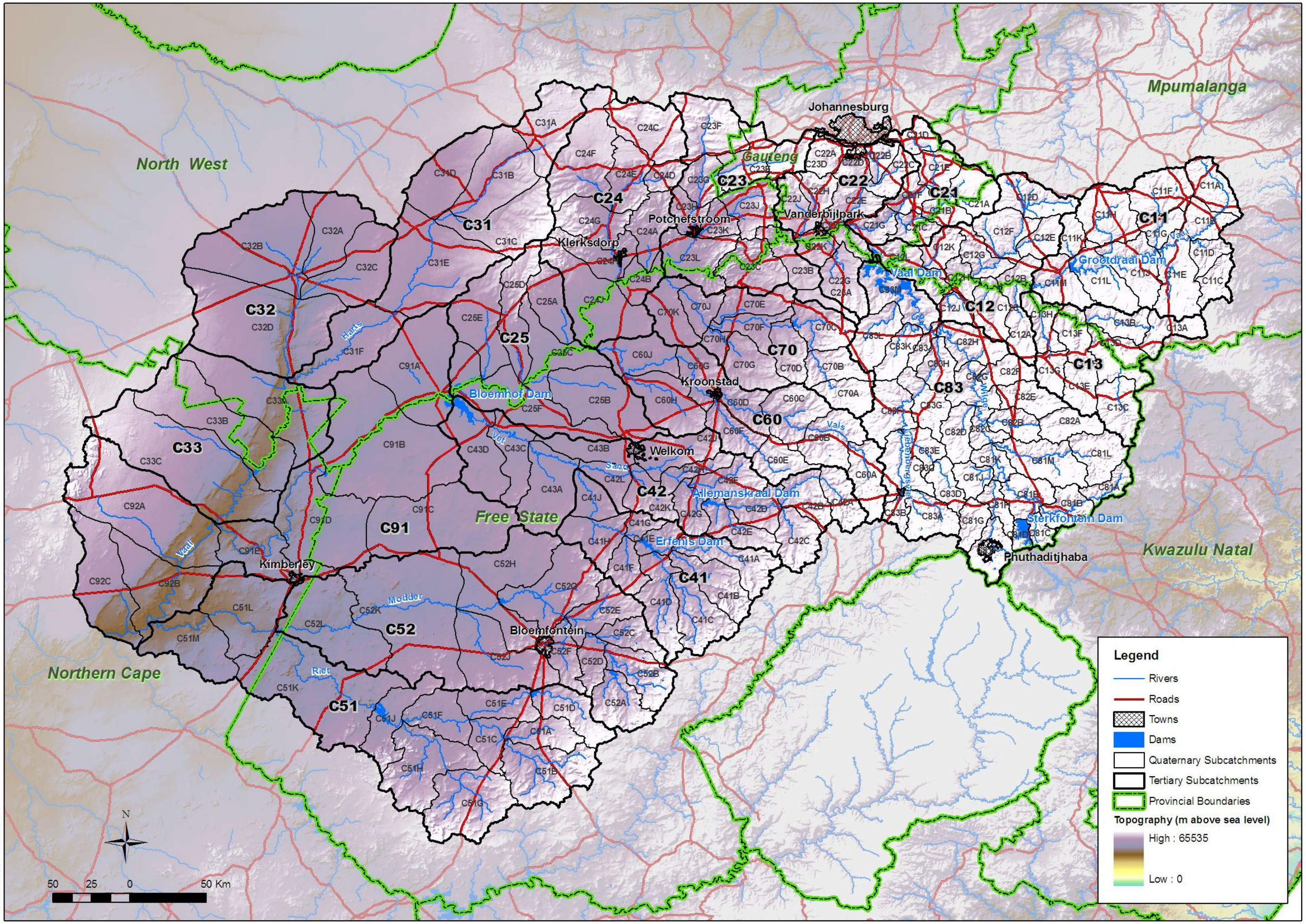

Figure 2.1 Map of the Vaal River catchment showing the major sub-catchments and rivers

2.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

2.2.1 Water quantity issues

The surface water resources in the Upper Vaal WMA is well developed and the system is highly regulated (DWAF, 2006). There are several large dams that have been developed allowing limited potential for further development. These dams include, Grootdraai Dam, Vaal Dam and Sterkfontein Dam. Large quantities of water are transferred into the WMA to augment local water resources. Transfers are from the Thukela and Usutu to Mhlatuze WMAs and from the Senqu River in Lesotho. Transfers out of the WMA are to the Crocodile (West) to Marico and Olifants WMAs and through releases along the Vaal River to the Middle and Lower Vaal WMAs.

The surface water occurring in the Middle Vaal WMA has been developed to its potential and all water is being fully utilised (DWAF, 2006). The Middle Vaal WMA is dependent on the Upper Vaal WMA for meeting the bulk water requirements of the mining, industrial and urban sectors in the Klerksdorp-Orkney and Welkom-Virginia areas. Large quantities of water are transferred into the WMA to augment local water resources. The local water resources within the WMA are used by smaller towns (Bothaville and Wolmaranstad) and for irrigation. Some small transfers also occur from Vaal Dam to Heilbron in the Middle Vaal WMA and out of Erfenis Dam to the Upper Orange WMA. Water is also transferred via the Vaal River through this WMA to Bloemhof Dam, from the Upper Vaal WMA to the Lower Vaal WMA. Management of water quality and quantity in the Middle Vaal WMA is therefore integrally linked to both the Upper and Lower Vaal WMAs. The water entering Middle Vaal WMA from the Upper Vaal WMA brings with it a large contribution of urban, industrial and mining return flows from the highly industrialised and urbanised areas within the Upper Vaal WMA. These carry with it high salinity levels and high nutrient concentrations which are “transferred” into the Middle WMA. As a consequence these high salinity levels need to be managed through dilution with fresh water from Vaal Dam to ensure water of an acceptable quality reaches the Middle Vaal WMA.

Virtually all the surface flow of the Vaal River, the main source of water in the Lower Vaal WMA, originates from the Upper and Middle Vaal WMAs. Very little surface run-off originates within the WMA itself due to the low rainfall, flat topography and sandy soils (DWAF, 2006). Large quantities of water are transferred from the Vaalharts weir on the Vaal River to supply the Vaalharts irrigation scheme in the Harts River catchment. The development of the surface water resources occurring in the Lower Vaal WMA has reached its potential but not all the water is fully utilised. Most of the water is used for urban, agricultural and mining purposes within the WMA. Water is also transferred into the WMA from the Upper Orange WMA into Douglas Weir.

A reconciliation of water availability and water demand was done for the Upper, Middle and Lower Vaal ISPs (DWAF, 2004a, b and c) (Table 2.2) for 2000 and projected for 2025.

Table 2.2: Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004a) for the Upper Vaal WMA

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[1]	Total	Balance
Year 2000							
Wilge River	59	0	59	60	0	60	-1
Upstream Vaal Dam	184	118	302	215	67	283	19
Downstream Vaal Dam	889	1224	2113	769	1343	2112	1
Total	**1132**	**1311**	**2443**	**1045**	**1379**	**2424**	**19**
Year 2000 (with yield of Mohale Dam)							
Wilge River	59	0	59	60	0	60	-1
Upstream of Vaal Dam	184	118	302	216	67	283	19
Downstream Vaal Dam	889	1544	2433	769	1343	2112	1
Total	**1132**	**1630**	**2763**	**1045**	**1379**	**2424**	**339**
Year 2025							
Wilge River	58	0	58	56	0	56	2
Upstream Vaal Dam	184	118	302	256	74	330	-28
Downstream Vaal Dam	987	1513	2500	957	1561	2518	-18
Total	**1229**	**1630**	**2859**	**1269**	**1634**	**2903**	**-44**

Table 2.3 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004b) for the Middle Vaal WMA

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[2]	Total	Balance
Year 2000							
Rhenoster-Vals	44	1	45	54	0	54	-9
Middle Vaal	-142	828	686	129	559	688	-2
Sand-Vet	147	59	206	187	2	189	17
Total	**49**	**829**	**878**	**370**	**502**	**872**	**6**
Year 2025							
Rhenoster-Vals	44	1	45	53	0	53	-8
Middle Vaal	-136	837	701	142	560	702	-1

[1] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

[2] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

Sand-Vet	147	59	206	187	2	189	17
Total	**55**	**838**	**893**	**382**	**503**	**885**	**8**

Table 2.4 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004c) for the Lower Vaal WMA

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[3]	Total	Balance
Year 2000							
Harts River	136	419	555	494	45	539	16
Vaal d/s of Bloemhof	-46	545	499	65	423	488	11
Molopo	35	4	39	36	0	36	3
Total	**125**	**500**	**625**	**595**	**0**	**595**	**30**
Year 2025							
Harts River	137	419	556	496	43	539	17
Vaal d/s of Bloemhof	-45	543	498	64	423	487	11
Molopo	35	4	39	34	0	34	5
Total	**127**	**500**	**627**	**594**	**0**	**594**	**33**

2.2.2 Water quality issues

A comprehensive assessment of the water quality status of the Vaal River was done as part of developing an integrated water quality management plan for the system (DWAF, 2006). It was found that a spectrum of water quality problems has been identified. Some issues were related to the whole length of the Vaal River while others were of a localised nature. The study confirmed that increases in salinity (and related macro ions) had the greatest impact on the usage of the water in the Vaal River. The increase in TDS and concomitant increase in constituents such as chloride and sulphate had major implications on domestic, industrial and agricultural water use. The occurrence of microbiological pollutants as localised problems was also an emerging concern, as well as elevated levels of certain metals. Eutrophication was the other key water quality problem in the Vaal River System. This problem has resulted in excessive algal blooms and growth of water hyacinth. Eutrophication impacts have resulted in economic impacts on users and large expenditure to control it. The effect of the extensive algal blooms and biomass upon water treatment processes and quality of potable may yet increase in significance.

The study as concluded that while the upper part of the catchment had water of fairly good quality, the areas of concern included the Vaal Barrage, Middle Vaal River, and Lower Vaal River downstream of the Harts River confluence, where TDS levels were high (DWAF, 2006). Of further concern was the impact of the high TDS concentrations on water users downstream of the Vaal Barrage and those abstracting from the Barrage.

[3] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

Specific catchments were also of concern in terms of their contributions to the deteriorating water quality of the Vaal River (DWAF, 2006). These included the Waterval, Suikerbosrand, Rietspruit, Klip River (Gauteng), Mooi River, Koekemoerspruit, Schoonspruit, Vierfontein, Sand Vet and the Harts River Catchments. Water quality management strategies should be developed for these catchments to alleviating the stress currently being placed on the Vaal River.

The study also found that land based activities and water use practices could not continue unabated as they have. Water users, major role players and the Department all had to start taking responsibility where required. A range of management strategies and control measures were required to deal with the current poor situation.

The study found that the water quality issues of the Vaal River System were related essentially to salinisation and eutrophication, which have been confirmed as the two critical challenges facing the sustainability of the system DWAF (2006). Microbiological pollution was also an emerging problem, however, this is related to more localised areas. The study found that the deterioration of the water quality was mainly attributable to the following land use impacts:

- Wastewater treatment works discharges (from the numerous small towns and urbanised areas within the catchment area, many of which are non compliant to the wastewater discharge standards and licence conditions);
- Mining pollution (point decants from dewatering and diffuse pollution originating from mining areas and tailings dams);
- Urban run-off (arising from the highly urbanised areas within the catchment with formalised and informal settlements);
- Irrigation return flow (originating from large irrigated areas within the system which carry fertilisers and high salt loads through leaching);
- Industrial pollution (originating from direct discharges to the water resource and from diffuse pollution at the numerous industrial complexes within the catchment area).

The study also elaborated on future impacts (DWAF, 2006) as summarised below:

- A key issue related to mining activities in the Upper and Middle Vaal WMAs is the management of the mine decants after the closure of the mines. This issue is of long-term significance which requires intervention in the short term.
- The proposed mining in the Grootdraai and Vaal Dam catchments due to the recommissioning of power stations in the area could contribute further impacts on the system.
- The failure to achieve closure and rehabilitation of tailings dams could possibly impact on the water resources of the system.
- Lack of action to address the state of disrepair, inadequate capacity and general non-compliance to discharge standards of the wastewater treatment works in many of the

towns in the system could result in a major catastrophe that causes greater pollution and more public health problems (waterborne diseases) in the surface water resources.

- The deterioration in the quality of the water at Grootdraai Dam and Vaal Dam impact on strategic users and the inter-basin transfer of water.
- Organic loads in the Middle Vaal River affect ecosystem health and the tropic status of the river.
- The water quality of the Grootdraai Dam and the Vaal Dam is influenced by inter-basin transfers into the Vaal River catchment. Deterioration of the water quality of the contributing catchments would result in the deterioration of the water quality in the receiving water bodies.

2.2.3 Aquatic ecosystem health issues

The ecological health of the Vaal River was included in the State-of-Rivers report that was prepared for the Free State region (RHP, 2003).

For the Upper Vaal catchment area it was found that the Lesotho Highlands Water Project released 14 cubic metres per second into the As-Liebenbergsvlei-Wilge River. This modified flow has resulted in degradation and habitat destruction in the receiving rivers. Some weirs have been modified to slow the velocity of the water, prevent further damage to the habitat and allow for fish migration. The overall health of the Klip River was good to fair and the Wilge was fair to poor, deteriorating in a downstream direction because of large scale agricultural activities. The health of the Elands River was also fair to poor. The upper Vaal tributaries played an important role in the water supply for domestic, agricultural and industrial users in the area. The marginal riparian vegetation consists of grassland at most sites. The Namahadi River headwaters were fair, but the health deteriorates downstream. The naturally low habitat diversity restricted the availability for invertebrates and resulted in low scores (RHP, 2003).

For the middle and lower Vaal River the overall health was found to be fair to poor. The Vaal River downstream of the Vaal Barrage was impacted and controlled by activities and effluent discharges from southern Gauteng. The Klip River and Blesbok Spruit systems drain large areas of southern Gauteng affected by urban development, mining industrialisation and farming. The overall health of the lower Harts River was fair to poor. Good rains flushed the Taung Dam, but all the sediment was trapped in the Spitskop Dam. This resulted in the dam becoming relatively shallow and nutrient rich. Urban runoff in the Pampierstad area and return flows from the Vaalharts irrigation scheme affect the health of the Harts River. Areas downstream of Taung Dam have diverse habitats and diverse marginal vegetation. Despite the dolomitic springs which feed the river, the upper Skoonspruit was in a poor condition. The Johan Neser Dam overflowed most of the time and fish scores below the dam were good. The health of the lower Skoonspruit varies according to flow rates. During the rainy season, fish were abundant in the turbid, high flows. No fish were found during low flows when treated effluent was the main source of water in this section of the river (RHP, 2003).

2.3 CONCLUDING REMARKS

In summary, a wide spectrum of water quantity, water quality and aquatic ecosystem problems have been identified in the Vaal River system. Some of these problems relate to the whole or very large parts of the Vaal River, and other issues are of a more localised nature. Adopt-a-River activities can accommodate both situations. Localised problems such as water quality problems in the middle Vaal River lends itself to activities that involve the local authorities, water service providers, industries and local community organisations. Problems that affect long reaches of the river, such as the gradual increase in salinity along the middle and lower Vaal River are still amenable for local Adopt-a-River activities but is requires coordination and consultation between interest groups to address a problems that is only manifested in the lower reaches of the river. A project to develop water quality objectives for the Vaal River system is nearing completion and several other smaller scale studies and management strategies are in various stages of development. All these initiatives could benefit from the in involvement of local communities in the wellbeing of the river and its tributaries in their areas.

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3. PONGOLA RIVER CATCHMENT

Responsible office: Kwa-Zulu Natal Regional Office

3.1 BRIEF OVERVIEW OF THE PONGOLA RIVER CATCHMENT

The Pongola River has its origin at about 1 800 mamsl on the interior plateau and from here the river flows eastward around low mountains and hills in the escarpment region to the confluence with the Bivane River. Downstream of the confluence with the Bivane, the Pongola flows through hilly terrain and is joined by several small tributaries that drain the foothills of the escarpment. Just upstream of the town of Pongola, the river valley enters the Lowveld and widens into the intensely cultivated area upstream of Pongolapoort Dam. The Pongolapoort Dam is located at the downstream end of a narrow gorge in the Lebombo Mountains. At this point, the Pongola River turns in a northerly direction and flows through a fertile floodplain for about 90 km joining with the Ngwavuma River about 15 km south of the RSA/Mozambique border. At the border, the Usuthu and Phongolo Rivers have their confluence and form the Maputo River.

Downstream of Pongolapoort Dam is located in an extensive floodplain that varies in width from about 1 km to 5 km in places. There are numerous depressions (pans) in the flood plain that are periodically filled when floods overtop the river banks. When overtopping of the river banks take place, the sudden decrease in flow velocities cause sediment to be deposited close to the river banks, forming natural levees. The depressions behind these levees form natural lakes that retain water when the floods recede.

There is a large amount of irrigation in the middle Pongola catchment with an estimated irrigated area of 199 km^2 upstream of the Pongolapoort Dam. There are also large areas under afforestation in the upper reaches of the Pongola catchment, with an estimated area of 480 km^2, which has reduced the assurance of supply to irrigators over the years.

The Pongolapoort Dam, one of the largest in South Africa, remains underutilised, but due to uncertainties relating to the social and ecological requirements of the flood plains downstream of the dam and international requirements, the allocable surplus from the dam is difficult to quantify accurately. The Bivane Dam, situated on the Bivane River upstream of the Pongolapoort Dam, was recently constructed to improve the levels of assurance to existing irrigators. The opportunity now presents itself to increase the area under irrigation, provided irrigators are willing to accept reduced assurances, which seems to be an economically sensible strategy. This will reduce the available yield from the Pongolopoort Dam but this is part of the 100 million m^3/annum allocable yield from the system referred to in the previous paragraph. An allocation for additional afforestation is also possible. The water quality between the Impala Irrigation Scheme and Pongolapoort Dam is poor due to irrigation return flows.

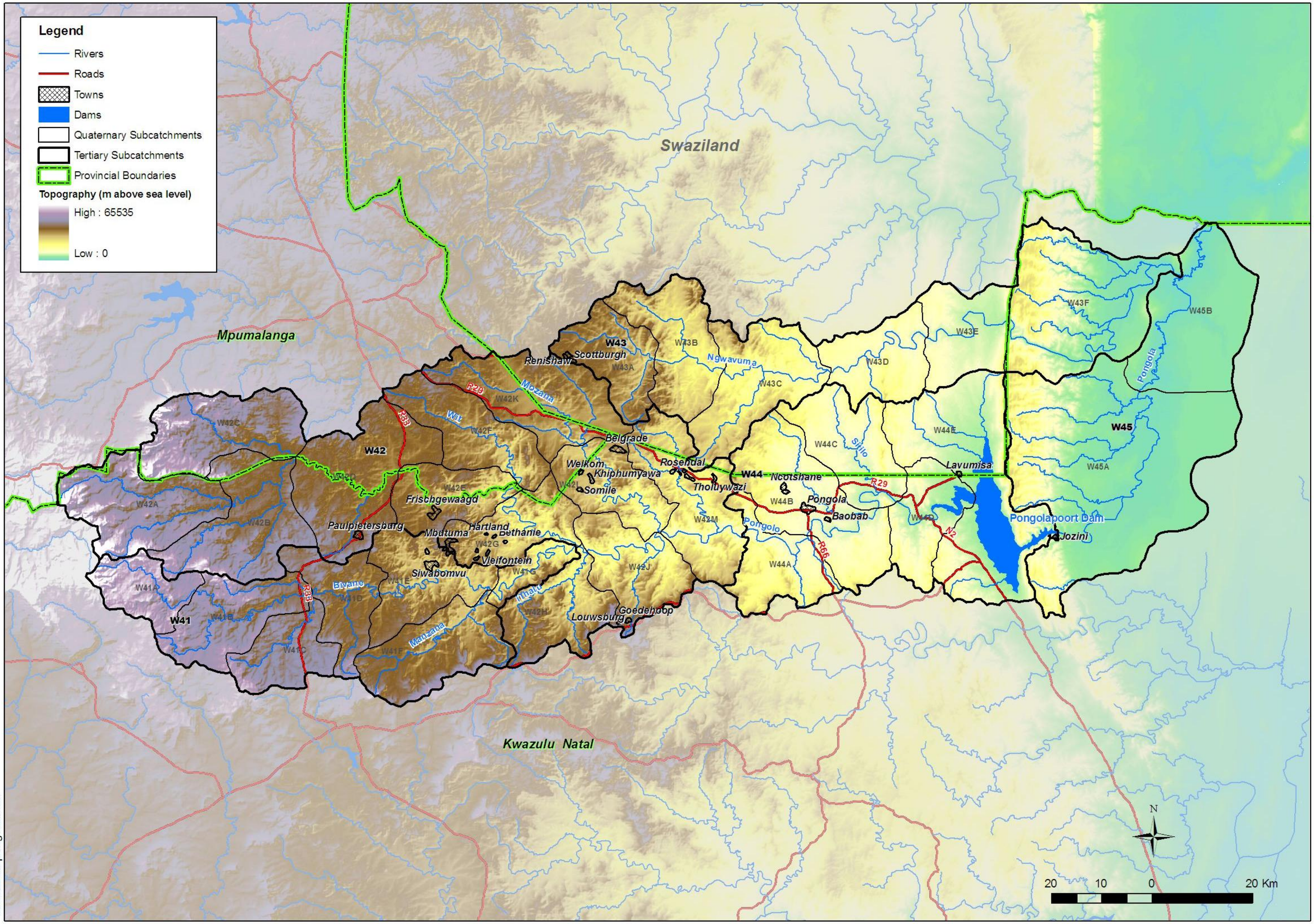

Figure 3.1 Map of the Pongola River catchment showing the major sub-catchments and rivers

3.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

3.2.1 Water quantity issues

A reconciliation of water availability and water demand was done for the Usutu to Mhlatuze ISP (DWAF, 2004). The largest water user in the Pongola catchment is the irrigation sector. The irrigators are mostly part of the Impala Water User Association situated near the town of Pongola. Forestry in the upper reaches of the catchment is also a significant water user. Water transfers, sources from Pongolapoort Dam, are for irrigation in the upper Mkuze catchment, and the town of Lavumisa in Swaziland.

Table 3.1 Reconciliation of the water requirements and the water resources in the Pongola catchment, including floodplain releases. (all units in million m^3/annum) (DWAF, 2004)

Available water	Local yield	645
	Transfer in	0
	Total	645
Water requirements	Local requirements	255
	Transfers out	38
	Floodplain releases	250
	Total	543
	Balance	102

Since the ISP was completed, a comprehensive investigation was undertaken of the water resources in the Maputo River Basin which included the Usuthu and the Pongola Rivers (Tanner *et al.*, 2008). This study evaluated ecological requirements and different development scenarios for water resources in the basin. It was found that if an objective is to maintain the Maputo River floodplain, downstream of the Pongola/Usuthu confluence, in its current ecological state then very little further development of water resources can be allowed. That is, more water is required in the lower reaches to maintain the floodplain status. However, if the ecological status is allowed to deteriorate by one class lower than the present state, then further water resource and economic developments are possible in the Pongola, Makhatini floodplain and Maputo floodplain. These assessments will be considered by the Tripartite Permanent Technical Committee (TPTC) of South Africa, Swaziland and Mozambique when a comprehensive agreement on water resources in the Maputo basin is negotiated in future (about 2010).

Table 3.2 Summary of water quantity issues in the Pongola River catchment

Sub-catchment	Water quantity issues
Upper Pongola (W41, W42)	The upper Pongola is the headwaters of the Pongola and Bivane River up to the confluence of the two rivers. It includes the Bivane Dam that was built by the Impala WUA to increase the security of water supply to the Impala Irrigation Scheme in the middle Pongola. There are extensive commercial forestry developments in the upper reaches of the two rivers. Water in the Upper Pongola is largely earmarked for forestry and for Impala Irrigation Scheme in the middle Pongola.
Middle Pongola (W44)	The middle Pongola is the catchment from the confluence of the Pongola and Bivane River up to the wall of Pongolapoort Dam. Water is used largely for irrigation of some 16 000 ha of sugar cane and about 1 000 ha of citrus, mangoes and vegetables are irrigated in the vicinity of the town of Pongola, upstream of the Pongolapoort Dam. The area is irrigated with water from the Bivane Dam in the Bivane River, and the Phongolo River. There are a number of game farms and nature conservancies in the foothills of the Lebombo Range, to the east of the irrigated area.
Lower Pongola (W45)	The lower Pongola is the catchment between Pongolapoort Dam and the confluence with the Usuthu River at the border with Mozambique. It includes the ecologically sensitive Mhakhathini floodplain and pans. Downstream of the Pongolapoort Dam, small farmer co-operatives have established some 3 400 ha of irrigated cotton and sugar cane. Further to the north, the floodplain of the Phongolo River supports some 180 000 people making a living from smallholdings in dense rural settlements. The Ingwavuma River is a major tributary that joins the Pongola just upstream of its confluence with the Usuthu River. However, very little flow reaches the lower Ingwavuma River due to over-exploitation its water resources.

3.2.2 Water quality issues

Table 3.3 Summary of water quality issues in the Pongola River catchment

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Upper Pongola (W41, W42)	Salinity in the upper Pongola in low and fit for all the intended water uses.	Nutrients in the upper Pongola are low and not a concern.	Incidents of outbreaks of water-bore diarrhea have in the past been reported in areas where people used water directly from the rivers and streams.	Concerns have been raised about possible trace metals in the Paulpietersburg area associated with acid mine drainage.	Acid mine drainage from old coal mines in the Paulpietersburg area is affecting local streams but not the mainstem Bivane or Pongola Rivers.	
Middle Pongola (W44)	Water quality in the Pongola River downstream of the irrigation scheme is marginal due to irrigation return flows. This is affecting salinity in Pongolapoort Dam which is currently ideal but shows a deteriorating trend.	High nutrients in the irrigation return flows results in elevated nutrient concentrations in the Pongola River downstream of the irrigation scheme. This has resulted in eutrophication problems at the inflow to Pongola-poort Dam and there were reports of animals that have died as a result of ingesting toxic algae in that area.	No concerns have been raised about bacteriological pollution.	No concerns have been raised about trace metals in the middle Pongola.	No concerns have been raised about pH in the middle Pongola.	Concerns have been raised about possible pesticide and herbicide residues in irrigation return flows. Concerns have been expressed about a new invasive water plant, Hydrilla verticilata, that was found in Pongolapoort Dam. Dense mats interfere with recreational boating.
Lower Pongola (W45)	Salinity increases between Pongolapoort Dam and the confluence with the Usuthu River. This is the result of irrigation return flows from the Makhathini Irrigation scheme and seepage of saline groundwater into pans and the river. The floodplain is situated on old marine deposits. Salinity is classified as acceptable just before the confluence with the Usuthu River.	No concerns have been raised about nutrients in the lower Pongola River.	Incidents of outbreaks of water-borne diarrhea and cholera have in the past been reported in areas where people used water directly from the river and its associated pans in the Makhathini floodplain.	No concerns have been raised about trace metals.	No concerns have been raised about pH related problems.	

3.2.3 Aquatic Ecosystem Health issues

A state-of-the-rivers report is being prepared for the Pongola River system and would only be ready by 2009 (Thirion, *pers. comm*.). However, as part of the Joint Maputo River Water Resources Study a desktop assessment was done of the present ecological state, ecological importance and sensitivity, and the socio-cultural importance (Louw and Higgins, 2007). The ecological importance and sensitivity considers aspects such as the presence of rare and endangered species, habitat diversity, importance as a migration route, conservation or natural areas, and its sensitivity and resilience to environmental changes. The results for the Pongola River is summarised below.

Sub-catchment	Present ecological state (PES)	Ecological and socio-cultural importance and sensitivity (EIS)
Upper Pongola	The headwaters of the Pongola and Bivane Rivers are in a good state with most of the rivers being in a B or B/C (upper fair) state. Sections of the Bivane River were in a C state (Fair) based on historical fish records.	The EIS in the upper Pongola varied between moderate to high. It is high in the upper reaches of the Pongola and moderate for most of the Bivane River. The Bivane upstream of the confluence with the Pongola was rated as a high EIS.
Middle Pongola	The middle Pongola River upstream of the irrigation abstractions was in a B state (good) but downstream of that point the state changes to a C (fair) based on extensive fish and invertebrate data available for the reaches upstream of Pongolapoort Dam.	The EIS for the middle Pongola was high but moderate in the area of the Impala Irrigation scheme. The river reach between the irrigation scheme and Pongolapoort Dam was rated as high.
Lower Pongola	The lower Pongola River downstream of Pongolapoort Dam was in a C (fair) ecological state based on fish and invertebrate information.	The EIS of the Pongola River downstream was rated as high to very high. The lower reaches of the Pongola upstream of the Usuthu confluence was rated as very high.

3.3 CONCLUDING REMARKS

Concerns in the Pongola River are centred on the impacts of abandoned coal mines in the Paulpietersburg area, the impacts of the irrigation scheme at Pongola on the river and the upper reaches of the Pongolapoort Dam, and human induced impacts in the ecologically sensitive Pongola River floodplain. Potential acid mine drainage problems in the Paulpietersburg area can be addressed through Adopt-a-River activities in the affected area that involves collaboration between the mining sector, government departments (DWA and DMEA), the local authorities, local communities, and Impala Water Users Association who receives the water from the affected area. The focus of these activities can be to address acid drainage problems. In the Pongola area and Pongolapoort Dam, Adopt-a-River activities should be centred on reducing the negative impacts of irrigation runoff on the Pongola River and upper reaches of the Pongolapoort Dam. These activities should involve the Impala Water Users Association, the local authority, the tourism sector, and wildlife conservation agencies active in the area. In the Pongola River floodplain, Adopt-a-River activities should focus on reducing human induced impacts on the floodplain pans and the river in order to protect fisheries resources, domestic consumption of water from the river, and cultural practices that involve the sustainable use of the floodplain and its floodplain vegetation. This should involve government departments such as DWA, Department of Health, Department of Agriculture, tribal authorities, local government, local authorities, and NGOs active in the floodplain.

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4. MOKOLO RIVER CATCHMENT

Responsible office: Limpopo Regional Office

4.1 BRIEF OVERVIEW OF THE MOKOLO RIVER CATCHMENT

The Limpopo Water Management Area (WMA) is the northern most water management area in the country and represents part of the South African portion of the Limpopo Basin which is also shared by Botswana, Zimbabwe and Mozambique. The WMA borders on Botswana and Zimbabwe, where the Limpopo River forms the entire length of the international boundary before flowing into Mozambique. The region is semi-arid, with economic activity mainly centred on livestock farming and irrigation, together with increasing mining operations.

The Limpopo WMA consists of a number of catchments which are mostly independent of each other. The main catchments are the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand, Nzhelele and Nwanedi.

The Mokolo catchment is the most developed in the Limpopo WMA and has more surface water available than any of the other catchment in the WMA (**Figure 4.1**). Apart from the higher than average rainfall, the large Mokolo Dam is situated in this catchment, which provides water for a multitude of uses, the most important being the supply to the Matimba Power Station and Grootgeluk coal mine. There are a large number of farm dams in the Mokolo catchment which has effectively moved much of the yield of the Mokolo Dam upstream where it is used to supply large areas of irrigation, with an estimated requirement of 68 million m^3/annum. There is also a significant amount of irrigation from groundwater.

The Mokolo catchment is a well developed catchment with industries, mines and extensive agricultural activities. The main industrial development relates to Eskom's Matimba Power Station. Associated with this power station is the Grootgeluk Coal Mine which supplies coal to the power station, local users, as well as for export. Both these bulk users are supplied from the Mokolo Dam. There are opportunities for further development of the substantial coal reserves and gas fields and other coal based industries and related development. This area, together with the Lephalala catchment, have approximately 40% of South Africa's remaining coal reserves and the development of new power stations in this area is inevitable as coal reserves on the highveld become depleted. The towns of Lephelale (formerly Ellisras) and Vaalwater are situated in this catchment. Extensive irrigation occurs in the Mokolo catchment, both upstream and downstream of the Mokolo Dam.

The Mokolo catchment appears to be approximately in balance and no further allocations should be made from surface water without carrying out detailed analyses to verify a sustainable source of supply. Groundwater is under-utilised and should be the first option to supply increased domestic requirements, provided the water quality is acceptable.

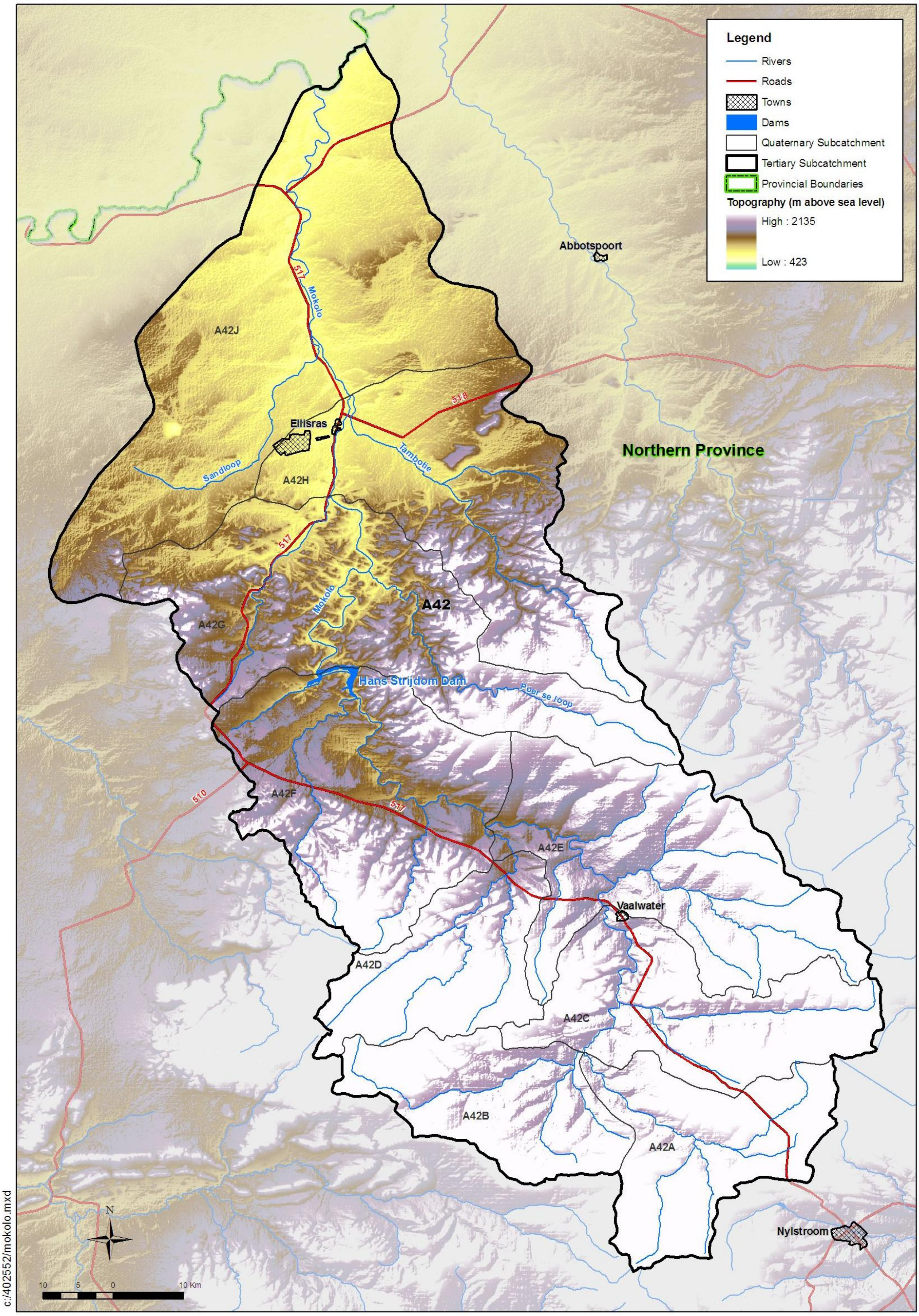

Figure 4.1 Map of the Mokolo River catchment showing the major sub-catchments and associated rivers

Where water of acceptable quality cannot be sourced, additional small dams may be required to supply increased domestic requirements.

4.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

4.2.1 Water quantity issue

The water resources of the Mokolo catchment are dominated by the Mokolo Dam situated in the lower reaches of the Mokolo River. This dam has a full supply capacity of 146 million m^3 and the river at this point a natural MAR of 240 million m^3/a, i.e. before all the abstractions for irrigation and the construction of farm dams took place upstream of the dam.

Irrigation is by far the largest water user the Mokolo catchment. It takes place mostly upstream of the Mokolo Dam, with water sourced from farm dams and run-of-river abstractions. There is an allocation of 10.4 million m^3/a (at 70% assurance) from the Mokolo Dam to irrigators downstream of the dam. Other allocations from the dam are 9.9 million m^3/a to the Grootgeluk mine and 7.3 million m^3/a to the Matimba Power Station. The actual use by the mining sector appears to be much less than the allocated amount. The urban use is that of the towns of Lephalale and Vaalwater.

Table 4.1 Reconciliation of water requirements and available water for the Mokolo catchment for the year 2003 (million m^3/a) (DWAF, 2004).

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[4]	Total	Balance
Year 2000							
Mokolo	83	0	83	83	0	83	0

While the Mokolo catchment is currently in balance, there are a number of planned developments for which additional water resources will need to be sourced. These developments relate to the natural gas and coal reserves and industries that require close proximity to large coal reserves.

- Extension of the existing mine and the development of additional coal mines.
- Potential development of gas fields found in this catchment.
- The construction of new power stations (Medupi Power Station).
- Development of petrochemical industries equivalent to Sasol or Secunda.
- Fast-growing informal settlements around Vaalwater and Alma.
- Iron and steel manufacturing.

The options being considered to address future water demands as a result of further developments include:

[4] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

- The raising of the Mokolo Dam (the dam was designed to be raised).
- Transfers of surplus return flows from the Crocodile/Marico WMA to the Mokolo catchment. Planning for such a scheme, the Crocodile West River Water Transfer Scheme is well advanced.
- Water trading with the irrigation sector.
- Groundwater through the development of large borehole networks in undeveloped areas within this catchment or neighbouring catchment.

4.2.2 Water quality issues

Groundwater quality in much of the Mokolo catchment is poor due to the coal and gas fields. This poor quality groundwater could still be used for industrial purposes or irrigation, however, but is unsuitable for domestic use.

Coal mining activities are also impacting on the surface water quality of the Mokolo catchment. The coal mining activities could also have a negative impact on the groundwater quality. The rapid and uncontrolled growth of informal settlements around Vaalwater and Alma is a source of concern with regard to the surface and groundwater quality in this area.

In terms of bacteriological water quality, it was reported by the local community that discharges from the Vaalwater sewage works into the Mokolo River were having an adverse impact on water quality (River Health Programme, 2006).

Informal settlements have developed rapidly around Vaalwater (A42C) leading to increasing demands on the water supply and a serious potential for groundwater pollution. A similar situation is occurring at Alma, south of Vaalwater. Groundwater quality could be seriously impacted from the uncontrolled growth of informal settlements around the existing towns. The quality of the water resource could also be affected by pollution from the Grootgeluk Coal Mine. Some of the water quality problems that could result from the coal mine are acid mine water, low pH and a concentration of TDS (DWAF, 2004).

4.2.3 Aquatic ecosystem health issues

The present ecological state of the Mokolo River Catchment lies predominantly in a Fair to Good Ecological Class (River Health Programme, 2006).

The fish populations of the catchment appeared to be slightly more impacted than aquatic invertebrates. This was attributed to reduced river flows due to the dams and weirs in the river system. Very few flow dependent or migratory fish species were encountered throughout the RHP survey. Invasive alien fish were recorded in the river at two locations. Despite modified flows across the catchment, invertebrate populations remain in a fair to good River Health Category. The more sedentary mollusc families were seldom found, reflecting the periodic cessation of flow in recent years.

Surveys of the riparian vegetation indicated the high occurrence of alien vegetation, encroachment of terrestrial vegetation and destruction of the riparian zone through poor land use practices.

The geomorphological state of the system reflected changes in flow and localised site impacts. As the geo-physical template for all other drivers, the geomorphological state also reflects reduced habitat availability and increased disturbance, which was often accompanied by invasive alien vegetation encroachment.

Water quality throughout the study area is considered to be good. However, pulsed releases from Mokolo Dam could interfere with water temperatures within the lower reaches of the river, and the unseasonal flow patterns may also adversely affect the lower river system.

Not one site within the catchment reflects a natural state or reference condition. Given the number of nature reserves on tributaries to the Mokolo, this fact was quite surprising to the RHP survey team.

No indication could be found to suggest that the spraying of reed beds was having an adverse effect on the fauna of the lower river.

Flow regulation was considered to be causing significant impact throughout the system.

While the Mokolo Catchment was currently in a Fair to Good state, increasing water demands within the catchment are likely to cause a downward trend in the overall status of the system.

Some of the issues of concern identified in the State-of-Rivers Report for the Mokolo River were (River Health Programme, 2006):

- In terms of water supply for the environment, there have been no formal studies undertaken for the Mokolo to date. It was recommended that, given the predicted increase in demand on the water resources of the catchment, the immediate determination of a comprehensive ecological Reserve is required.
- Pulsed water releases from Mokolo Dam are coordinated for agricultural purposes with little recognition of environmental requirements. It was recommended that the releases should be coordinated in order to provide maximised benefits to downstream users and the environment. The maintenance of pools in the immediate downstream reach of the Limpopo River for hippopotamus should be a consideration in this regard. An ecological Reserve for the lower river would provide guidance on this matter.
- In some areas of the catchment, alien vegetation encroachment is a serious problem. It was recommended that a concerted effort to eradicate alien invasive vegetation in the catchment should be prioritised. Poplars are recognised as the worst invaders in the catchment. The issue should be publicised with local land owners.
- Large areas of the lower sections of the river near Lephalale are being mined for sand and this has a serious effect on the system. Sand mining appeared to be bypassing the necessary EIA procedures, (administered through Limpopo Environmental Affairs), and EMP's, (administered through the Department of Mineral and Energy). It was recommended that the situation needed to be reviewed by the respective departments. Public awareness combined with a formal audit of the current situation is required.

4.3 CONCLUDING REMARKS

The greatest impacts of concern are centred on the current and future areas of coal mining, power generation, and related activities. Adopt-a-River activities should be aimed at addressing current and especially future impacts resulting from the development of the area. Activities should involve the DWA, local authorities, ESKOM, the mining sector, local communities, and wildlife conservation organisations.

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5. OLIFANTS RIVER CATCHMENT

Responsible office: Mpumalanga Regional Office

5.1 BRIEF OVERVIEW OF THE OLIFANTS RIVER CATCHMENT

The Olifants River originates in the Highveld of Mpumulanga. The river initially flows northwards before curving in an easterly direction through the Kruger National Park and into Mozambique. The Olifants WMA falls within three provinces via Gauteng, Mpumulanga and the Limpopo provinces.

The topography is characterised in the southern part by gently rolling hills before the river cuts through the Drakensberg to enter the relatively featureless lowveld region. The rainfall is strongly seasonal occurring mainly in summer. The mean annual precipitation varies from 500 mm in the Lowveld region, reaching 1000 mm in the mountains and reducing to 700 mm in the south in the Mpumulanga Highveld. The potential evaporation is well in excess of the rainfall.

The Olifants River catchment was divided into 4 sub-catchment areas for the purposes of discussing the water resource quality issues and concerns. The sub-catchments are the Upper Olifants, Middle Olifants, Steelpoort and Lower Olifants Sub-catchment. The location of the sub-areas is shown in **Figure 5.1**.

The Upper Olifants Sub-area is the most urbanised of the four sub-areas with the majority of the urban population located in Witbank and Middelburg. The population in these urban centres is projected to grow in the future. There are extensive coal mining activities in the sub-area both for export through Richards Bay and for use in the six active coal fired power stations in the sub-area. The presence of coal also led to the establishment of the steel manufacturing industries located in Middelburg and Witbank.

The population in the Middle Olifants Sub-area is largely undeveloped with scattered rural settlements. The predominant land use is agriculture with extensive irrigation taking place from Loskop Dam. There are a number of platinum and chrome mines being developed in the Middle Olifants Sub-area. The mines have increased the water requirements in the area both due to direct water use and the influx of people into the area to work on the new mines.

The Steelpoort Sub-area is largely rural with agriculture the predominant land use. There is vanadium and chrome mining and mineral processing taking place in the sub-area. The demographics of this sub-area are also affected by the new mining developments in the WMA with the population of Burgersfort projected grow.

The Lower Olifants Sub-area is also rural in character with the main urban centre being Phalaborwa. Extensive irrigation takes place along the Olifants River, in the Blyde River catchment and in the upper reaches of the Ga-Selati catchment.

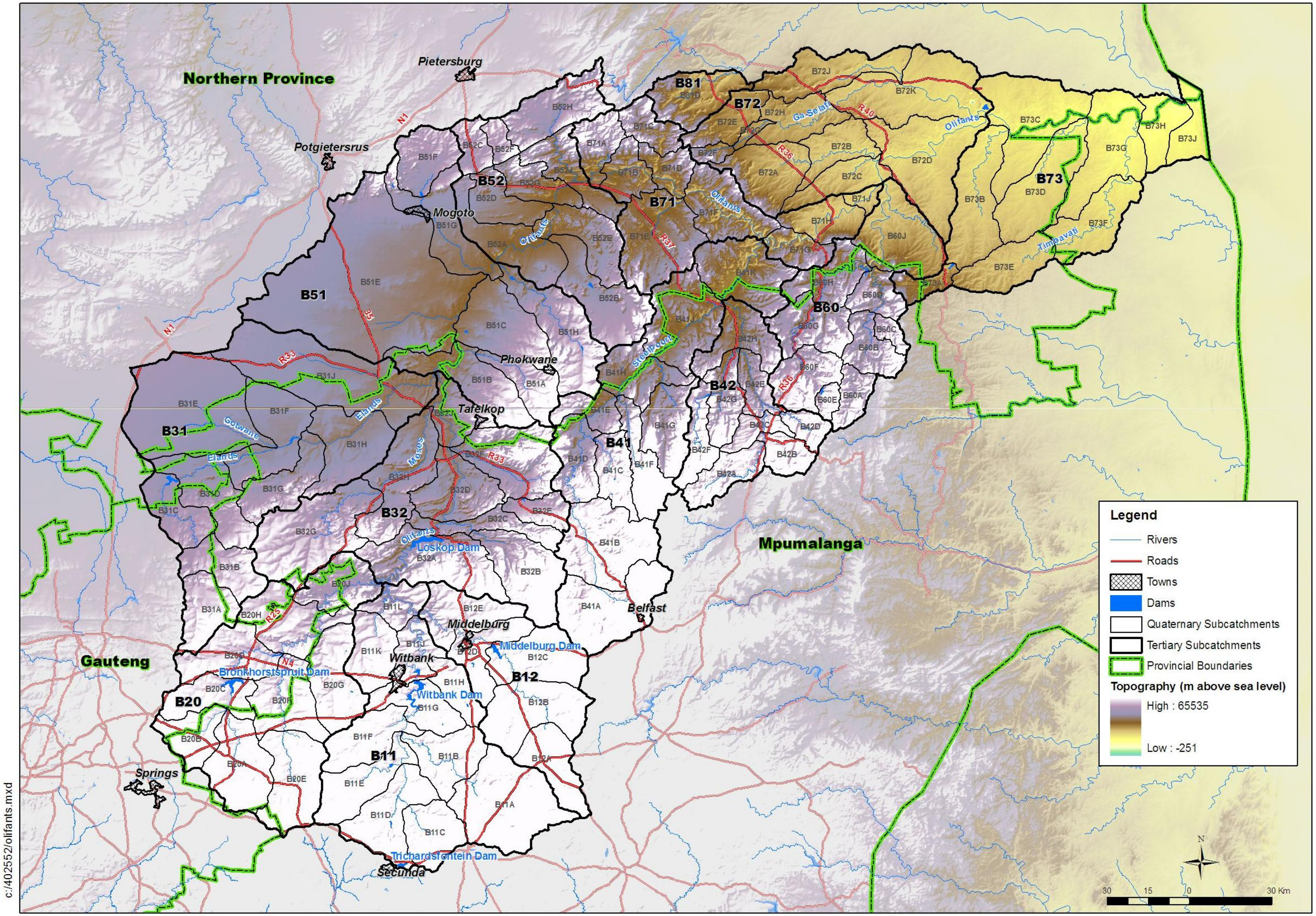

Figure 5.1 Map of the Olifants River catchment showing the main sub-catchments and rivers

Ecotourism is an important industry with a number of private game parks and the Kruger National Park (KNP) located in the sub-area. There is mining with the main mining activity being the copper and phosphorus mining taking place in the vicinity of Phalaborwa.

5.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

5.2.1 Water quantity issues

In the Olifants WMA ISP report a water balance was compiled for the year 2000 and for the year 2025 which took the growth in water demand and return flows into account (DWAF, 2004) (Table 5.1).

Table 5.1 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004)

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[5]	Total	Balance
Year 2000							
Upper Olifants	238	171	409	314	96	410	-1
Middle Olifants	210	91	301	392	3	695	-94
Steelpoort	61	0	61	95	0	95	-34
Lower Olifants	100	1	101	164	0	164	-63
Total for Olifants	**609**	**172**	**781**	**965**	**8**	**973**	**-192**
Year 2025							
Upper Olifants	256	209	465	383	82	465	0
Middle Olifants	212	77	289	430	2	432	-143
Steelpoort	62	0	62	96	0	96	-34
Lower Olifants	100	1	101	165	0	165	-64
Total for Olifants	**630**	**210**	**840**	**1074**	**7**	**1081**	**-241**

Table 5.2 Summary of water quantity issues in the Olifants River catchment

Sub-catchment	Water quantity issues
Upper Olifants	The water availability in this sub-area is impacted on by coal mining. The mining process impacts on the natural hydrological system by disturbing the integrity of the overlying rock and soil strata resulting in increased infiltration and recharge of the groundwater system. This "additional" water, although of poor quality, represents extra water which can be utilised in the sub-area. The quantity of the "additional" water needs to be determined. The water volumes stored in the mine workings can also be utilised as dams during drought periods to augment the yield of the system. The water requirements in the Upper Olifants Sub-area are projected to grow significantly in the urban areas of Witbank and Middelburg. The initial projections were obtained from the local authorities during a study (DWAF, 2000) to develop an integrated modelling tool for the Loskop Dam catchment. The projections were later revised and reported in the VRESS Study (DWAF, 2001) on augmenting the supply from the Eastern subsystem. The revised growth in the water requirements for Witbank was substantially increased and Middelburg's reduced. DWA needs to assess the projected water requirements for Witbank and Middelburg as these

[5] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

Sub-catchment	Water quantity issues
	requirements impact on augmentation volumes and timing of the next schemes. DWA needs to interact with these local authorities to explain DWA's position regarding WC&DM and development of local groundwater resources. The coal mining industry in this sub-area is projected to decline over the next 20 years. There is therefore uncertainty over the future of many of the smaller towns in this area that have been developed almost exclusively for the mines.
Middle Olifants	There are a number of irrigation schemes in this area that have fallen into disuse. The schemes are being revived as poverty eradication initiatives and the use of water on the schemes will grow steadily as the schemes come back on line. Although these irrigation requirements have been included in the water requirements for this sub-area given in the reconciliation, the water requirements currently not being used has eased the deficit situation in the sub-area. The growth in the water requirements in the Middle Olifants Sub-area is largely due to the new mining operations being established in the Dilokong Corridor. The extent of the mining operations and the projected growth in water requirements as regards the influx of people to the area is not fully known. A study (DWAF, 2003) to determine the requirements in this area is nearing completion. The updated water requirement figures will be available in a few months time. The new information together with the planned new infrastructure needs to be incorporated into the reconciliation for the WMA.
Steelpoort	The water requirements in the Burgersfort area are growing due to the influx of people being housed in the town. The extent of the growth is being determined as part of the study (DWAF, 2003). Like the Middle Olifants sub-area, there are irrigation schemes that have fallen into disuse. Plans are being implemented to revive these schemes as part of poverty eradication initiatives.
Lower Olifants	The majority of the sub-area is dry with an MAP of less than 500 mm except for the area along the escarpment where the MAP can reach 1000 mm. The Blyde River catchment has a high rainfall and the water emanating from the Blyde River makes an important contribution to the base flows in the lower reaches of the Olifants River passing through the Kruger National Park. The base and drought flows in the lower reaches of the Selati River are maintained by return flows from the Foskor mining complex. The return flows are largely discharges from the tailings dams. Extensive programs are being investigated by Foskor to recycle much of this effluent, which will impact on the flows and water quality in the lower Selati. These flows also contribute water to the drought flows in the Olifants River flowing through the KNP. The water requirements in this area are not foreseen to grow significantly. The water requirements in the Phalaborwa area are likely to drop with the implementation of treatment and the recycling of water by Foskor and the advent of underground mining by Palabora Mining Company. The water requirements in this area need to be confirmed.

5.2.2 Water quality issues

Table 5.3 Summary of water quality issues in the Olifants River catchment

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Upper Olifants	Water quality concerns in the Olifants and Klein Olifants River catchments are high concentrations of dissolved solids (TDS) and sulphate, low pH, and at times high concentrations of iron, manganese and aluminium as a result of mining activities. It was found that TDS and sulphate concentrations increased where streams pass through mining areas. In the Klipspruit catchment, major concerns have been expressed about pH, TDS, sulphate, aluminium and manganese. In the Olifants River between Witbank Dam and Loskop Dam, concerns were noted about low pH, high EC and high sulphate concentrations in the Spookspruit, but Loskop Dam appeared to meet guidelines values, probably as a result of the Wilge River improving the inflowing water quality into Loskop Dam.(Olifants WMA)	Concerns have been expressed about the impacts of high nutrient concentrations being discharged into Loskop Dam leading to eutrophication problems and toxic algal blooms in the upper reaches on the dam.	Concerns have been expressed about bacterial pollution from informal settlements and poorly services urban and peri-urban areas.	Water quality concerns in the Olifants and Klein Olifants River catchments are at times high concentrations of iron, manganese and aluminium as a result of mining activities.	In the Klipspruit catchment, major concerns have been expressed about pH, sulphate, aluminium and manganese.	Concerns have been expressed about the cumulative impacts of acid mine drainage in the upper Olifants and about the long-term impacts on communities and aquatic eco-systems.
Middle Olifants	In the middle Olifants River, concerns have been expressed about high salinities at the downstream ends of the Moses River and Elands River, especially during the low flow periods. These increases were mostly due to irrigation return flows from irrigation projects. Sodium and chloride were	Minor concerns noted about nutrients in treated wastewater effluent from towns in the middle Olifants catchment.				Concerns have been expressed about the potential impacts of agro-chemicals in the irrigation return flows of the Loskop Irrigation Scheme.

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
	identified as the main quality variables of concern during the low flow periods. Water quality in the middle Olifants catchment is also regarded as poor as a result of high TDS concentrations with high sodium and chloride being the constituents of concern. The high salinities are also ascribed to irrigation activities at the Loskop Irrigation Scheme. (Olifants WMA)					
Steelpoort		Some concerns about treated wastewater elevating the nutrient concentrations in the lower Steelpoort River.		Concerns have been expressed about heavy metal pollution from chrome and vanadium mining activities in the Wapadskloof area and Groot Dwars River area of the Steelpoort River catchment. (Olifants WMA)		
Lower Olifants	The production of sediment, particularly in the Middle Olifants Sub-area causes operational problems at the downstream Phalaborwa Barrage.				Concerns have been expressed about the pH in the lower Selati River receiving runoff from adjacent industrial sites.	In the Lower Olifants Sub-area, the water quality is influenced by the water quality of the return flows from the mining complex around Phalaborwa in the Ga-Selati River. This water quality is poor, it has high fluoride concentrations and impacts on the Olifants River. (Olifants ISP)

5.2.3 Aquatic ecosystem health issues

The Olifants Catchment experiences extreme demand for natural resources, and associated land modification and pollution. Thus river ecosystems in this area are generally in a fair to poor condition. Exceptions are the Tongwane, upper Mohlapitse, and most of the Blyde Rivers, where a natural state prevails, and the lower reaches of the Olifants River, which is protected by conservation activities (River Health Programme, 2008).

In the upper parts of the catchment mining-related disturbances are the main causes of impairment of river health. There is also an extensive invasion by alien vegetation, and to a lesser extent alien fauna. Ecologically insensitive releases of water and sediment from storage dams are another major cause of environmental degradation downstream, which is particularly relevant in the middle and lower parts of the catchment.

Upper Olifants sub-catchment – Mining, predominantly for coal, and other industrial activities in this area are the main contributors to poor instream and riparian habitat conditions. In-stream conditions are impaired by poor water quality, where acid leachate from mines in a primary contributor. Low pH (high acidity) and high concentrations of dissolved salts are characteristics of streams in this section. Stream diversions occur as a result of agricultural and mining activities. In some parts, access roads, mostly related to mining and industrial activities, have resulted in severe disturbances of riparian habitats, and increased erosion of both land and riverbed. Alien plants such as wattles also occur within the riparian zone, competing with indigenous vegetation and reducing available water in the riparian zone. The in-stream and riparian habitats in these ecoregions showed a fair to unacceptable state, with the general condition being poor and fair in ecoregions. Biological communities also reflect fair to unacceptable health, with the streams in ecoregion 7.04 in a slightly better state than those in ecoregion 7.02. Sections of the Bronkhorstspruit are good to fair. The Wilge is in an overall good state and the state of the Klein Olifants is fair. The riparian habitats and vegetation of the Olifants River in this section are generally in good health. In-stream conditions are more variable, ranging from good to fair.

Middle Olifants sub-catchment - The Olifants River upstream of the Arabie Dam is impacted by agricultural activities. Runoff from commercial agricultural areas contains agro-chemicals, which cause eutrophication or contamination of water, either of which can impair the health of invertebrates and fish. There is serious erosion of the riparian zone in the Olifants River. In particular, sediment from Sekhukuneland settles here, resulting in siltation and loss of habitat. Cultivation and grazing also causes the riverbanks to de-stabilize, undercutting occurs and riverbanks are swept away by floods. River habitats in this region are in a poor to unacceptable state. The exception is upstream of the Rust de Winter Dam where the Elands River is in a fair condition. In-stream biota in the Olifants River is fair to poor, with the riparian vegetation being in a poor state. For the Elands River the riparian vegetation is fair , but in-stream biota varies from fair to unacceptable . The worst part is immediately downstream of Rust De Winter Dam, where the river is often dry because releases from the dam are insufficient or non-existent. In the Olifants River downstream of the Loskop Dam and the Moses River the in-stream habitat is in a fair state; fish in a fair to poor health, and invertebrates reflect good health. Riparian habitats and vegetation are in fair condition.

Steelpoort sub-catchment – Overgrazing and dryland cultivation throughout the ecoregions, including in the riparian zone, leads to erosion, which causes high silt levels in the rivers. The Spekboom River is in a good state, with riparian vegetation slightly more impacted and reflecting fair health. The overall state of the Beetgekraal River is fair, with fish and invertebrates being good. The ecological state of the Steelpoort River is fair to unacceptable. The Spekboom River is generally in a good state. The habitats and riparian vegetation of the Waterval River are fair, while fish populations are good and invertebrates reflect a natural state of health.

Lower Olifants sub-catchment - Sediment, from upstream activities including overgrazing and industrial and mining activities, accumulates in the Phalaborwa barrage. When barrage is flushed at out from time to time, large quantities of sediment are released. This causes severe damage to in-stream habitats and biota in the downstream part of the Olifants River. Heavy metals and chlorides from industrial and mining origin in the Phalaborwa area may reach unacceptable levels during low flow periods. The Olifants River is generally in a fair state with fish and invertebrates occasionally reflecting poor conditions. The Ga-Selati is generally in a fair state with the state of fish and riparian vegetation being poor. The health of the Olifants River improves downstream of the confluence with the Blyde River, as the water coming in from the Blyde River is of better quality than that in the Olifants River. Upstream of the Phalaborwa Barrage, the Olifants River is in a fair to poor state in terms of in-stream and riparian habitat, while the biological indicators in general reflect a fair state.

5.3 CONCLUDING REMARKS

The Olifants River is highly impacted my mining developments in its upper reaches, agricultural and land-use impacts in the middle reaches, and agricultural and industrial impacts in the lower reaches. Localised Adopt-a-River activities where communities, industries, agriculture and local, provincial and national government cooperate can have a high beneficial impact on specific river reaches, and the Olifants basin as a whole. The focus of these activities will be on local issues and concerns as mentioned in this report because Adopt-a-River groups will want to see tangible benefits and success stories from such activities. All interest groups are well represented in the catchment and it may be prudent to promote Adopt-a-River implementation in this basin even if it only focused on specific rivers in the basin.

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6. KLIP RIVER AND WONDERFONTEINSPRUIT CATCHMENTS

Responsible office: Gauteng Regional Office

6.1 BRIEF OVERVIEW OF THE KLIP RIVER AND WONDERFONTEINSPRUIT CATCHMENT

The Klip River and Wonderfornteinsruit fall within the Upper Vaal Water management Area. The Klip River drains into the Vaal River Barrage and Wonderfonteinspruit drains into the Mooi River which drains into the Vaal River near the town of Potchefstroom. Both these rivers are affected by mining and mine dewatering activities in their catchments.

Klip River

The Klip River catchment covers an area of approximately 3000 km2. The catchment includes three sub-catchments namely the Upper Klip, the Rietspruit and the Lower Klip. The river has its origins in the range of hills and ridges which run across the Witwatersrand urban complex in an east-west alignment for approximately 60km. The catchment is generally characterised by a gently undulating topography except for several small hill ranges in the north-west (e.g. Klipriviersberg). Mine dumps are characteristic features of the landscape, particularly in the headwaters of the catchment. Urban development covers most of the headwaters and the downstream reaches of the Klip River catchment. The city of Johannesburg and neighbouring satellite towns lie at the head of the catchment, whilst the industrial town of Vereeniging is located at the confluence of the Klip River and the Vaal Barrage. Most of the Klip River catchment between these urban centres is presently characterised by agricultural and market gardening activities. However, urban expansion, including informal settlements, in the areas of both Johannesburg and Vereeniging is encroaching towards one another. Much of the catchment, however, is underlain by dolomites. Wetland reaches are common along watercourses, especially in the upper Klip River, whilst stands of exotic trees are found adjacent to the river in parts of the catchment.

Flow in the Klip River is dominated by runoff from both urban areas and discharges from wastewater treatment works (WWTWs). These water sources contribute to poor water quality in the river system, but at the same time they result in the Klip River flowing on a permanent basis, permitting year round recreational activities and irrigation. Without these additional contributions to flow, the Klip River would virtually run dry in winter. Impoundments or dams on the Klip River system are largely confined to the upper reaches of the catchment.

Wonderfonteinspruit

The Wonderfonteinspruit (also called the Mooirivierloop) originates in the Krugersdorp area and flows in a south-easterly direction, past the mining areas of Carletonville, and joins up with the Mooi River upstream of Boskop Dam near Potchefstroom. Its catchment is situated on the Far West Rand with the upper section in the Gauteng Province and the lower part of the catchment in the North West Province. The river receives contamination from a wide variety of point and diffuse sources.

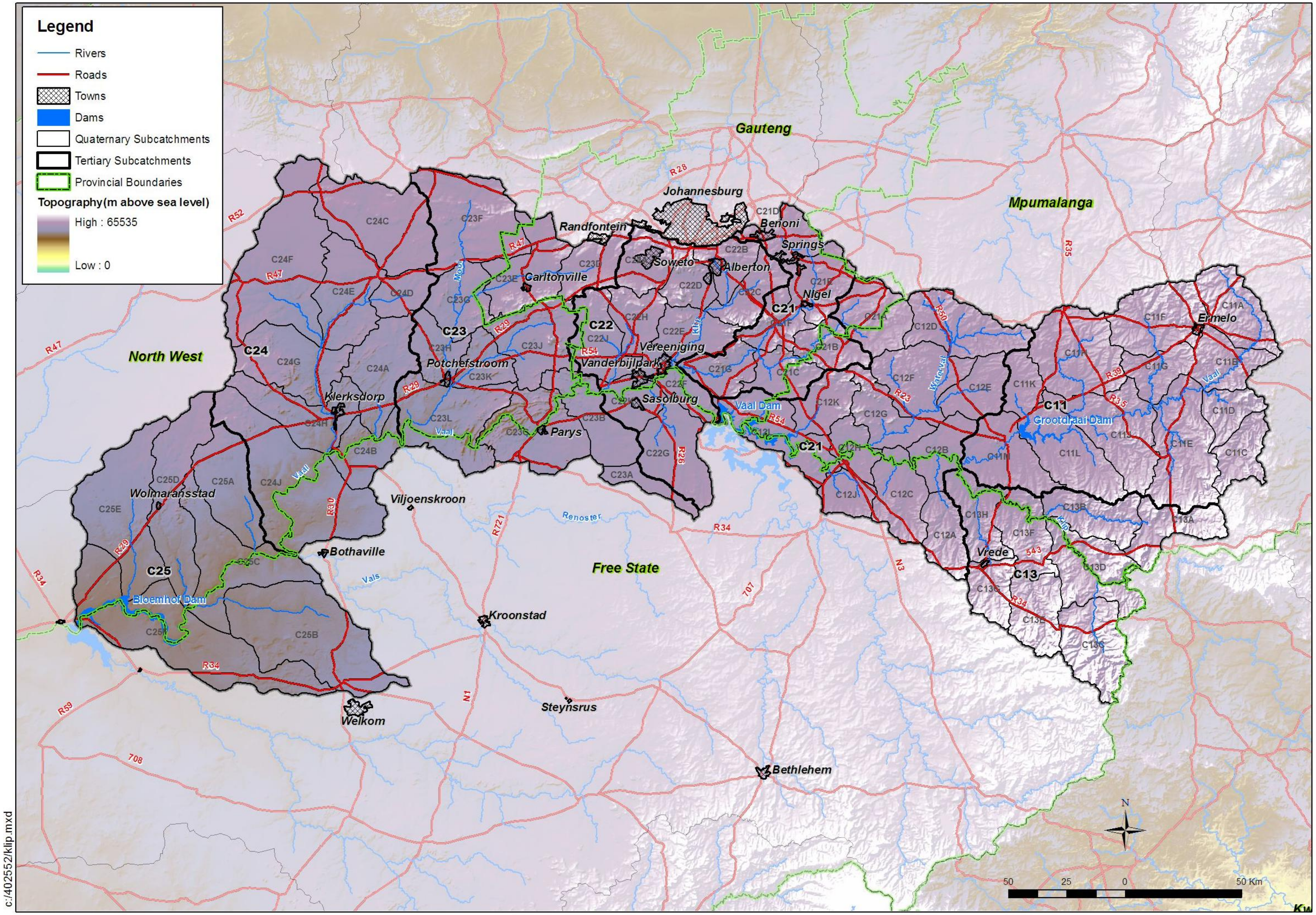

Figure 6.1 Map of the Klip and Wonderfonteinspruit catchments

The headwaters of the Wonderfonteinspruit originate around the mine residue deposits of several old and abandoned mines. These mine tailings dams, sand dumps and rock dumps are potentially significant contributors to diffuse pollution. Furthermore, numerous active gold mines are discharging fissure and process water into the water environment. Most of the catchment area is underlain by dolomite of which three of the dolomite compartments are dewatered by the gold mines. The water in the Wonderfonteinspruit is diverted into a one metre diameter pipeline, which transports the water over two of the dewatered compartments. A number of growing communities are located in the catchment, including Kagiso, Mohlakeng, Toekomsrus, Rietvallei and Bekkersdal. These developments, as well as informal developments, contribute to the diffuse sources of pollution.

6.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

6.2.1 Water quantity issues

In the Upper Vaal WMA ISP document (DWAF, 2004), the Klip River and the Wonderfonteinspruit formed part of the larger catchment called "Downstream of Vaal Dam". It therefore included rivers such as the Suikerboschrand River and the Mooi River. Water resources were therefore not assessed on an individual river scale.

Table 6.1 Reconciliation of water requirements and available water for the Mokolo catchment for the year 2003 (million m^3/a) (DWAF, 2004)

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[6]	Total	Balance
Year 2000							
Downstream of Vaal Dam (without yield of Mohale Dam)	889	1224	2113	769	1343	2112	1
Downstream of Vaal Dam (with yield of Mohale Dam)	889	1544	2433	769	1343	2112	1
Year 2025 base scenario							
Downstream of Vaal Dam	987	1513	2550	957	1561	2518	-18

6.2.2 Water quality issues

Klip River

The Klip River catchment is characterised by a great deal of mining activities, as well as urban, industrial and agricultural development activities. Consequently, the catchment has been highly altered due to these activities. These developments have significantly also affected the water level, flow regime and stream morphology of the Klip River, as well as its water quality.

[6] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

Certainly, all of these effects have impacts on the beneficial use of the Klip River itself and on downstream users of the Vaal Barrage into which the Klip River drains.

The upper reaches of the Klip River catchment (the Upper Klip) are characterised by pollution from mining land, industrial areas, urban runoff, informal settlements and leaking or blocked sewers. Pollution manifests itself principally by way of acid mine drainage (saline water), nutrient rich organic compounds, pathogens and to a lesser extent heavy metals and radio activity. Due to the closure of gold mines and the use of purified water instead of river water for industrial processing, the ERPM gold mine on the East Rand now remains as the only significant point pollution source in the middle reaches of the Klip River system. The poor quality of river water in the headwaters of the catchment can thus be largely ascribed to the presence of a diverse range of diffuse pollution sources. The upper reaches of the Klip River catchment are dominated by the treated effluent discharges from the three southern Johannesburg Water's Waste Water Treatment Works (WWTWs) in the Johannesburg area and four East Rand Water Care Company (ERWAT) WWTWs on the East Rand. These are the point pollution sources in the Klip River catchment. High nutrient levels and pathogens compromise water quality, although a certain degree of abatement is achieved through wetland reaches in the river below the WWTWs.

The lower Klip River is more agricultural in nature although the Meyerton WWTW and its industrial area, together with the town of Vereeniging, contribute to the pollution load in the Klip River to varying extents. Pollution impacts from agricultural activities in the aforementioned areas, however, tend to be masked by the dominance, in terms of flow, of the WWTWs in the middle Klip River. Increasing urban development, particularly in the middle Klip River segment of the catchment, can be anticipated in the future. This will require careful management and control to prevent further deterioration of the water quality in the river.

Concerns have been raised about radioactivity in the Klip River. DWAF (2003) found that the general conclusion was that of the 20 sites monitored, 12 showed a water quality which is in the ideal class for continuous lifetime use. Eight sites had a dose between 0,1 and 1,0 mSv/year, showing a slight increase above natural background, but still fully acceptable for lifetime use with no significant detrimental effects to the user.

Wonderfonteinspruit

The groundwater situation in the Mooi/Wonderfonteinspruit area needs to be investigated. The groundwater in the dolomites in this area is being dewatered by the mines and is used for irrigation and domestic use. There are pressures to expand irrigation and there is uncertainty about the time schedule for dewatering and the ultimate rewatering of the compartments. (Upper Vaal ISP).

Gold mining operations on the West Rand (e.g. Libanon, West Rand Consolidated, West Driefontein, Blyvooruitzicht, Deelkraal, Kloof, Anglo Gold and Leeudoorn Gold Mines) has led to significant contamination of the Mooirivierloop (Wonderfonteinspruit) and Loopspruit. As a result the extensive underlying dolomitic compartments also appear to be significantly contaminated. (Upper Vaal WMA)

Gold mines on the West Rand decant poor quality groundwater into the Upper Mooi River (Wonderfonteinspruit) and Loopspruit. It is generally acknowledged that this decanting of groundwater by gold mines does impact negatively on water quality, sometimes affecting downstream users (Upper Vaal WMA).

Serious concerns have been raised about radioactivity in the Wonderfonteinspruit. DWAF (1999) found that that of the 41 sites monitored, 39 showed a water quality which is either ideal or acceptable for continuous lifetime use. Five sites showed a slightly larger increase above local natural background, but still fully acceptable for lifetime use with no significant detrimental effects to the user. Only two sites had significant elevation of the radiation dose which showed the need for planning to reduce the exposure over the course of time. Both these sites involved the discharge of mine water that had been pumped to the surface.

6.2.3 Aquatic ecosystem health issues

Klip River

A poster entitled *Ecological state of Southern Gauteng Rivers* (RHP, 2003), summarised the ecological state of the Klip River. The findings were as follows:

Indicator	Upper reaches	Middle reaches	Lower reaches
Habitat	Good	Fair	Fair
Aquatic invertebrates	Poor	Poor	Poor
Fish population	Poor	Poor	Poor
Riparian vegetation	Fair	Fair	Poor
Water quality	Poor	Poor	Fair

The poor ecological state of the rivers were ascribed to the following impacts on the river:

- Urban developments: Formal and informal housing, paving and road networks seal natural surfaces. In this way 47% of Gauteng is urbanised and does not allow natural infiltration of rainwater. Urbanisation also harms rivers through concentrated waste disposal, natural plant removal and effluent discharges into rivers.
- Mining: Mine dumps from underground and opencast mining are a common sight. Mine water of poor quality has been released into the rivers for more than a century.
- Industrialisation: Industries such as steel mills, paper mills, power stations and factories in the East Rand and the Vereeniging/Vanderbijlpark areas contribute to poor water quality in
- the catchment. Unregulated liquid and solid waste disposal from smaller industries also contributes to poor river health.

Wonderfonteinspruit

The only ecosystem health information that was readily available on the Wonderfonteinspruit was two posters dealing with habitat integrity (RHP, 2007). It was found that the Wonderfonteinspruit receives mining processing water that deteriorates the water quality. Peat mining in the tributary that is formed from the Gerhard Minnebron dolomitic eye has reduced the habitat integrity in this part of the catchment. It was found that the habitat integrity in the lower reaches of the Wonderfonteinspruit varied between extremely modified to largely modified.

6.3 CONCLUDING REMARKS

There is great interest in Adopt-a-River type of activities in these two river systems, and initiatives with aims similar to those of the Adopt-a-River programme are already underway in the area. The Gauteng Regional office is aware of these and it is recommended that the Adopt-a-River programme identify appropriate initiatives to collaborate with.

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7. MODDER AND RIET RIVER CATCHMENTS

Responsible office: Free State Regional Office.

7.1 BRIEF OVERVIEW OF THE MODDER AND RIET RIVER CATCHMENTS

The Modder and Riet Rivers are situated in the Orange Free State and Northern Cape provinces in South Africa and they form part of the Vaal River drainage basin. The Modder and Riet Rivers catchment covers an area of almost 35 000 km^2 (DWAF, 2006).

The Riet River flows in a north-westerly, to westerly direction to the confluence with the Vaal River. The Tierpoort Dam, used for irrigation purposes, is situated on the Kaffer River. The Kalkfontein Dam, which supplies water to the Riet River Government Water Scheme, is just downstream of the confluence of the Kromellenboogspruit and Riet Rivers. The Modder River is the main tributary of, and joins the Riet River just upstream of Ritchie.

The Modder River flows in a north-westerly direction before turning to a westerly direction before Krugersdrift Dam and eventually joining the Riet River. Above Mockes Dam several small tributaries join the Modder River. Some of these tributaries flow through the populated areas of Botshabelo and Thaba'Nchu. Most of the natural runoff into the Modder River is from above the confluence of the Modder and Klein Modder Rivers. The rest of the Modder River catchment is very flat and very little runoff occurs. Below the Krugersdrift Dam the river flows through very low gradient terrain where numerous pans are found.

There are three main transfer schemes within the Modder and Riet Rivers catchment, namely the Caledon–Bloemfontein Scheme, the Orange–Riet Scheme, and the Caledon–Modder (Novo) Scheme.

Agriculture is one of the most important land uses of the area under consideration. The Lower Modder River sub-catchment uses approximately 72% of the total abstraction for the area, where the major crops under irrigation are maize and wheat. The Middle Modder River and Upper Riet River sub-catchments rely on good quantity and quality water, mainly for irrigation purposes, where lucerne is the major green feed under irrigation. There is an increasing demand from the agricultural and aqua-cultural sectors, to use water resources for producing food. It is especially foods produced by small-scale riparian farmers that might farm within or just outside the boundaries of the cities and towns.

The three largest urban areas are Bloemfontein, Botshabelo and Thaba'Nchu, with a number of smaller towns in each municipal area. Less significant urban areas are Brandfort, Koffiefontein, Edenburg, Petrusburg, Dewetsdorp, Fauresmith, Jagersfontein, Reddersburg, Jacobsdal and Trompsburg. Most water used for domestic purposes is treated before being distributed to users. The informal use of water, particular in the rural areas, requires the raw water to be of a better quality (since it does not undergo any treatment before use).

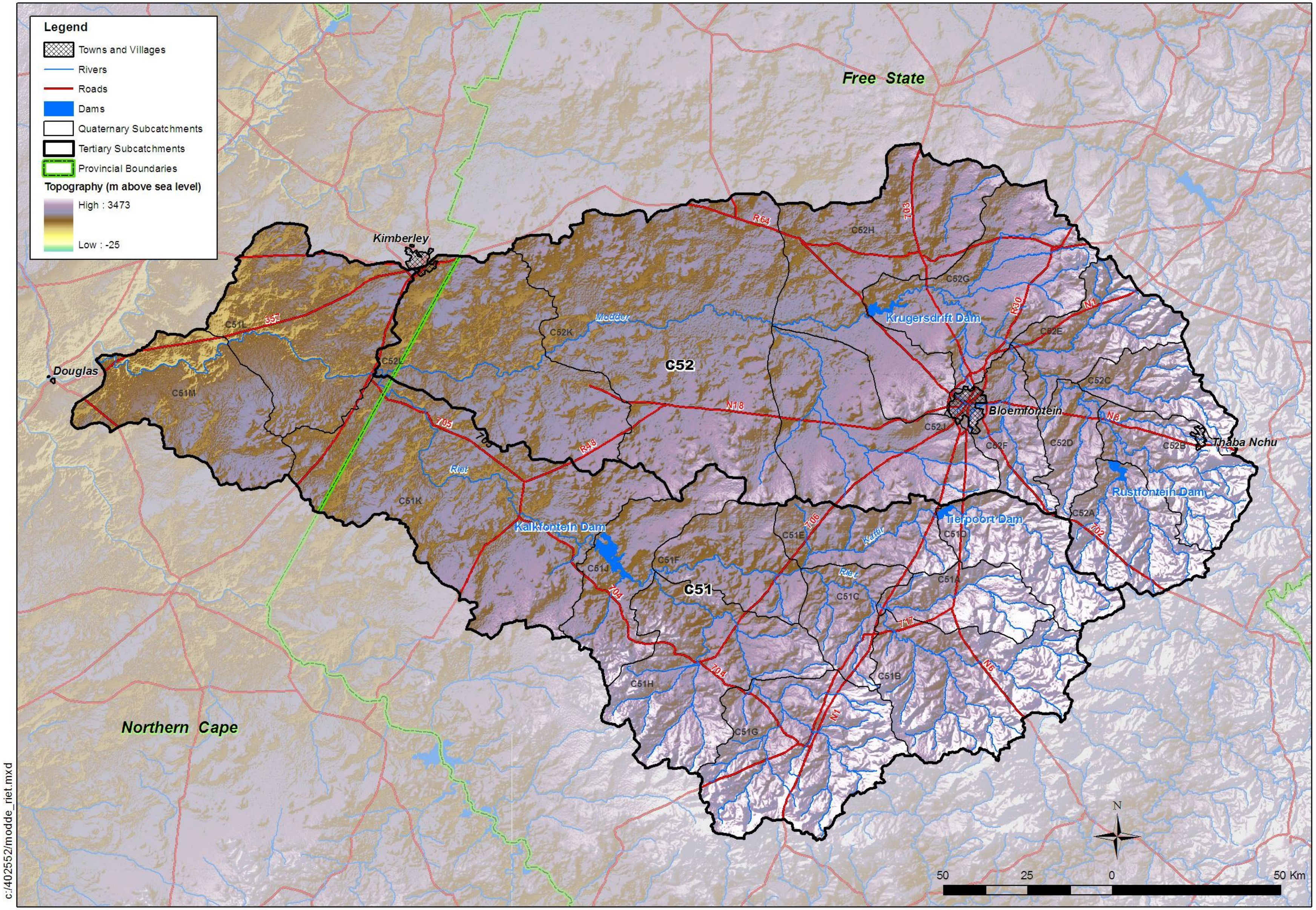

Figure 7.1 Map of the Modder-Riet catchment showing the major sub-catchments and rivers associated with it

Surface runoff from informal settlements and residential areas with inadequate sanitary facilities, contribute substantially to the pollution of rivers. Several tributaries of the Modder River sub-catchment flow through urban, peri-urban and rural areas, where small riparian communities use the water for their daily existence, with or without treatment of any kind.

7.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

7.2.1 Water quantity issues

The catchment of the Modder/Riet system covers an area of about 35 000 km^2 most of which is semi-arid (DWAF, 1999). The mean annual precipitation (MAP) is between 300 and 500 mm per annum except in the extreme east where the MAP increases to 500-600 mm per annum. Only about 70% of the catchment contributes to the river network, the rest drains to pans and enclosed drainage basins.

In the headwaters of the Modder River (upstream of Rustfontein Dam) the areas of scheduled and diffuse irrigation are supplied from run of river abstractions and from the numerous farm dams in the area. Rustfontein Dam was commissioned in 1954 as a major water source for the Bloemfontein area. The water released runs along the Modder River into the Mockes Dam and is eventually abstracted and purified at the Maselspoort Water Purification Works and pumped to Bloemfontein. The new Rustfontein water purification works was commissioned at the end of 1998 and supplies Botshabelo and Thaba Nchu with purified water abstracted from Rustfontein Dam.

The middle Modder River catchment is highly developed in terms of agriculture and urbanisation. Botshabelo and Thaba Nchu are situated in the upper reaches of this region, with Bloemfontein further downstream. Botshabelo receives water from the Rustfontein purification works but can also be supplied via the Caledon-Modder transfer scheme. Thaba Nchu receives water from Groothoek Dam as well as the Rustfontein purification works. Bloemfontein receives water primarily from the Caledon-Modder transfer scheme as well as from Mockes Dam. Mockes Dam is primarily a balancing dam to ensure a constant supply of water to the purification works at Maselspoort Weir. Krugersdrift Dam was commissioned in 1971 to supply water to the Modder River Government Water Scheme further downstream. There is also intensive irrigation upstream of Krugersdrift Dam which is supplied from run- of-river abstractions and farm dams.

Most of the lower Modder River catchment (the area between Krugersdrift Dam and Tweerivier) comprises of the Modder River Government Water Scheme. The Krugersdrift Dam supplies the Scheme, as well as numerous farm dams which store catchment runoff as well as provide storage for water pumped from the many weirs on the Modder River. A large portion of this area does not contribute to river flow due to the extremely flat topography. Only a narrow corridor along the river actually contributes to the flows in the river.

Diffuse irrigation in the upper Riet River catchment is supplied mostly from farm dams as the river is frequently dry. The middle Riet River (to Kalkfontein Dam) contains numerous small farm dams which are used for irrigation and livestock watering purposes (as well as ground water). The rivers in this area frequently run dry and are therefore not a reliable source of water.

A significant portion of the lower Riet River catchment (from Kalkfontein Dam to Aucampshoop) is endoreic; that is the catchment does not contribute to flow in the river. The Riet River Government Water Supply Scheme is situated on either side of the Riet River and is supplied from the dam via an irrigation canal, and directly from the river when it is not dry. Further downstream on the Riet River is the Scholtzburg and Ritchie Irrigation Boards whose requirements were supplied by the Kalkfontein Dam prior to 1987, but are now supplied from the Orange-Riet transfer scheme. There is also extensive irrigation along the Orange-Riet canal, however, most of this area falls within the endoreic zone and does not drain to the Riet River. Urban developments in this region are Koffiefontein town, the mine and Jacobsdal that are supplied from the Kalkfontein Dam irrigation canal. A new pipeline was constructed and Jacobsdal is now supplied with water from the Orange-Riet canal. There is extensive irrigation (Lower Riet River Irrigation Board) downstream of the Modder-Riet confluence to the Riet- Vaal confluence which is supplied from run-of-river abstractions.

The surface water resources, which naturally occur in the catchment area are already well developed, and with a high degree of utilization (DWAF, 2006). Water requirements outstrip the local yield and water is transferred into the catchment to meet requirements (**Table 7.1**) (DWAF, 2004). There are three main transfer schemes within the Modder and Riet Rivers catchment, namely the Caledon–Bloemfontein Scheme, the Orange–Riet Scheme, and the Caledon–Modder (Novo) Scheme.

Table 7.1 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004)

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[7]	Total	Balance
Year 2000							
Riet/Modder	137	242	379	351	29	380	-1
Year 2025							
Riet/Modder	160	301	461	410	52	462	-1

7.2.2 Water quality issues

The water quality in the Modder and Riet River Catchment is generally acceptable, with a few exceptions (DWAF, 2006):

[7] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

- Domestic use - The only variable of concern is chloride in the Lower Riet River. However the value is still below where it will have an effect on human health, and at present the only concern would be its corrosive properties with respect to the distribution system and household appliances that are made of metal. At the same time the water is fairly hard which will result in a protective coating of pipes and appliances. The elevated chloride concentration in the Lower Riet River is therefore not seen as a major concern.
- Agricultural use - Both the Lower Modder and Lower Riet Rivers are affected by high salinity. In the case of the Lower Modder River, the exceedance is slight and will occur predominantly during the winter low flow season, i.e. outside the growing season. Although not ideal, the situation is not seen as serious. In the Lower Riet River the salinity significantly exceeds the upper limit for good (acceptable) water quality, but is still far below the upper limit of marginal (200 mS/m) waters. As it currently stands, the water quality will allow the irrigation of salt-tolerant crops on well-drained soils only.
- Aquatic ecology - The aquatic ecology is mainly affected by the elevated levels in nutrients, specifically phosphorous. This can lead to eutrophic conditions in standing water, although in clear, shallow, moving water it can lead to excessive growth of rooted water plants and/or anchored algae that can choke waterways. This situation is seen as serious. The Middle Modder River is also subject to elevated ammonia levels that are cause for concern.
- Industrial use - Industrial use will only be affected in the Lower Riet River, but as there are no industries in that part of the catchment, this is not significant.
- Recreational use - Recreational use is not affected by water quality in the catchment.

Excessive sewage loads entering sewage treatment works that are either too small, or are operated inefficiently, result in poor levels of treatment. If this effluent is then discharged into a river system it can cause a wide variety of problems (River Health Programme, 2003).

Table 7.2 Summary of water quality issues in the Modder/Riet River system

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Modder River (C52)	The surface water quality shows elevated salinity and nutrient levels. The elevated salinity levels within the Jacobsdal area are due to the closed nature of the groundwater system which does not allow for the flushing out of the accumulating salts. (DWAF, 2004) Increasing aridity and the impact of Thaba Nchu, Bloemfontein and Botshabelo effluent discharges raised the average TDS in Krugersdrift Dam to 347 mg/l , with peak concentrations during drought conditions exceeding 900 mg/l. (DWAF, 2004)	Local microbial and nutrient pollution occurs in the streams downstream of Thaba Nchu and Botshabelo and in the Modder River. Diffuse source pollution contributes to these pollutant loads.(DWAF, 2004). Severe algal problems were found in the Klein Modder River and Modder downstream of the confluence. Kugersdrift Dam could develop eutrophication problems (DWAF, 1999).	Local microbial and nutrient pollution occurs in the streams downstream of Thaba Nchu and Botshabelo and in the Modder River. Diffuse source pollution contributes to these pollutant loads.(DWAF, 2004). Concerns were raised about faecal contamination from cattle drinking directly from the river as well as urban and peri-urban areas (DWAF, 1999)	High metal concentrations have been observed in Rustfontein Dam, possibly due to de-oxygenation of the water column. (DWAF, 2004). High aluminium and iron concentrations were measured in Mockes Dam and Mazelspoort but did not pose a threat to the environment (DWAF, 1999).	No specific concerns raised	The extent of the pollution of the groundwater system and the behaviour of the system within the Riet-Modder sub-area needs to be understood. (Upper Orange ISP) The extensive irrigation in this area has also led to the pollution of groundwater resources. The high turbidity in the Modder River causes problems at the treatment works (DWAF, 1999).
Riet River (C51)	Increasing aridity leads to an average TDS concentration in Kalkfontein Dam of 390 mg/l, with recorded peaks exceeding 800 mg/l. (DWAF, 2004) Salinity induced by irrigation return seepage is the main water quality problem. This is especially apparent lower down the Riet River, where the flow to the Vaal River all but ceases during low flow conditions. (DWAF, 2004)	High phosphorus problems could cause eutrophication problems and limit recreational use of Tierpoort and Fouriespruit Dams (DWAF, 1999).	Concerns were raised about faecal contamination from cattle drinking directly from the river (DWAF, 1999).	No specific concerns raised	No specific concerns raised	

7.2.3 Aquatic ecosystem health issues

The overall aquatic ecosystem health of the Modder River is poor (River Health Programme, 2003). Numerous natural and human influences have accelerated changes in the structural, species composition and functional characteristics of the vegetation along the river as reflected in the driving forces.

The common reed (Phragmites australis) encroaches on rivers downstream of weirs and dams, where the current is not strong enough to dislodge the rhizome mat. Areas of sediment deposition are particularly favourable to the establishment of reed beds.

The fish population of the Modder River is fair to poor. The Orange River mudfish is the most widespread fish species. Largemouth yellowfish have been sampled in dams. Alien fish species include the common carp and the mosquito fish. The Modder-Riet system is host to the Orange-Vaal smallmouth yellowfish that has a conservation status of “least concern” and the Orange-Vaal largemouth yellowfish that has a conservation status of “near threatened” (Wolhuter and Impson, 2007). Water pollution and over-abstraction in the Vaal and Modder-Riet system were listed as threats to these species.

Many alien plant species occur in the riparian zone along the Modder River. Some of these alien species are invasive and a cause for concern.

The driving forces that affected the present ecosystem health included (River Heath Programme, 2003):

- Extensive agriculture - irrigation (water abstraction), ploughing of the floodplains, over-grazing and incorrect farming practices
- Artificial structures - road construction, bridges, weirs, dams, etc.
- Urban development - abstraction, stormwater runoff and treated sewage discharges, illegal disposal of sewage effluent, mainly due to poor maintenance and exceeding the capacity of sewage treatment works
- Sand mining and diamond diggings

7.3 CONCLUDING REMARKS

Adopt-a-River activities should focus on urban rivers and reducing the impacts of urban runoff and wastewater discharges on water quality in Bloemfontein and peri-urban Bloemfontein, and in Botshabelo. In the lower reaches of the Riet and Modder Rivers, water user associations and other interest groups should focus on reducing the impacts of irrigation agriculture in order to minimise the impacts of downstream users and the Lower Vaal River.

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8. MTATA AND BUFFALO RIVER CATCHMENTS

Responsible office: Eastern Cape Regional Office

8.1 BRIEF OVERVIEW OF THE MATA AND BUFFALO RIVER CATCHMENT

8.1.1 Mtata River

The Mtata River is approximately 100 km long and the major river draining the T20 catchment which has an average natural runoff of approximately 382 million m^3 (DWAF, 2001b). The area of the T20 catchment is 2600 km^2. There is very little urban development in the study area with Umtata town being the only major town. The Mtata Dam near Umtata town is the only major dam in the study area. Two small dams on the Mtata River, namely First Falls Dam and Second Falls Dam, are used as balancing dams for hydropower generation.

The study area is generally very hilly with numerous rivers draining deep valleys and flowing in incised gorges towards the coast (DWAF, 2001b). The headwaters of the Mtata River rise in the steep escarpment at the edge of the plateau region of the Eastern Cape at an altitude of approximately 1 700 masl. These headwaters drain to a wide plain located between the escarpment and the town of Umtata at an altitude of 850 masl with Mtata Dam positioned at the outlet of this wide plain. Below Umtata the river enters a deeply incised meandering gorge some 200 – 300 m below the surrounding hills for a distance of approximately 70 km before discharging into an 8 km long estuary.

The Mtata catchment is heavily populated but it has a low level of economic development. The level of economic activity has been gradually decreasing over the past few years. This is to some extent offset by growth in the informal sector. Most industries and businesses which once flourished in the area and particularly in Mtata town, the former capital of the Transkei, have since relocated. The subsidy structures which once favoured investment in Mtata are no longer in place. Rural poverty and lack of employment present serious problems. The agricultural sector is poorly developed and largely of subsistence nature. Small patches of irrigation take place. Forestry is a major contributor to the economic value added and employment of this key area. There are two main sawmills in the area, Langeni and KwaBhaca.

8.1.2 Buffalo River

The Buffalo River rises in the forested areas of the Amatola Mountains. It flows eastwards across the coastal plateau before entering the Indian Ocean at East London. The Buffalo River is almost pristine at its source, but urban developments and dense peri-urban and rural settlements impact the water quality in the middle and lower reaches. Population pressure on surface water resources is very high (RHP, 2004).

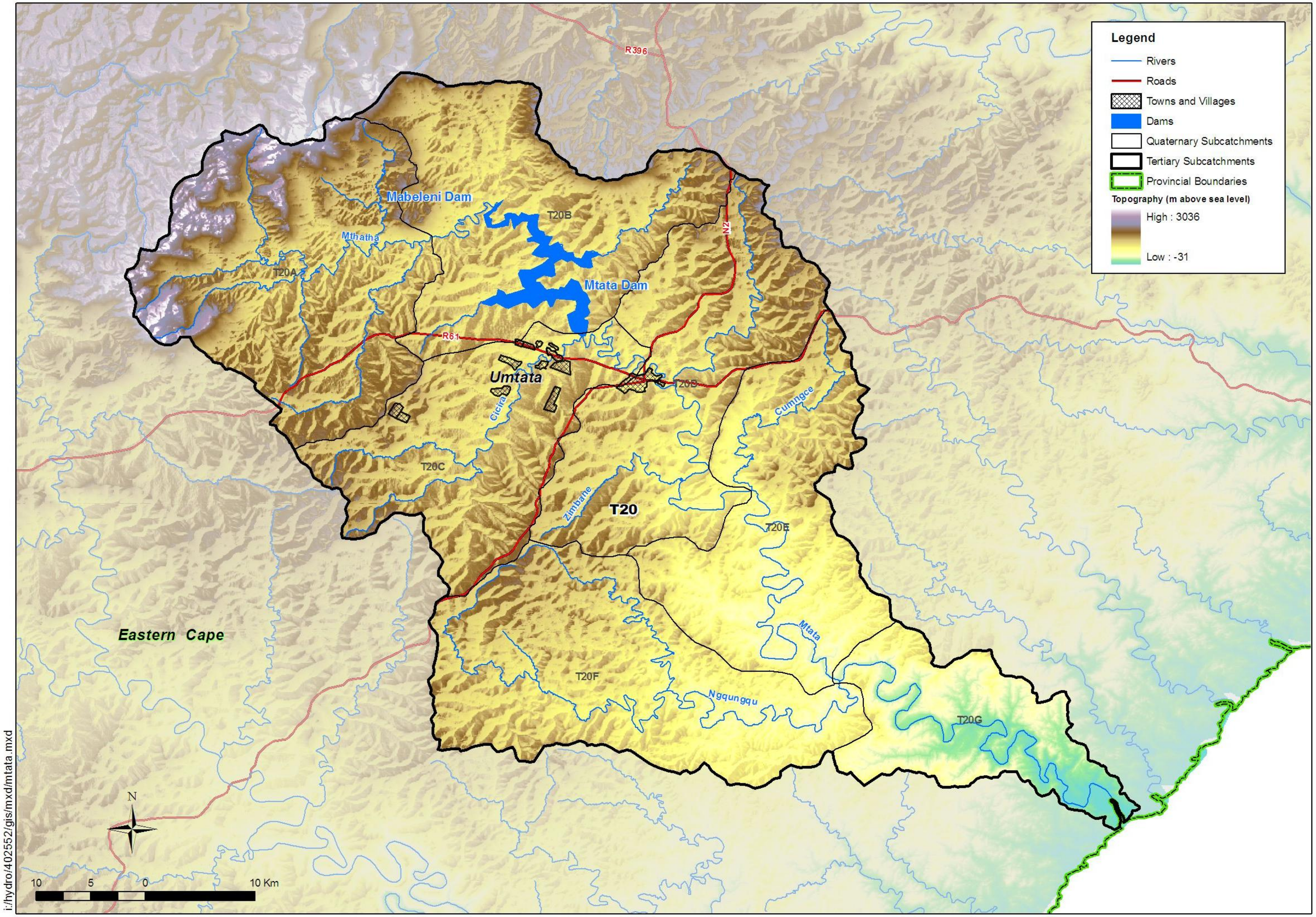

Figure 8.1 Map of the Mtata River catchment

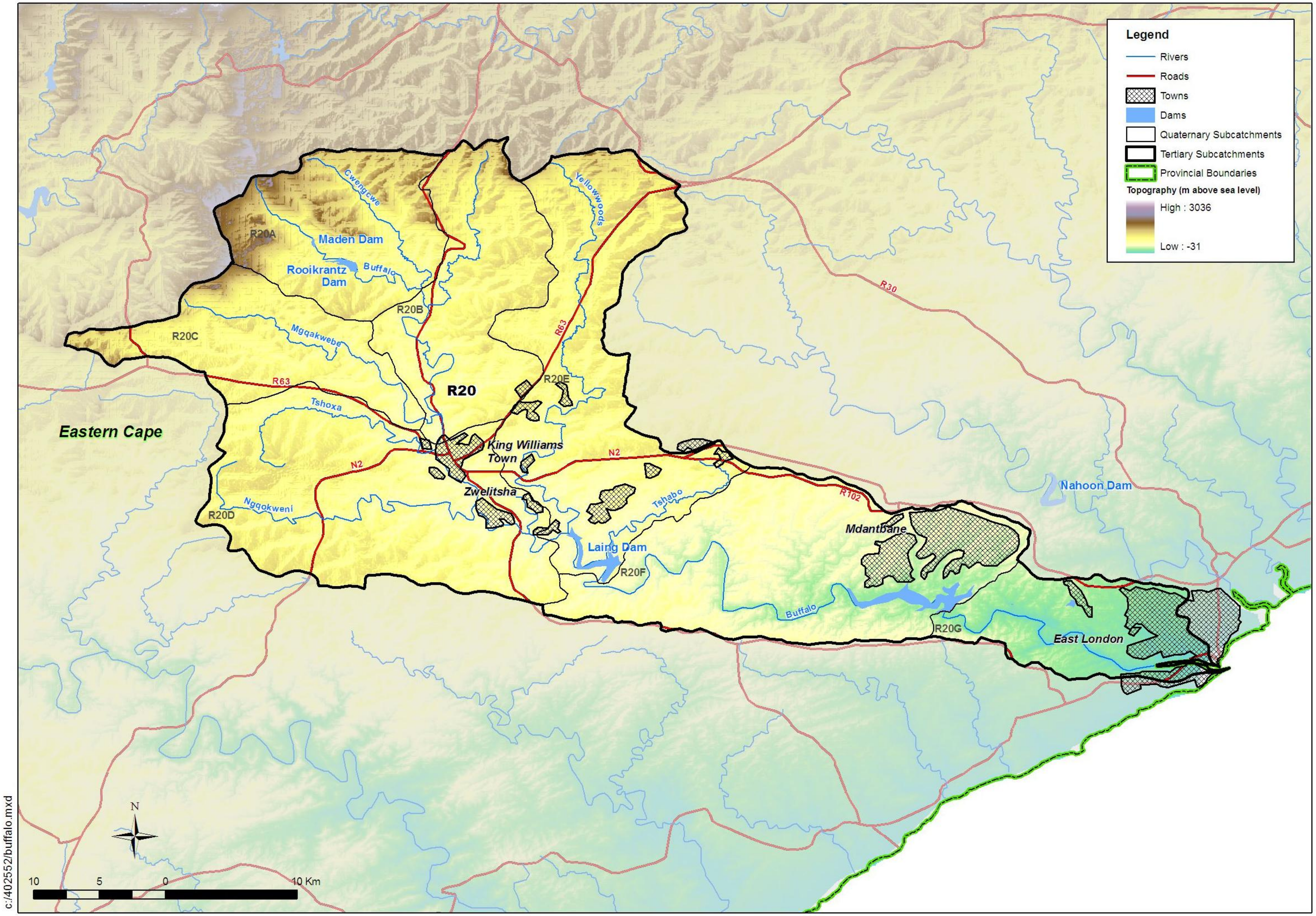

Figure 8.2 Map of the Buffalo River catchment showing the rivers and sub-catchments.

Along the Buffalo River there are four dams supplying water to the urban areas of King William's Town, Zwelitsha, Mdantsane and East London (Buffalo City Municipality). While dams restrict the natural movements of fish, they do have some benefits. Laing Dam, for example, is an efficient silt trap and a sink for nutrients, at the same time diluting saline effluent from upstream industrial sources. The dams have no mechanisms for releasing water to stimulate natural river flows in order to maintain functioning aquatic ecosystems. Overflow from Maden Dam and a trickle from a crack in the Rooikrantz Dam are the only water releases from these two upstream dams. Fortunately, side streams augment the river flow (RHP, 2004).

Blockages in the sewerage systems, inadequate treatment capacity and poor management result in the discharge of partially treated and untreated sewage into the river and dams. This results in problems that include algal blooms and unacceptably high concentrations of faecal bacteria. Industrial effluents are either inadequately treated or not treated at all. Poor water quality poses a serious health risk for rural communities, since many households rely solely on untreated river water (RHP, 2004).

The pollution of the Buffalo River basin also extends beyond the estuary, affecting both marine and coastal water quality. The non-compliance with marine water quality standards will render coastal waters unfit for recreational and other beneficial users, including the non-attainment of blue flag beach status, which will in turn impact negatively on coastal tourism and related activities (RHP, 2004).

8.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

8.2.1 Water quantity issues

Mtata River

The water sources of the Mtata key area are dominated by the Mtata Dam (DWAF, 2005). Its capacity of 254 million m^3 is approximately 120% of the MAR. The impact of the Reserve on the yield of this dam is not really relevant since most of the water is released into the river for hydropower generation. However, the temporal distribution of the releases has a significantly negative impact on the ecological functioning of the Mtata River downstream of the dam, including the estuary.

The largest water user by far is the forestry sector, which reduces run-off in the Mtata River by an estimated 37 million m^3/a. Forestry in the Mtata catchment is situated mostly upstream of the Mtata Dam where it has a major impact on the yield of this dam. The only other large water users are in the urban sector, and the rural sector. The urban water requirement is mainly the requirement of Mtata and its surrounding communities. There are two relatively small hydro-electric power generation schemes at First and Second falls with a combined capacity of 17 MW and releases are made from Mtata Dam.

Table 8.1 Reconciliation of water requirements and available water for the year 2000 (million m^3/annum) (DWAF, 2005)

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out	Total	Balance
Year 2000							
Mtata	146	0	146	57	0	57	89

There appears to be a substantial surplus in the Mtata River catchment but it must be borne in mind that this surplus relates mostly to the yield available from the Mtata Dam, which is actually used for hydropower generation. The surplus yield is therefore mostly only available downstream of the hydropower stations at First and Second falls, and would be subject to the release patterns required for power generation.

Buffalo River

In the ISP for the Mzimvubu to Keiskamma Water Management Area, the Buffalo River was included into the Amatole sub-area. Other rivers in the Amatole sub-area were the Nahoon River, Gqnube River, Kwelera River and the Kwenxura River (DWAF, 2004). The Amatole sub-area is highly regulated and developed and is presently in balance with respect to existing water use and existing supplies sourced from within the subarea (DWAF, 2004) (**Table 8.2**). As growth in demand is experienced in the sub-area mainly from Buffalo City, it will be necessary to implement the inter-basin transfer of water from Wriggleswade Dam on the Kubusi River to the Amatole sub-area catchments. It is estimated that even with this transfer and demand side management and water re-use, the Amatole sub-area is likely to experience a water deficit by the year 2012.

The inter-basin transfer of 18 million m^3/a of water from the Kubusi catchment in the Lower Kei sub-area to the Amatole sub-area is only made during serious droughts, but the quantity is reserved for future urban use in the Amatole Water Supply System serving Buffalo City.

Table 8.2 Reconciliation of water requirements and available water for the Amatole sub-area for the year 2000 (million m^3/a) (DWAF, 2004) without and with inter-basin transfer from Wriggleswade Dam

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[8]	Total	Balance
Year 2000							
Amatole sub-area	80	0	80	82	0	82	-2
Amatole sub-area with transfer in	80	18	98	82	0	82	16

[8] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

8.2.2 Water quality issues

Table 8.3 Summary of water quality issues in the Mtata and Buffalo River systems

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Mtata River	The Mtata River has low salinity levels with EC values ranging between 5 mS/m and 10 mS/m under natural conditions. An increase in the EC was observed as the river passed the peri-urban settlements with the greatest increase (especially chloride) being seen after the Umtata Municipal sewage effluent discharge (DWAF, 2001a).	Elevated nutrients in waste water discharges from Mtata WWTW are a concern. Algal blooms restricted by high turbidity (DWAF, 2001a).	The sewage flows are so high that the existing sewage treatment works are unable to cope, and as a result significant quantities of untreated sewage enter the Mtata River. Lack of sanitation infrastructure in rural and informal settlements in the catchments has led to a deterioration in water quality. (DWAF, 2005) The Mtata River is heavily polluted by flows of untreated sewage from the Umtata urban area and the pollution is a health threat to rural communities downstream who use the untreated river water for household purposes. (DWAF, 2001a)	Metal concentrations were generally low but Cadmium concentrations exceeded the SA Water Quality Guidelines. It was postulated that the source of cadmium were diffuse in nature (Fatoki *et al*., 2001). Increases in lead, manganese and copper concentrations are also observed below the sewage effluent discharge (DWAF, 2001a).	No specific concerns raised.	Soil erosion problems partly due to overgrazing and poor land-use management have also led to water quality deterioration within this catchment. (DWAF, 2005). The high turbidity in Mtata Dam is preventing algal blooms by limiting available light (DWAF, 2001a).
Buffalo						
Buffalo headwaters	Water quality in the headwaters of the Buffalo River is good.					
Buffalo upstream of Laing Dam		High nutrient levels are resulting in eutrophication. (RHP, 2004)	In the catchments of the Buffalo and Nahoon Rivers water quality has been adversely affected by urban development and gives cause for concern. (DWAF, 2002)	A tannery dumping site, since closed, still leaches toxic heavy metals into the Buffalo River near Zwelitsha. (RHP, 2004)		Industrial effluents are either inadequately treated or not treated at all.(Buffalo SOR) A textile factory discharges its waste into the Buffalo River, just upstream of Laing Dam. Urban developments and expanding rural settlements aggravated by the high population densities, impact negatively on the river. Sewage treatment works are overloaded, spilling effluent that is not properly treated into the river. (RHP, 2004)

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Buffalo on the coastal plain		Water bodies in the Buffalo River suffer from eutrophication related water quality problems which are the result of nutrient enrichment (DWAF, 2002). The high nutrient loads cause eutrophication and result in potentially toxic algal blooms in the dam and excessive growth of water hyacinth. (RHP, 2004)	Blockages in the sewerage systems, inadequate treatment capacity and poor management result in the discharge of partially treated and untreated sewage into the river and dams. This results in problems that include algal blooms and unacceptably high concentrations of faecal bacteria			The population pressure in this area is high. Dumping sites are either lacking or not properly managed, leading to solid waste pollution. Clearing of the indigenous vegetation from the riparian zone provides an opportunity for alien vegetation to invade. Agriculture along the river is extensive and overgrazing is common. This leads to erosion and increased sediment loads. (RHP, 2004)
The Lower Buffalo river, estuary and harbour			The Central Sewage Treatment Works (Amalinda) is overloaded and releases effluent that is not properly treated. (RHP, 2004)			Pollution output of industries is high leading to water contamination. Second Creek waste disposal site leaches directly into the estuary. (RHP, 2004)

8.2.3 Aquatic ecosystem health issues

Mtata River

An instream flow requirement (IFR) study was undertaken as part of the Mtata Basin Study (DWAF, 2001c) and the key findings are summarised in

Two IFR sites were investigated, one downstream of Mtata Dam (Site 1) and one below the Nqunqu tributary (Site 2). The temporal distribution of the releases for hydropower generation has a significantly negative impact on the ecological functioning of the Mtata River downstream of the dam, including the estuary (DWAF, 2005).

Sub-catchment	Overall Ecostatus	Instream habitat, riparian zone habitat, and riparian vegetation integrity	Fish assembly integrity	Macro-invertebrate integrity	Ecosystem Water quality
Mtata River	Poor (D)	Riparian and instream vegetation – Poor to extremely degraded (D-E) - Heavily impacted by exotics and stripping. Flow regime not conducive to stable instream vegetation development. Fluvial geomorphology – Fair (C) - There appeared to be some improvement in the channel erosion and the catchment erosion. Instream habitat integrity – Poor (D) The condition of the instream vegetation improves as the river reaches the second site (E-B). Riparian habitat integrity – Degraded (E) - State of riparian vegetation improves from the town of Umtata (F degraded, very poor) towards the estuary (D, poor).	Poor (D) – it was concluded that it was highly unlikely that fish, which rely on seasonal floods (summer floods) to trigger spawning events would adapt to the artificial flow regime. Mtata River species need to spawn at high summer water temperatures among newly-flooded vegetation.	Fair to Poor (C-D) - The invertebrate population at site 1 was depauperate, and sparse, but at site 2 which was below the Nqunqu tributary, the species variety and the number increase considerably.	Good – Fair (B-C) - Chemical water quality criteria recorded in the Mtata River fell within the national water quality guidelines (NWQG) for aquatic ecosystems (DWAF, 2001c).

Buffalo River

The ecosystem health of the Buffalo River system was assessed as part of the River Health Programme's State of the Rivers Report (RHP, 2004).

Sub-catchment	Overall Ecostatus	Instream habitat, riparian zone habitat, and riparian vegetation integrity	Fish assembly integrity	Macro-invertebrate integrity	Ecosystem Water quality
Buffalo headwaters	Fair	The Index of Habitat Integrity is rated as Fair. Much of the catchment upstream of the Madden Dam enjoys the status of a protected state forest, so pressures from human activity are limited to forest management and recreational activities. The Riparian Vegetation Index is rated as fair. Historical uncontrolled of several indigenous species have resulted in the disturbance of the natural composition of the forest, contributing to the invasion of alien vegetation species	The Fish Assemblage Integrity Index is rated as fair as very few indigenous fish species occur because trout and other alien fish were introduced earlier on.	The SASS was rated as fair.	Not done as part of the Buffalo River System SOR report.
Buffalo upstream of Laing Dam	Fair	The Index of Habitat Integrity is rated as Fair. The Geomorphological Index is rated as poor. There was no available data for the Riparian Vegetation Index	The Fish Assemblage Integrity Index is poor.	The SASS was rated as poor.	Not done as part of the Buffalo River System SOR report.
Buffalo on the coastal plain	Fair	The Index of Habitat Integrity is rated as Poor to Fair. The Geomorphological Index is rated as poor. There was no available data for the Riparian Vegetation Index	The Fish Assemblage Integrity Index is rated as poor.	The SASS was rated as poor.	Not done as part of the Buffalo River System SOR report.
The Lower Buffalo River, estuary and harbour	Fair	The Index of Habitat Integrity is rated as Fair. The Geomorphological Index is rated as fair. The Riparian Vegetation Index is rated as fair.	The Fish Assemblage Integrity Index is rated as good.	The SASS was rated as good.	Not done as part of the Buffalo River System SOR report.

8.3 CONCLUDING REMARKS

Mtata River

Adopt-a-River initiatives can make a meaningful contribution to mitigating the impacts of urban runoff on the Mtata River. These initiatives should involve the local authorities, DWAF and local communities. Local communities can undertake activities such as stream cleaning, awareness creation to prevent pollution of urban stormwater drains, and the local authority can contribute by ensuring that the wastewater treatment works is operated correctly and according to specifications.

Buffalo River

Adopt-a-River initiatives should also be centred on the serious impacts of urban stormwater runoff on rivers and reservoirs in the Buffalo River catchment. Industries can also get involved to minimize their impacts and to support community based type activities. Local authorities can ensure the correct operation of wastewater treatment works and properly maintaining the sewerage infrastructure.

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9. OLIFANTS AND DORING RIVER CATCHMENTS

Responsible office: Western Cape Regional Office

9.1 BRIEF OVERVIEW OF THE OLIFANTS/DORING RIVER CATCHMENT

The major river is the Olifants River, of which the Doring River (draining the Koue Bokkeveld and Doring areas) and the Sout River (draining the Knersvlakte) are the main tributaries. The study area incorporates the E primary drainage region.

The Olifants River rises in the mountains in the south-east of the study area and flows north-west. Its deep narrow valley widens and flattens downstream of Clanwilliam until the river flows through a wide floodplain downstream of Klawer. The Doring River is a fan shaped catchment. The main river rises in the south and flows in a northerly direction. It is first joined by the Groot River and then by the Tra-Tra River flowing from the west and the Tankwa River from the east, before flowing in a westerly direction to its confluence with the Olifants River just upstream of Klawer.

The north of the study area is flatter and much of the basin lies between 500 and 900 m above sea level. In the east there are significant mountain ranges, the Hantam near Calvinia and the Roggeveld to the south, which rise to about 1 500 m above sea level. West of Nieuwoudtville lies the Bokkeveld Mountains escarpment, where the plateau elevation of about 700 m drops to about 300 m. The rolling hills and plains of the 30 to 40 km wide strip along the coast from the southern boundary of the WMA to the estuary of the Olifants River are known as the Sandveld. The deep sandy deposits overlaying the bedrock in this area are “primary” aquifers which provide a significant groundwater resource.

Climatic conditions vary considerably as a result of the variation in topography. Minimum temperatures in July range from –3 ºC to 3 ºC and maximum temperatures in January range from 39 ºC to 44 ºC. The area lies within the winter rainfall region, with the majority of rain occurring between May and September each year. The mean annual precipitation is up to 1 500 mm in the Cederberg Mountains in the south-west, but decreases sharply to about 200 mm to the north, east and west thereof, and to less than 100 mm in the far north of the WMA. Average gross mean annual evaporation (as measured by Symons pan), ranges from 1 500 mm in the south-west to more than 2 200 mm in the dry northern parts. Due to the diverse soil types and variance in rainfall distribution, vegetation is varied and includes at least six veld types and several thousand plant species. Karoo and Karroid Types, False Karoo Types, Temperate and Transitional Forest Types, Scrub Types, and Sclerophyllous Bush Types occur in the Olifants/Doorn WMA.

Important conservation areas include the Tankwa-Karoo National Park, the Verlorenvlei wetland in the Sandveld (which enjoys Ramsar status), the Cederberg Wilderness Area, and the northern section of the Groot Winterhoek Wilderness Area.

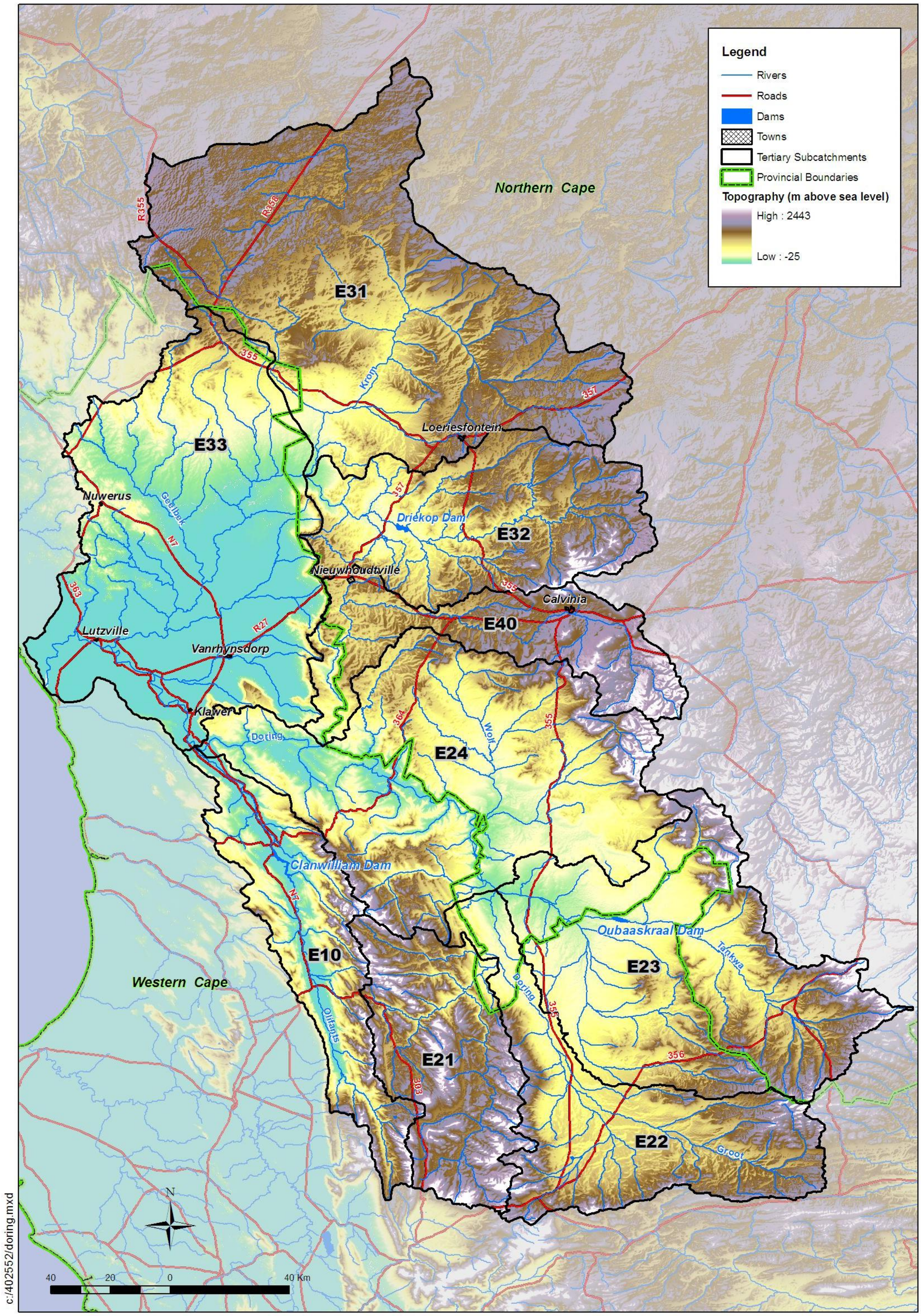

Figure 9.1 Map of the Olifants-Doring catchment showing the major sub-catchments and associated rivers

The Olifants River and its tributary, the Doring River are important from a conservation perspective because they contain a number of species of indigenous and endemic fish that occur in no other river systems, and that are endangered. In addition, reaches of some of the tributaries are virtually unspoiled by human manipulation and are of high to very high ecological importance. The Olifants estuary is one of only three permanently open estuaries on the west coast of South Africa. It therefore represents a critical habitat to many estuarine-associated fish species. The estuary also supports at least 86 species of estuarine waterbirds and has a wide range of habitats. It plays an important role in bird migration and is considered to be in the top ten South African locations of importance for conservation of waterbirds.

The Olifants/Doring catchment was divided into six sub-catchments corresponding to the current divisions used in surface water resource management by the Western Cape Regional Office. These are the Upper Olifants (E10 sub-catchment), Koue Bokkeveld (E21 sub-catchment), Doring (E22, E23, E24A-M, E40 sub-catchment), Knersvlakte (E31, E32, and E33), and Lower Olifants (E10H-K, E33F-E33H sub-catchments).

The Olifants/Doorn WMA is the least populated WMA in the country with approximately 0.25% of the national population residing in the area. Approximately 113 000 people live in the WMA. More than half of the population live in urban or peri-urban areas, and the rest in rural areas. About 65% of the population is concentrated in the south-western portion of the WMA in the Koue Bokkeveld, Upper and Lower Olifants and Sandveld sub-areas. The population growth expected for the area appears to follow the general trend of decreasing rural populations which can be attributed to the lack of strong economic stimulants, migration of young people and the impacts of HIV/ AIDS (NWRS, 2004). There is strong in-migration of seasonal workers during the harvest and planting seasons.

9.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

9.2.1 Water quantity issues

The reconciliation of supply and demand in the ISP report (DWAF, 2005) indicated a deficit of 29 million m^3/a for the lower Olifants River. This reflects a shortage but in practice irrigators accept a lower level of assurance. The anticipated future water situation assumes a base scenario with little change water demand and high water use scenario where the demand in the lower Olifants River increases slightly. The proposed raising of Clanwilliam Dam could provide additional yield of up to 40 million m^3/a (DWAF, 2005).

Table 9.1 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2005) for the Olifants and Doring River catchments

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[9]	Total	Balance
Year 2000							
Doring	11	3	14	15	0	15	-1
Upper Olifants	197	0	197	103	94	197	0
Lower Olifants	25	94	119	144	4	148	-29
Year 2025 (base scenario)							
Doring	11	3	14	15	0	15	-1
Upper Olifants	197	0	197	103	94	197	0
Lower Olifants	25	94	119	143	4	147	-28
Year 2025 (high scenario)							
Doring	11	3	14	15	0	15	-1
Upper Olifants	198	0	198	105	94	199	-1
Lower Olifants	26	94	120	146	4	150	-30

[9] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

9.2.2 Water quality issues

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Upper Olifants	Salinity in the Upper Olifants is ideal for irrigation use (DWAF, 1998, DWAF, 2002).	Nutrient concentrations in the upper Olifants River are low, and both Clanwilliam and Bulshoek Dams have been classified as mesotrophic dams.	Concerns have been expressed about bacteriological pollution upstream of Citrusdal and NMMP monitoring points have been established on the Olifants and Boontjies Rivers (NMMP, 2008).	No concerns have been raised about trace metals in the upper Olifants catchment.	No concerns have been raised about unnatural pHs in the upper Olifants catchment.	
Lower Olifants	Salinity in the Lower Olifants deteriorates in a downstream direction due to irrigation return flows entering the river. In the lower reaches the quality near Lutzville salinity is classified as unacceptable for irrigation purposes (DWAF, 1998, DWAF, 2002).	No nutrient data was available in the lower Olifants although one can expect the irrigation return flows to have elevated nitrogen concentrations.	Concerns have been expressed about bacteriological pollution in the lower Olifants River and the irrigation canals and NMMP monitoring points have been established on them (NMMP, 2008).	No concerns have been raised.	No concerns have been raised.	The presence of pesticide and herbicide residues in irrigation return flows can be a concern.
Doring River	Water quality in the Doring River is marginal and TDS concentrations increase in a downstream direction. In the lower reaches, the water quality varies between good at the end of winter and marginal at the end of summer, probably as a result of the predominantly winter rainfall in the catchment Highly saline flows from the Tankwa Karoo tributaries have a sporadic influence (DWAF, 1998, DWAF, 2002)..	No concerns have been raised	No concerns expressed yet.	No concerns have been raised	No concerns have been raised.	

The surface water quality of the Olifants-Doorn WMA is quite variable. Water quality in the Clanwilliam Dam area is suitable for all uses. There is a slight increase in concentration of total dissolved solids (TDS) in a downstream direction. Previous studies (Olifants Doring Basin Study Phase 1, 1998) found that there was a difference between unimpacted catchments and the main stem of the Olifants River that was impacted by agricultural activities. Unimpacted catchments, like the Jan Dissels River, showed evidence of a seasonal trend in the data. The seasonal trend indicated elevated TDS concentrations at the end of summer (March/April) and decreased concentrations at the end of winter (July – October). It was found that TDS concentrations in the main stem Olifants River were higher but still suitable for agricultural and domestic purposes (DWAF Basin Study, 1998). No trend was evident but there were strong seasonal variations with higher concentrations early in winter probably originated from the wash-off of salts from the catchment, and reduced concentrations at the end of winter. In the Olifants River downstream of Clanwilliam Dam and upstream of the Doring River confluence the water quality remained suitable for agriculture and domestic water supplies.

The quality of water in the upper Doring River (E22), when flowing, is suitable for agriculture and domestic water supplies. However, TDS concentrations in the Kruis River are very high and variable, and the water quality has been classified as marginal to poor (Olifants Doring Basin Study Phase 1, 1998). Water quality in the Doring River (E24) is marginal and TDS concentrations increase in a downstream direction. In the lower reaches, the water quality varies between good at the end of winter and marginal at the end of summer, probably as a result of the predominantly winter rainfall in the catchment. The water quality is still suitable for all uses but it does indicate deterioration. It has been reported (Dr Cate Brown, Southern Waters pers. comm. 2004) that farmers stop irrigating when the water begins tasting salty. Highly saline flows from the Tankwa Karoo tributaries have a sporadic influence.

The water quality status in the Oudekraal (E23), Oorlogskloof (E40), Kromme (E31), Hantams (E32), Lower Olifants (E33) and Namaqualand (F60) areas is not adequately known. It should be noted that water availability in these rivers is limited.

Other water quality variables were also examined in the Olifants Doring River Basin Study Phase I (1998) and it was concluded for the Olifants River that:

- The source water of the Olifants River had elevated TDS and nitrogen concentrations, probably as a result of agricultural activities in the upper catchment which have an impact on the river, especially during the summer months;
- Physical and chemical characteristics of the Olifants River gorge and the mountain river reaches largely resemble natural conditions in unimpacted streams of the Western Cape. Water quality is very good until the valley widens at Citrusdal;
- The middle reaches of the river (Citrusdal to Bulshoek Weir) are impacted by agricultural activities which lead to elevated levels of dissolved and suspended solids, and nutrients, in particular nitrates. The effect of poorer water quality is exacerbated during the summer months.

9.2.3 Aquatic ecosystem health issues

Sub-catchment	Overall Ecostatus	Instream habitat, riparian zone habitat, and riparian vegetation integrity	Fish assembly integrity	Macro-invertebrate integrity	Ecosystem Water quality
Upper Olifants River (Headwaters)	Good - Fair	Habitat integrity – Natural to good, geomorphology index – Good, Riparian vegetation index – Good.	Fair	Natural	Natural
Upper Olifants River (Lower reaches at Clanwilliam)	Fair	Habitat integrity – Fair, geomorphology index – Fair, Riparian vegetation index – Fair.	Fair	Poor	Poor
Lower Olifants River (near Klawer)	Fair	Habitat integrity – Poor to fair, geomorphology index – Fair, Riparian vegetation index – Fair.	Fair	Poor	Fair
Doring River (after Tankwa River confluence)	Fair	Habitat integrity – Fair, geomorphology index – Fair, Riparian vegetation index – Fair.	Fair	Fair	Fair
Doring River (upstream of confluence with Olifants River)	Good	Habitat integrity – Fair to good, geomorphology index – Fair, Riparian vegetation index – Good.	Fair	Good	Good

Generally, only the upper reaches of the main rivers and their tributaries in the Water Management Area are still in a natural or good ecological state. Portions of the area are protected through conservation initiatives such as the Greater Cederberg Biodiversity Corridor and the Knersvlakte Centre of the Succulent Karoo. The middle and lower reaches of many rivers are in poor ecological condition as a result of alien plant and fish infestation, as well as intensive agricultural development. Alien fish have severely impacted indigenous fish populations (RHP, 2006).

Many of the Olifants/Doring and Sandveld rivers suffer from habitat loss due to farming disturbances in the riparian zone (construction of levees, bulldozing, clearing of indigenous riparian vegetation, overgrazing, crops within the floodplain). This has resulted in invasion by alien plants, a loss of cover and food for aquatic animals, a reduction in water quality and increased sedimentation of the river bed (RHP, 2006).

A variety of invasive alien plants occur throughout the Water Management Area. In the wetter Olifants and Kouebokkeveld areas, black wattle and red river gum are common on river banks where indigenous riparian plants have been removed. Mesquite dominates the riparian zone of the arid Doring and Sout catchments, while oleander completely blocks the channel in parts of the Doring and Groot Rivers. Disturbance of the riparian zone has resulted in infestation of Port Jackson throughout the Sandveld. These alien plants modify the river channel, and reduce habitat integrity and baseflows in rivers (RHP, 2006).

Alien fish (banded tilapia, bluegill sunfish, bass, carp) occur mostly in the mainstem of the Olifants and Doring Rivers, as well as the lower reaches of the tributaries. Predation by alien fish (bass) has resulted in localised extinctions of indigenous fish, particularly in the Olifants and Doring Rivers and many of their tributaries.

Flow modification is affecting the aquatic ecosystem health. Flow is severely modified in the lower Olifants River as a result of the large dams, Clanwilliam Dam and Bulshoek Dam. No environmental releases are made from these dams (RHP, 2006). A large number of instream and off-channel farm dams in the Kouebokkeveld have severely modified flows (low flow and floods) in the Houdenbek and Winkelhaak Rivers. Water abstraction from surface and groundwater resources throughout the Water Management Area has further modified flow. Modified flows are impacting negatively on the functioning of the river, as well as the overall ecological integrity, which in turn affects the ability of the system to deliver certain goods and services provided by the rivers (water supply, breakdown of pollutants) (RHP, 2006).

9.3 CONCLUDING REMARKS

Adopt-a-River activities in the Olifants-Doring catchment can fulfil two roles. The first is aimed at protecting the good quality water in the upper reaches of both river systems by involving the farming communities in Adopt-a-River activities. The second is to reduce the impacts of irrigation return flows on the middle and lower reaches of the Olifants River by involving the water users association, local authorities and government departments in protecting these river reaches.

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10. HARTS RIVER CATCHMENT

Responsible office: Northern Cape Regional Office

10.1 BRIEF OVERVIEW OF THE HARTS RIVER CATCHMENT

The Harts River forms part of the Lower Vaal WMA along with rivers like the Molopo, Kuruman and lower reaches of the Vaal River. It includes three tertiary catchments namely the upper Harts River (C31), the Dry Harts (C32), and the Harts River downstream of the confluence with the Dry Harts River (C33).

Although the source of the Harts River is in the North West Province near the town of Lichtenburg, the larger part of the catchment is situated in the Northern Cape Province. The Harts River flows in a south-westerly direction via Barberspan and Taung Dam to Spitskop Dam, after which it flows into the Vaal River near Delportshoop.

The catchment has relatively flat terrain with no distinct topographic features (DWAF, 2006). There are no climatic barriers and thus climate varies gradually according to the larger regional patterns, and is fairly uniform from east to west. The rainfall is strongly seasonal occurring mainly in the summer months. The overall feature of the mean annual precipitation is that it decreases fairly uniformly westwards from the western parts of the North West Province to the eastern parts of the Northern Cape Province. Mean annual rainfall precipitation ranges between 100 mm in the west and 500 mm to the east. Mean annual evaporation can reach as high as 2 800 mm per year which is in excess of rainfall. As a result of the arid climate, vegetation over the WMA is sparse, consisting mainly of grassland and some thorn trees (notably the majestic camel thorns) (DWAF, 2006).

The Harts River plays an important role in the water supply to domestic and agricultural users in the area. Land use in the area is predominantly urban (both formal and informal) and agriculture (irrigated land as well as stock watering). Industrial users receive water from the Vaalharts irrigation scheme.

10.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

10.2.1 Water quantity issues

Virtually all the surface flow of the lower Vaal River originates from the upper reaches with very little surface run-off originates within the Lower Vaal WMA itself. The Vaal River is fed by the only tributary, the Harts River which drains a catchment area of 31 000 km^2, with the Dry Harts being the major tributary of the Harts River, joining it just downstream of Taung (DWAF, 2006). The only lake and wetlands of note are at Barberspan in the Upper Harts River catchment which has been given Ramsar status as a wildlife conservation area.

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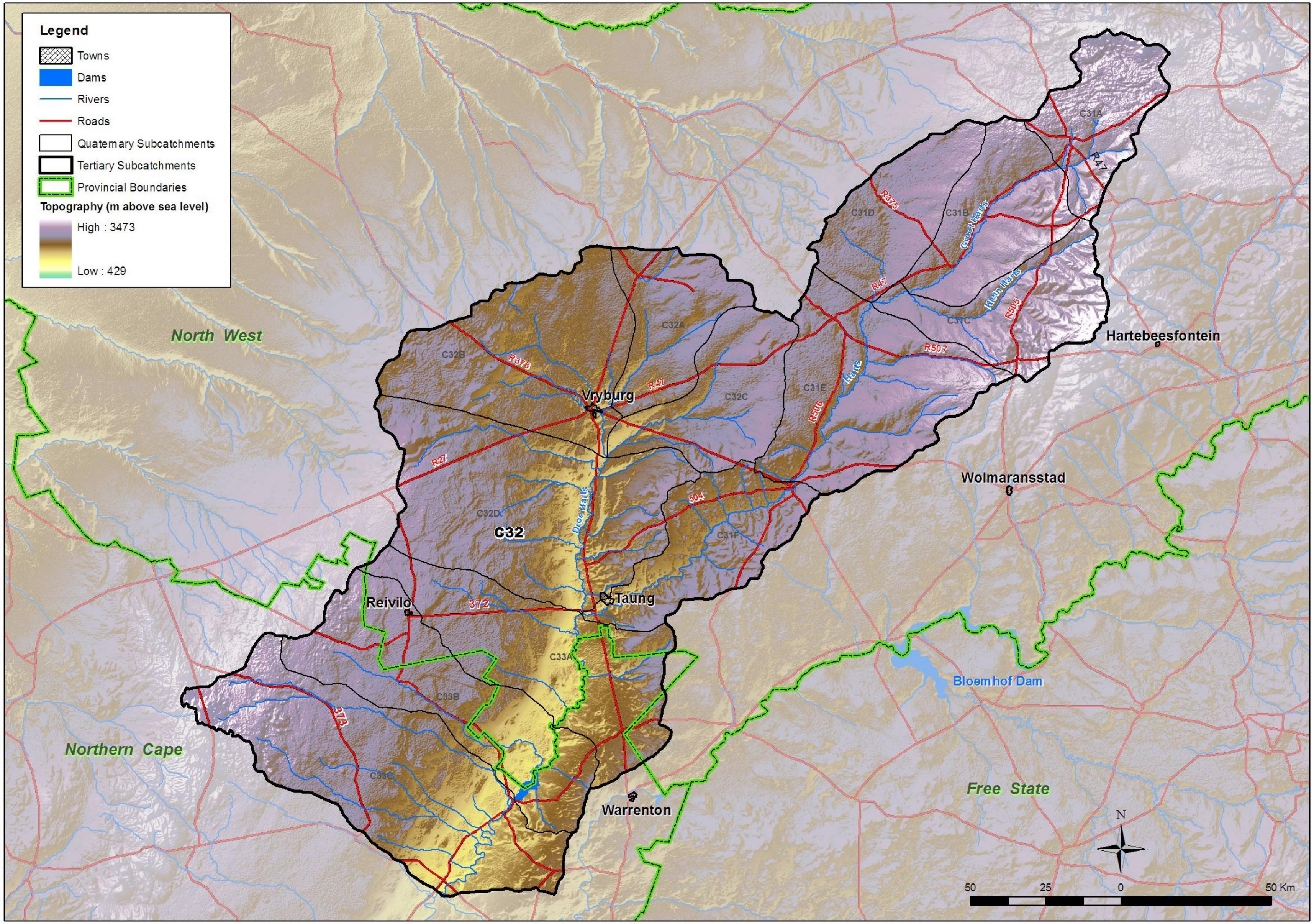

Figure 10.1 Map of the Harts River and associated rivers.

Large quantities of water are transferred from the Vaalharts weir on the Vaal River to supply the Vaalharts irrigation scheme (**Table 10.1**). The Vaalharts Irrigation scheme generates irrigation return flows which enter the Harts River upstream of Spitskop Dam. The return flows contribute salinity and nutrients to the Harts River. The water in Taung Dam and Spitskop Dam are currently not utilised (DWAF, 2006). The quality of surface water in the Harts is highly impacted upon by irrigation return flows which limit the usability of water in the lower reaches of the river (DWAF, 2004).

Table 10.1 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004)

Sub-catchment area	Local yield	Transfers in	Total	Local requirements	Transfers out[10]	Total	Balance
Year 2000							
Harts	136	419	555	494	45	539	16
Year 2025							
Harts	137	419	556	496	43	539	17

10.2.2 Water quality issues

Water quality in the Harts River is largely affected by irrigation return flows from the Vaalharts Irrigation Scheme (**Table 10.2**) and salinity and nutrient enrichment are the two main concerns.

[10] Transfers into and out of sub-areas may include transfers between sub-areas as well as transfers between WMAs. Addition of the transfers per sub-area therefore does not necessarily correspond to the total transfers into and out of the WMA.

Table 10.2 Summary of water quality issues in the Modder/Riet River system

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Harts River	Water in the Harts River downstream of the Vaalharts irrigation scheme is of exceptional high salinity as a result of saline leachate from the irrigation fields (± 1 100 mg/l salinity), and needs to be carefully managed through blending with fresher water. The water quality in the Harts River is affected by concentrating the salts in the return flows from the irrigation schemes in the catchment and by evaporation while the return flows from the Vaal Harts Scheme are stored in the Spitskop Dam. (DWAF 2004, DWAF, 2006). The water quality data of the Harts River catchment indicates high TDS values and the water quality would be classified as marginal.	In addition to the concentration effect in the return flow, fertilisers are also applied, which add to the nutrient load in the return flows. The nutrients have resulted in the growth of algae in the Spitskop Dam. The Spitskop Dam has been cited as the source of algae, in particular blue green algae found in the main stem Orange and Lower Vaal WMA. (DWAF, 2004, DWAF, 2006)	No specific concerns raised	No specific concerns raised	No specific concerns raised	Sections of the Harts River upstream of Taung Dam are severely impacted on by digging activities, which causes sedimentation. There are serious concerns about pesticide and herbicide residues in the surface waters, biota and sediments downstream of the Vaalharts Irrigation Scheme. A research project by the University of Jphannesburg is underway to assess the ecological risks and to measure residues in fish, sediments and the water (Malherbe, pers comm..).

10.2.3 Aquatic ecosystem health issues

The overall health of the lower Harts River is fair to poor (RHP, 2003). Good rains flush the Taung Dam, but all the sediment is trapped in the Spitskop Dam. This results in the dam becoming relatively shallow and nutrient rich. Urban runoff in the Pampierstad area and return flows from the Vaalharts irrigation scheme affect the health of the Harts River. Areas downstream of Taung Dam have diverse habitats and diverse marginal vegetation (RHP, 2003).

10.3 CONCLUDING REMARKS

Irrigation return flows from the Vaalharts Irrigation Scheme has a major impact on water quality and aquatic ecosystem health impacts of Spitskop Dam and the lower Harts River. DWAF (2006) recommended that the Harts sub-catchment was a key area requiring attention from a water quality management perspective and required some intervention (e.g. use of Taung Dam), as irrigators were actively trying to flush salts out of the soil. It was felt that the current situation was an inevitable cost of large-scale irrigation. The aim should therefore be to not let the water quality deteriorate any further. A further issue in the Vaalharts irrigation scheme was the large losses between the amount of water transferred from the Vaalharts weir on the Vaal River and the quantity irrigated. It was estimated that only 51% of the water diverted from the Vaal River reaches the irrigated crops. If this transfer scheme could be optimised, more water could be available to dilute the irrigation return flows leaving the scheme (DWAF, 2006).

Adopt-a-River activities should be centred on reducing the impacts of urban runoff on the upper Harts River and reducing the impacts of irrigation return flows on the lower hats River. This would entail involving communities at Pampierstad in initiatives to prevent pollution and litter on streets and an awareness that runoff drains to rivers and dams. Farming communities at the Vaalhartz Irrigation Scheme can contribute to managing irrigation return flows and the application of fertilizer and agro-chemicals in a way that would minimise the impacts on the receiving water bodies, Spitskop Dam and eventually the lower Vaal River.

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11. CROCODILE RIVER (WEST) CATCHMENT

Responsible office: North West Regional Office

11.1 BRIEF OVERVIEW OF THE CROCODILE RIVER CATCHMENT

The Crocodile River is a major tributary of the Limpopo River (Drainage Region A) which discharges into the Indian Ocean in Mozambique. The Pienaars, Apies, Moretele, Hennops, Jukskei, Magalies and Elands rivers are the major tributaries of the Crocodile River, which together make up the A2 secondary catchment with its 39 quaternary catchments. The Crocodile River itself does not form any international boundaries but contributes to the flow of the Limpopo which is an international river basin shared with Botswana, Zimbabwe and Mozambique.

The upper portion of the catchment, south east of Hartbeespoort Dam, is located in the Gauteng Province. The north and north-east corners lie in the Limpopo Province whereas the central or western sections fall within the North West Province. The total area of the Crocodile River Catchment is 29 400 km^2. There are nine major storage dams in the catchment with very limited scope for additional dams. Large quantities of water are transferred into the Crocodile River (West) Catchment to augment the local water resources, constituting close to 46% of the total water use in the catchment. The most significant transfers of water are the supply of potable water via the Rand Water bulk distribution system from the Upper Vaal WMA to northern Johannesburg, Tshwane, Rustenburg and surrounds. A quantity of almost 520 million m^3 was transferred during the year 2000. A small quantity of water is transferred from the Olifants WMA to the Cullinan Mine. Transfers out of the Crocodile River (West) Catchment are from the Pienaars River to the towns of Bela Bela and Modimolle in the Limpopo WMA and from the Vaalkop Dam into the Marico River Catchment to the Deelkraal cement factory.

The total quantity transferred out of the Crocodile River (West) Catchment is approximately 3 million m^3/annum. Main transfers within the Crocodile River (West) Catchment are from the Roodekopjes Dam to Vaalkop Dam as well as via the Magalies bulk water distribution system. Water is also released from the Roodekopjes Dam for irrigation in the Lower Crocodile sub-area. Groundwater forms an important feature with regard to water resources in the Crocodile River (West) Catchment. A large dolomitic aquifer stretches along the southern parts of the catchment. Significant volumes of water are drawn for irrigation and other purposes from this aquifer, including a significant portion of the water supply to the City of Tshwane. This aquifer extends across the boundaries of the various WMAs in this area. Sandy aquifers occur along the Lower Crocodile River, from which large quantities of water are abstracted for irrigation. These aquifers are recharged from rainfall as well as river flow. The remainder of the catchment is mostly underlain by fractured rock aquifers, which are well utilised for rural community water supplies.

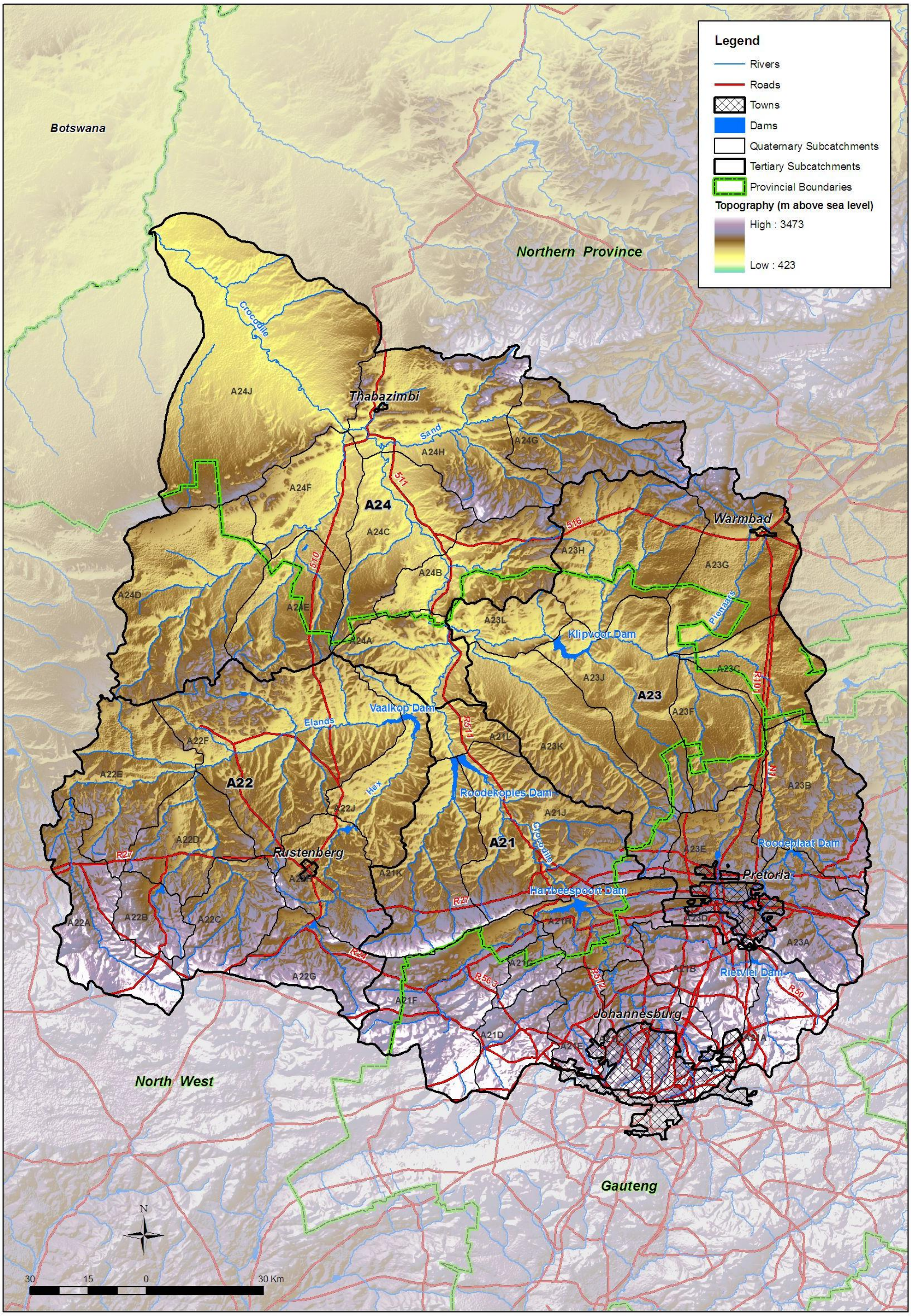

Figure 11.1 Map of the Crocodile (west) catchment showing the major sub-catchments and river

The Crocodile River (West) Catchment was divided into four sub-catchment areas to facilitate more detailed description of water resource quality issues and concerns (Figure 11.1). These sub-areas are the Upper Crocodile sub-catchment (A21), the Elands River sub-catchment (A22), the Apies/Pienaars sub-catchment (A23), and the Lower Crocodile sub-catchment (A24).

11.2 SUMMARY OF WATER RESOURCE QUALITY ISSUES AND CONCERNS

11.2.1 Water quantity issues

In the Crocodile (west) ISP report a water balance was compiled for the year 2000 and for the year 2025 which took the growth in water demand and return flows into account (DWAF, 2004) (**Table 11.1**). This table clearly illustrates how the surplus in the Crocodile catchment is expected to increase over time as a result of increased transfers into the catchment to sustain economic growth and the increase in the associated return flows.

Table 11.1 Reconciliation of water requirements and available water for the year 2000 and for the year 2025 base scenario (million m^3/annum) (DWAF, 2004)

Sub-catchment	Local yield	Transfers in	Local requirements	Transfers out	Balance
Year 2000					
Upper Crocodile (A21)	336	279	556	17	42
Elands (A22)	86	71	113	24	20
Apies/Pienaars (A23)	186	182	280	87	1
Lower Crocodile (A24)	59	112	171	0	0
Total for the catchment	**667**	**519**	**1120**	**3**	**63**
Year 2025					
Upper Crocodile (A21)	399	382	673	13	95
Elands (A22)	90	71	124	24	13
Apies/Pienaars (A23)	244	287	399	92	40
Lower Crocodile (A24)	59	113	173	0	-1
Total for the catchment	**792**	**727**	**1369**	**3**	**147**

Sub-catchment	Water quantity issues
Upper Crocodile (A21)	The southern part of the catchment is highly developed with large industrial, urban and semi-urban sprawls of northern-Johannesburg, Midrand and southern Pretoria. Large volumes of water are imported from the Vaal River system via Rand Water because local source cannot meet water requirements. Large return flows of treated waste water are generated which supply other downstream users. A concern is the high project growth in water demand required to sustain economic growth in the region (DWAF, 2004). These demands have to be met through additional transfer schemes and would result in higher return flow volumes. The overall ecostatus of this sub-catchment is poor and the drivers of change are urbanisation (increased impervious surfaces, lack of sufficient capacity of sewer systems, and substantial channel and flow modification) and increased change in land-use from natural to urban and industrial (RHP, 2005).

Sub-catchment	Water quantity issues
Elands (A22)	This is the drier part of the catchment. Rustenburg, the main urban centre, has seen rapid growth due to expansion of platinum mining activities in the area. Local water resources are under-utilised while significant volumes of water are transferred to the area from the Vaal River system. The rapid economic growth of the area would lead to a further increase in water demand and increased return flows to rivers (DWAF, 2003, 2004). Flow related concerns in the Selons/Koster River sub-catchment relate to altering the natural flow regime due to impounding and inefficient water abstractions for irrigation (RHP, 2005).
Apies/Pienaars (A23)	A major part of this sub-catchment is the densely populated city of Pretoria, its northern suburbs and sprawling towns such as Soshanguve, Mabopane, Hammanskraal and Makapanstad. The bulk of the water requirements are supplied by Rand Water, sources from the Vaal River system (DWAF, 2004). The increased return flows would result in projected future surpluses. Some of the surpluses have been allocated for improvement and expansion of the water supply in the areas north of Pretoria. Transferring some of the return flows into the Western Highveld region (Olifants River WMA) is being investigated (DWAF, 2004). The ecostatus in the Apies sub-catchment is poor and the flow related drivers are high levels of development and urbanisation, canalisation of water courses, and modification of flow patterns (RHP, 2005). The ecostatus in the Pienaars River is poor and the flow related patterns are the impounding of water altering natural flow patterns, higher than normal peak flows in urban areas (increased impervious areas) and high volumes of return flows.
Lower Crocodile (A24)	This sub-catchment is characterised by large-scale irrigation activities along the mainstem Crocodile River. Water requirements in the lower-Crocodile are met by return flows. However, 45 million m^3/yr is reserved for the possible development of a power station on the neighbouring Mokolo sub-catchment (DWAF, 2004). The overall ecostatus of this sub-catchment is poor and the flow related drivers are abstractions for irrigation impacting on the natural flow in the river and dams and weirs acting as barriers to flow and migration of fauna (RHP, 2005).

11.2.2 Water quality issues

Table 11.2 Summary of water quality issues in the Crocodile (West) catchment

Sub-catchment	Salinity	Nutrients	Bacteriological	Trace metals	pH	Other
Upper Crocodile (A21)	Increases in salinity and nutrient concentrations in the water also result from irrigation return flows, and severe eutrophication problems are experienced at Hartbeespoort Dam as well as Roodeplaat, Rietvlei, Bospoort and Vaalkop Dams. (Crocodile West and Marico Water Management Area - Overview of Water Resources Availability and Utilisation)	Informal settlements without access to sanitation, sewage spills from poorly maintained or overloaded sewage networks (Sandton & Alexandria), industrial and agricultural pollutants have all contributed to a build up in the nutrients in the rivers of the Hartbeespoort (A21B-H) catchment. (DWAF, 2004)	Groundwater pollution (*E.coli* and nitrates) is occurring as a result of poor sanitation services in informal settlements & other rural communities (DWAF, 2004). The Juskei River, a tributary of the Crocodile River, is probably the river most affected by urbanisation and industrial activity in the country. (DWAF, 2003)			The contribution of mine dewatering on the surface and groundwater resources within the Roodekoppies Dam catchment (A21J-L) is assumed to have some negative impact on users and the environment (DWAF, 2004)
Elands (A22)			Poorly treated sewage effluent from the Rustenberg WWTW flows into the Bospoort Dam with the resource becoming unusable for urban consumption. (DWAF, 2004)			Land use practices and natural erosiveness of soils in the Elands River (south of Sun City) are leading to a high silt load that flows into the Vaalkop Dam (Crocodile-West ISP)
Apies/Pienaars (A23)	The salt content of the groundwater is elevated in some of the areas north of Pretoria in catchments A23F and A23J where conductivities above 150mS/m occur naturally. (DWAF, 2004)		The Apies and Pienaars Rivers receive effluent discharges from Pretoria. (DWAF, 2004)			All dams in this catchment are eutrophic. Fluoride values >1.5 mg/l are locally present in the groundwater in the granitic area east of the Klipvoor Dam (DWAF, 2004)
Lower Crocodile (A24)	There is some evidence of salinisation of the soil along the Lower Crocodile but it is not sure whether it can attributed to the poor water quality or poor irrigation practices. (DWAF, 2004)		The Lower Crocodile River catchment receives all the return flows from the upper catchments which all have water quality problems to a greater or lesser degree. (DWAF, 2004)			

11.2.3 Aquatic ecosystem health issues (DWAF, 2005)

Sub-catchment	Overall Ecostatus	Instream habitat, riparian zone habitat, and riparian vegetation integrity	Fish assembly integrity	Macro-invertebrate integrity	Ecosystem Water quality
Upper Crocodile (A21)	Poor, except for the middle Crocodile (fair/poor), Skeerpoort (natural/good) and the upper Sterkstroom (good/fair)	The Instream Habitat Integrity is poor because of urban development - the majority of the river is canalised, urban runoff is high because of paved areas and sewage spills and industrial discharges are common because infrastructure cannot cope with the high levels of utilisation. It must be mentioned that some of the tributaries feeding the Crocodile River are not as severely impacted. The Riparian Zone Habitat Integrity is also POOR primarily because the river has been engineered and the flow patterns completely altered. Riparian Vegetation Integrity is POOR - natural vegetation has been completely altered because of urbanisation, and encroachment by poplar species is severe.	The Fish Assemblage Integrity is poor because increased flow volumes and increased peak flows after heavy rains because impervious surfaces have altered natural flow regimes. There is complete loss of sensitive species and even hardy species have lowered frequencies of occurrence.	Macro-invertebrate Integrity is POOR - diversity and abundances are severely impacted by urban runoff including sedimentation, sewage flows and industrial discharges.	Water Quality is POOR with high levels of nutrients and an increased frequency of water quality problems. The percentage of species tolerant to organic pollution indicates that the water is free from significant organic pollution. Water quality in the urban areas is severe - mostly because of sewage spillages and industries discharging into the sewer network. The sewerage system is not able to cope with the increase in housing density.
Elands (A22)	Fair for upper and lower Elands, Selns/Koster and Upper Hex, poor for lower Hex River.	In the lower Hex River the Instream Habitat Integrity was poor primarily because of high levels of development especially in terms of mining activities as well as water abstraction for irrigation purposes. Stretches of the river have been diverted for the mines but more recently for the upgrade of the N4 Platinum Toll Highway. The Riparian Zone Habitat Integrity was fair due to channel modifications caused by diversions for mining have impacted on riparian zone habitats. The Riparian Vegetation Integrity was good because there is some vegetation clearing for sand winning activities and some pockets of sesbania and blue gums, both of which are very localised.	The Fish Assemblage Integrity in the lower Hex is poor because sensitive species are absent due to flow modifications and obstructions. Water quality problems originating from the mines and from agriculture have created stress conditions for fish species.	The Macro-invertebrate Integrity in the lower Hex River is poor due to the cumulative impacts of reduced water quality and, flow and habitat modifications have had a large effect on invertebrate diversity and abundance.	Water Quality in the lower Hex is fair because intermediate levels of nutrients were found but largely free of significant organic pollution. High conductivity readings were recorded – high salinity levels were possibly due to mines.
Apies/Pienaars (A23)	Poor	Poor due canalisation in urban areas, higher flows from return flows. Poor water quality, sewage spills and litter impact on functional integrity of the rivers.	Poor because sensitive species are absent and fewer numbers of even hardy species.	Poor diversity and abundance, heavily impacted by modified flow regime and poor water quality.	Water quality is poor due to urban runoff, high nutrients from treated wastewater effluent, and high organic loads.
Lower Crocodile (A24)	Poor	The Instream Habitat Integrity is poor due to extensive irrigation and multiple abstractions having a severe impact on river functioning. Flows are regulated through a series of weirs and dams resulting in unseasonal releases (to maintain irrigation) which leads to undercutting of river banks and increased sedimentation. The Riparian Zone Habitat Integrity is poor due to the large number of dams causing a loss in flow variability. A lack of high flows resulted in reed encroachment. Riparian Vegetation Integrity is poor because it has been cleared in many areas for agriculture. A number of game farms along the river protect certain sections of the riparian vegetation.	Fish Assemblage Integrity is poor because only hardy species are present, loss of habitat and connectivity of the river has resulted in stress conditions for most fish species.	Macro-invertebrate Integrity is poor due to reduced water quality and diminished flows leading to dry sections and isolated pools. This reduction in suitable habitat has a severe impact on invertebrate diversity.	Water Quality is poor there are intermediate levels of nutrients have been found and the sites sampled are heavily contaminated with organic pollution. Low scores can be attributed to high agricultural return flows.

11.3 CONCLUDING REMARKS

There are many opportunities for Adopt-a-River activities in the Crocodile River (west) catchment. Improving the quality of urban runoff in the urban centres can potentially have a very positive impact on the quality of rivers that drain into the major impoundments in the catchment. Adopt-a-River activities at the major impoundments can create a mechanism for involving a large number of key role players in the management of such water bodies. The various initiatives at Hartebeespoort Dam serve as one example of how communities, local authorities, the DWAF, property owners, special interest groups, etc. can cooperate towards a common goal. Consideration should be given to extending such initiatives to the other problem impoundments in the catchment.

11.4 REFERENCES FOR THE CROCODILE (WEST) CATCHMENT

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12. CONCLUSIONS

Implementation of the Adopt-a-River programme will have a better chance of success if it is focused on rivers and river reaches where problems are experienced, and where the involvement of communities, different spheres of government, the agricultural sector, and the industrial sector can make a difference. This report attempted to highlight some of the problems and problems areas that occur in different regions of the country. It is now up to the regional offices of DWAF to consider these when looking for opportunities to launch Adopt-a-River initiatives.