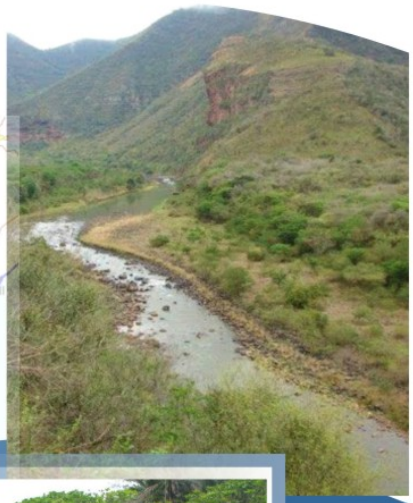
REPORT NUMBER: RDM/WMA11/00/CON/CLA/0113

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

PROJECT NUMBER: WP 10679

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



JULY 2013

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

RfA13_2013

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

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

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE COMPREHENSIVE RESERVE AND RESOURCE QUALITY OBJECTIVES IN THE MVOTI TO UMZIMKULU WATER MANAGEMENT AREA

STATUS QUO ASSESSMENT, IUA AND BIOPHYSICAL NODE DELINEATION AND IDENTIFICATION

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REPORT SCHEDULE

Version	Date
First draft	*April 2013*
Second draft	*July 2013*

EXECUTIVE SUMMARY

INTRODUCTION

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

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

WATER RESOURCES STATUS QUO ASSESSMENT

Water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system were selected and are summarised below.

Mvoti (Tertiary catchments U40 and U50): *Land use consists mostly of communal land inland (Mapamulo), commercial timber in the upper reaches of the catchment, dryland and irrigated sugar cane along the coastal strip, and urban areas of Stanger and Greytown. The water resources of the Mvoti catchment are poorly developed and have not kept pace with the water requirements. As a result the requirements far exceed the available resources and the catchment can be considered to be stressed.*

Mdloti (Tertiary catchment U30): *The Mdloti Key Area includes both the Mdloti and the Tongati rivers. The major dams in the area include Hazelmere Dam on the Mdloti River and the smaller Dudley Pringle Dam in the Tongati River catchment. Land use in the Mdloti Key Area consists mostly of dryland and irrigated sugar cane, mostly on communal land. Water is transferred out of the catchment to the Mvoti catchment. The water quality of the catchment is generally poor due to point source pollution, especially along the coastal strip. The inland regions generally enjoy better water quality but erosion and resultant sedimentation is a problem.*

Mgeni (Tertiary catchment U20): *The Mgeni River system is largely regulated and developed. The catchment is currently serviced by the following four major dams on the Mgeni River as well as the Mooi-Mgeni transfer scheme; Midmar Dam, Nagle Dam, Albert Falls Dam and Inanda Dam. The water requirements in the Key Area are currently approximately in balance with the available yield. Water quality in the lower Mgeni River and in the Msunduze River is generally poor. This is due to the dense human population in and around Durban and Pietermaritzburg, some of which is not serviced with adequate sanitation.*

Mlazi and Lovu (Tertiary catchments U60 and U70): *The catchment is dominated by irrigation and afforestation, with irrigation being by far the dominant water user. Much of this irrigation use is for intensive vegetable farming to supply Durban and Pietermaritzburg. This is important from a food supply perspective. The catchment is largely unregulated. However, large farm dams are present in the upper reaches of the Lovu River. The Shongweni Dam on the Mlazi River has silted up over the years and is now only used for recreational and educational purposes. The water quality in the catchment is poor, especially the Mlazi River.*

Mkomazi (Tertiary catchment U10): *The two largest water users in the catchment are industry, with SAPPI-SAICCOR's water requirement of 44 million m^3/annum at the mouth of the Mkomazi River, and the irrigation sector. Forestry and dryland sugar cane are also significant in the area. The catchment is unregulated and development of major water resources infrastructure is reserved for the transfer of water to the Mgeni River System.*

South Coast (Tertiary catchment U80): *The South Coast is a largely undeveloped area with limited water requirements. Forestry and dryland sugar cane are also very limited in the area and are not significant factors from a water resources point of view. The catchment as a whole is experiencing a small deficit, which is experienced by some of the coastal resorts and the Sezela sugar mill. Water shortages have been experience in the urban sector are due to the seasonality of the tourism industry. The water-related infrastructure (including the water resources) cannot cope with the large influx of holiday-makers in December.*

Mtamvuna (Tertiary catchment T40): *The Mtamvuna is a largely undeveloped catchment. The only significant water requirement is that of the coastal towns which are mostly supplied through transfers from the Umzimkulu River. There are large areas of dryland sugar cane in the catchment but the reduction in runoff due to this has little impact on the available yield because of its location along the coast. Irrigation in the catchment is insignificant.*

Umzimkulu (Tertiary catchments T51 and T52): *This are is characterised by relatively large rural use and extensive afforestation, which has a significant impact on the low flow in the catchment. The catchment is unregulated in the sense that there is no major dams in the catchment.*

STATUS QUO OF THE ECONOMY

The situational reality of the socio economic position in the Water Management Area must be taken into consideration in the evaluation of the current economic activities as well as possible scenarios.

It is of course primarily the socio-economic features of a province which shapes the developmental challenge. In KwaZulu-Natal, despite the concerted efforts of the Provincial Government to address the twin challenges of poverty and unemployment in the first two decades of democracy, poverty and unemployment rates have remained chronic and rising. KwaZulu-Natal remains a predominantly rural province, with dependency ratios and poverty levels highest in the rural areas, although the greatest numbers of poor people (poverty density) are to be found in the major urban centres.

The economic significance of water uses in the Mvoti to Umzimkulu WMA is dominated by primary sectors such as irrigated agriculture and commercial forestry, subsequently by secondary industries in particular saw and sugar mills as well as a pulp and paper factories which has become service cetres for the local population. Tertiary flow of the economy represents the tourism sector. The WMA covers the very important economic hubs of eThekwini Metropolitan Municipality (Durban) and Msunduzi Local Municipality (Pietermaritzburg) which together represent more than 60% of the industrial output of the KwaZulu-Natal (KZN) Province.

As already mentioned it is also a very important agricultural region hosting large sugar cane production areas throughout the WMA with the accompanying sugar mills. A large variety of other

agricultural products are produced varying from beef and dairy production in the inland areas to crop and horticultural production in both the coastal and inland areas.

This area includes some of the most popular tourist and holiday areas in the country varying from a number of coastal holiday towns/resorts, Durban beaches and inland tourist destinations such as the Drakensberg region and very popular game parks. The Durban port together with the N3 highway, accompanying railway and fuel lines are the most important transport nodes in the country.

Eight Economic Regions were identified and conform to the secondary catchments of WMA 11. In all the regions, agricultural related industry (i.e. sugar and saw mills) is prominent. The dominant activity for therural section of the catchment is the agricultural related industry.

ECOLOGICAL GOODS, SERVICES AND ATTRIBUTES (EGSA) STATUS QUO

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

Based on Census 2011, a total population of just fewer than 7 million individual is located in the study area. The average population density is 166 individuals per square kilometre (km^2). The spatial distribution of this population shows a sharp transition from low density rural populations with limited development to high density urban environments where water is largely sourced from formal systems. The study area, because of the nature of the communities that it intersects, plays an important role in maintaining important Ecological Goods, Services and Attributes (EGSA) on-site as well as other users.

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

- *Commercial Agriculture and plantation: This is largely given over to zones dominated by commercial farming entities. Utilisation of EGSA tends to be low and restricted often to farm workers or incidental recreational aspects.*
- *Subsistence agriculture: These areas are dominated by subsistence agriculture but in areas where population densities are relatively low. Utilisation of EGSA tends to be higher here and the populations that make use are often poor and marginal. For the most part these are areas that were part of the former homelands of KwaZulu and the Transkei.*
- *Rural Closer Settlement – Subsistence: These are the former homeland areas that have generally higher population densities than the purely subsistence areas. In some instance densities are high enough to be categorised as closer settlement/informal urban. Utilisation of EGSA tends to be higher here and the populations that make use are often poor and marginal. However, the population densities are such that resources tend to be under pressure.*
- *High Density Formal Urban: These are the SQs heavily influenced by the cities of Durban and Pietermaritzburg as well as a number of other hinterland towns and the highly developed coastal belt. The utilisation of EGSA tends to be low as the populations tend to be urbanised and alienated from direct use of the resources.*

- *Drakensberg/Recreational/Dams/Game Farms. These are SQs within the Drakensberg mountain belt, game farms as well as SQs dominated by dams. Recreational usage tends to dominate EGSA.*

The following rivers have sections of high EGSA importance:

- *U1 Mkomazi: Mkomazi, Lufafa and Xobho Rivers have areas that are entirely rural with a significant dependance on EGSA, especially informal agriculture.*
- *U2 Mgeni: Tholeni, and 2 sections of Mgeni River have rural areas and informal agriculture.*
- *U3 Mdloti: Mdloti, Mona, Mwangala and Tongati Rivers are almost entirely rural with scattered households along the river. Informal agriculture occurs.*
- *U4 Mvoti: One section on the Mvoti River is entirely rural with settlements and informal agriculture.*
- *U6 Umlazi: On section on the Bivane River is entirely rural with settlements and informal agriculture.*
- *U7 Lovu: Rural and urban areas.*
- *U8 Ifafa: Kwa-Malukaka, Mtwalume, Mgeni and aMahlongwa River include reaches that are entirely rural with extensive informal agriculture.*
- *T4 Mtamvuna: Sections of the Goxe, Weza, Mtamvuna, Ludeke, Ku-Ntlamvukazi, Tungwana, Londobezi, and Hlolweni Rivers include areas of significant informal agriculture and are mostly entirely rural.*
- *T5 Umzimkulu: Sections of the Gungununu, Malenge, Ngwangwane, Umzimkulu, Little Bisi, Bisi, Mzim-khulwana and Mbumba include areas of signficant informal agriculture and townships*

ECOLOGICAL STATUS QUO: WETLANDS

Available desktop maps indicate hundreds to thousands of wetlands are present in the study area. There are too many wetlands to evaluate on an individual basis and a desktop level quaternary-scale catchment assessment of the wetlands across the entire study area was undertaken. This approach allows for the average PES and EIS categories of wetlands within each quaternary catchment to be estimated using available desktop data and has been used in several previous DWA studies.

The EIS assessment indicated that High and Very High EIS wetland areas tend to be concentrated in the middle and upper catchment areas, with Moderate and Low EIS areas dominating the lower reaches and coastal zone. A Ramsar site, the Ntsikeni wetland, is located in the Very High EIS T51H quaternary catchment. The Mgeni Vlei in U20A has recently been proclaimed a Ramsar site. Other large wetlands located in the upper catchments account for the similarly Very High categories are U20A (e.g. Mgeni Sponge) and U10A quaternaries.

The average PES of the wetlands is estimated at a low C. Although some catchments are characterised by high PES (B and B/C) wetlands, most of the quaternary catchments are characterised by C or C/D wetlands. Lower reaches are, in general, in worse condition than the upper reaches.

The widespread landuse conversion and encroachment of landuse within wetlands is attributed to the current PES. At the catchment scale, dams, irrigated agriculture and afforestation have reduced inflows to wetlands. Urban and industrial areas, and to a lesser extent agriculture, have negatively affected water quality entering wetlands. Within the wetlands themselves,

encroachment of agriculture, forestry and sugar cane in to the wetland areas has caused degradation of wetlands across much of the catchment. Drainage of wetlands associated with these landuse changes, as well as erosion by dongas, has reduced wetted areas and durations within wetlands, causing further degradation.

Encroachment from forestry and agriculture are the main impacts in central and upper catchments; with impacts from sugar cane and urban areas becoming increasingly dominant in lower and coastal areas. Good buffers from forestry and agriculture however sometimes play a significant amelioration role.

ECOLOGICAL STATUS QUO: RIVERS AND RIVER LINKED WETLANDS

A desktop analysis was undertaken to determine the ecological status quo (otherwise referred to as the Present Ecological State (PES) of 288 river reaches covering the study area. The PES is described in terms of Ecological Categories (EC) of A to F with A being almost natural and F meaning critically modified. Reasons for the change from natural are provided and it is indicated whether these are flow (e.g. abstraction) or non-flow (e.g. riparian vegetation removal or land use practices) related.

T4 Mtamvuna: *The reach is dominated by B and B/C PES rivers. Quaternary catchment T40A (Mafadobo and Goxe rivers) is subjected to small areas of forestry and low density rural settlements with the primary impacts being non-flow related (sedimentation). T40B has flow and non-flow related impacts, consisting of extensive forestry occurring in the upper reaches, with a timber mill and rural settlements. Subsistence farming, grazing and low density rural settlements occur in T40C. T40D is mostly in a good state which is often due to the protection provided by gorges. Impacts are non-flow related as well as for the rivers further downstream with impacts being primarily non-flow related (rural settlements, subsistence farming, sedimentation and grazing).*

T5 Umzimkulu: *The upper Umzimkulu contains several headwater streams and are mostly in an A or B PES, with a single C PES. Low severity impacts that exist are created by small patches of afforestation and other alien vegetation, small dams, tourism, irrigation and rural community use in the form of subsistence farming (grazing and trampling, agricultural lands). Most of the rivers in the Middle Umzimkulu and Mzimkhulwana tributary are in a B/C and C PES. Extensive rural development and associated settlements are the main impacts. Forestry, irrigation, trampling and erosion, dams and alien invasive plants occur. Further downstream, dense human settlements and large townships occur. SQs with a high PES originate in the Ntsikeni Wildlife Reserve and in other areas, are protected by being within steep valleys. The one SQ that is in an E PES is drowned by dams.*

The Lubhukwini River (T51H-04846) is noted for high priority wetlands (extensive seeps) which are KZN priority monitoring sites and is also a Ramsar site. Very high priority channelled valley bottom wetlands with meandering grasslands have been noted in the Pholelana (T51D-04460) and Pholela (T51E-04478) Rivers. Meandering floodplains in the Pholela are KZN priority monitoring sites. Some wetlands are inundated and grazing and formal agriculture has affected wetland PES.

The lower Umzimkulu are all in a B PES. The good state is mostly attributed to the protection provided by a large gorge section. Impacts in this area is primarily non-flow related, related to

small scale subsistence farming, grazing, limited forestry, erosion and sedimentation of instream habitats.

U8 Mzumbe and Mtwalume: *All the SQs that comprise the Mzumbe system have B PES. Impacts in the Mzumbe comprise mainly forestry (U80B-05145), rural settlements and subsistence farming, small dams in the tributaries, and associated non-flow related impacts such as grazing, but all with low severity or extent.*

The Mtwalume and its tributaries are mostly in a B, C, B/C and D PES and both flow and non-flow related impacts dominate. Notable are instream dams, forestry, subsistence agriculture and sugar cane fields. No importance has been noted for wetlands.

The Mzinto River is in a D PES. Extensive sugar cane farming, in addition to other developments in the catchment is present. The Mpambanyoni system is in a B, B/C and C PES. Impacts are forestry on the upper catchments, with rural developments and associated cultivation, as well as in-stream weirs downstream. The Fafa River system is in a C PES mainly due to rural developments, plantations and an in-stream weir. Low priority wetlands have been noted on the Fafa (U80G-05097), Mzinto (U80H-05109) and Mpambanyoni (U80K-04952) Rivers. These consist of small to narrow patches of both channelled and unchannelled valley bottom wetlands.

The lower density in human settlement in the Mbizana (T4) River has resulted in a B PES. The higher density of rural settlements, sugar cane farming, an in-stream dam, WWTW and quarries close to the river, places the Vungu (T4) River in a B/C PES. No wetlands of any importance were noted.

U1 Mkomazi: *The rivers are mostly in an A, A/B and B PES category. The few impacts that exist are created by small patches of afforestation and other alien vegetation, small dams and trout farms, tourism, and rural community use in the form of subsistence farming (cattle trampling, erosion, roads, and agricultural lands).*

The Nzinga River (U10D-04199) is noted for low priority wetlands, mainly small pockets of channelled valley bottom wetlands, and several wetland clusters (predominantly seep wetlands and channelled valley bottom wetlands) (Nel et al., 2011).

The middle Mkomazi are in a C PES. The Mkomazi and Luhane rivers are dominated by non-flow related impacts (mainly forestry and rural settlements with informal agriculture), while the Elands and its tributaries are dominated by both flow (mainly small dams and some irrigation) and non-flow related (mainly forestry and rural settlements with informal agriculture) impacts. The Mkomazi gorge is dominated by a B PES. These reaches are impacted by both flow and non-flow related activities, consisting primarily of forestry, subsistence farming and sugar cane agriculture, resulting in instream sedimentation, riparian zone modification and flow alterations.

The Mkomazi, Mkobeni , Pateni and Lufafa Rivers are all noted for low importance wetlands (mostly small or narrow valley bottom wetlands).

The dominant PES is C and B/C in the lower Mkomazi with the main impacts being dams, forestry, overgrazing and agriculture.

Wetlands have been noted for very high and high importance in the Xobho (large valley bottom wetlands in headwater area) and Mkomazi (extensive narrow valley bottom wetlands) rivers respectively, while the Nhlavini River was noted for wetlands, but with a low importance.

U7 Lovu: *The upper Lovu catchment is situated in areas mainly covered with plantation forestry (C and B/C PES). Sugar cane, rural development (towns/townships), and dams, have increased impacts on these rivers, especially the water quality (C/D PES). The deeper valleys of the Lovu and Nungwane prevent the people from impacting too much on the rivers but water quality impacts prevail.*

All the coastal rivers in the Lovu catchment is in a C PES, and the impacts are very similar for all these rivers; Rural settlement with extensive high density townships, with associated activities (informal agriculture and some sugar cane).

The Lovu at U70C-04859 has been noted for low priority, isolated, small and narrow channelled valley bottom wetland patches associated with the main channel.

U6 Mlazi: *The upper Mlazi is dominated by C/D and D PES rivers. Upstream of the Shongweni Dam predominant impacts are both flow (instream dams and irrigation) and non-flow related (forestry, agricultural activities, alien invasive vegetation, and water quality. The Mlazi are noted for wetlands of moderate and low importance respectively. Most wetlands consist of isolated patches of valley bottom wetlands that have a C or D PES. Many of the wetlands are inundated or reduced in extent by forestry and agricultural activities. The Sterkspruit (U60C-04556) is noted for wetlands of moderate importance.*

The Lower Mlazi is in a D PES and impacts are degraded water quality and riparian vegetation removal (wood harvesting and grazing).

The upper Mbokodweni is a B PES and the remainder of the IUA a C PES. Impacts are non-flow related including water quality, vegetation removal (wood harvesting) and sugar cane plantations (in the upper reach).

The Mhlatuzana and Umbilo Rivers upstream of Durban harbour are highly developed with many residential, rural and industrial areas. Main impacts are non-flow related with poor water quality, trampling, sedimentation, alien vegetation and vegetation removal resulting in a PES of D and D/E for the Umbilo and Mhlatuzana respectively.

U2 Mgeni: *The Mgeni upstream of Midmar Dam is mostly in a C and B/C PES. Forestry is not restricted to the higher altitudes, patches occur throughout the area. In between these patches are well-organised commercial farms comprising of irrigation and dryland agriculture. Flow impacts stem from damming and water transfers (Mpofana River), while water quality impacts are associated with irrigation return flows, urban runoff and effluent from different sources (towns, farming, trout dams). A large section of the main stem is also inundated by the Midmar Dam.*

This zone contains several wetlands clusters (Nel et al., 2011) and is noted for Mgeni vlei (a RAMSAR site). The upper portion of the U20A quaternary has a high density of seep wetlands (mostly not associated with the main channel), and some channelled valley bottom wetlands farther down. Impacts on the wetlands in U20A (C PES) comprise mainly of inundation,

agricultural encroachment and grazing. The Kusane and Mgeni have moderate priority wetlands noted. Instream dams, forestry, road crossings, irrigation and cultivation result in wetlands ranging from D to E PES.

The Mgeni River reach from Midmar Dam to Albert Falls Dam is in a C and B/C PES, except the Kusane River which is a D due to a combination of forestry, dams and irrigation impacts. The main stem of the Mgeni River becomes very regulated as 0.9 m^3/s is released constantly from Midmar Dam. All the tributaries between the two dams are also heavily impacted due to forestry, irrigation and dry land agriculture (formal), weirs and dams, and removal of riparian vegetation.

The northern tributaries of the Umgeni River downstream of Albert Falls Dam to Inanda Dam have a PES of C/D and three tributaries have a B/C PES. Impacts are primarily flow (consistent high base flows from Albert Falls Dam) and non-flow related with extensive forestry and formal agriculture (sugar cane) present in this area. Some rural areas and townships with associated non-flow (grazing, subsistence farming) and water quality (runoff) related impacts are also present. The main Umgeni is in a B/C due to protection of steep river valleys. The main impacts are dense rural settlements on higher plateaus and on gentle river slopes as well as impacts due to deforestation, agriculture (erosion, sedimentation etc.). The reach in which Nagle Dam is, is in an E PES due to the presence of the dam and the flow related impacts DS of the dam. There are no releases from Nagle Dam.

Low priority wetlands have been noted in the Mpolweni River (U20F-04224) and are mostly valley bottom wetlands.

Msunduze: *The reach contains all SQs within the U20H and U20J quaternary catchments. The main river is the Msunduze and tributaries include the Nqubeni, Slang Spruit and Mpushini Rivers. Upstream of Henley Dam the PES is a C, with non-flow related impacts (poor water quality, rural settlements, sedimentation, overgrazing, agriculture and alien vegetation). Downstream of Henley Dam through Pietermaritzburg the PES ranges from C to D to E. The E PES is due to poor water quality, canalisation, inundation, instream barriers and high intensity urbanisation. Downstream of the E, the river is impacted by poor water quality, rural settlements, informal agriculture, clearing of vegetation, overgrazing and some erosion.*

Valley bottom wetlands have been noted for the following SQs: U20H-04449, U20J-04364, U20J-04452 and U20J-04461. Several wetland clusters, not necessarily associated with the main stream are noted in this zone.

The lower Mgeni River downstream of Inanda Dam is especially in a poor state (E PES) due to the flow regulation (Inanda Dam), coupled with extensive urban and industrial areas. The Palmiet River reaches a range between a PES of C and D and the alterations are primarily non-flow and water quality related due to the extensively developed catchment (urban/residential and industrial areas).

U3 Mdloti: *This zone includes all the rivers falling within quaternary catchments U30A (upper Mdloti), U30B (lower Mdloti), U30C (upper Tongati and Mona Rivers) and U30D (lower Tongati). The Mdloti River upstream of Hazelmere Dam is in a B/C and D PES. The impacts are non-flow related activities (informal settlements with related subsistence agriculture and grazing). The river*

downstream of Hazelmere Dam is in a D PES. The tributary is in a B/C PES. Non-flow related activities (informal settlements with related subsistence agriculture and grazing).

High priority wetlands have been noted for both the Mdloti (U30B-04475) and Ohlanga (U30B-04498) Rivers. These are mainly floodplain and channelled valley bottom wetlands with coastal estuaries and are generally in a C PES (excludes estuaries). The Black Mhlashini (U30B-04465) has been noted for low priority wetlands.

The Tongati reach is in a B/C PES. Only the two upper SQs were evaluated as the lower Tongaat is represented by the estuary (E PES). The impacts in the two SQs related to non-flow related activities (informal settlements with related subsistence agriculture and grazing). The Tongati (U30D-04315) SQ has been noted for low priority wetlands.

U4 Mvoti: *Most SQs are in a C and B/C PES, with only the Mvozana a C/D PES. Impacts are predominantly non-flow related such as forestry, agriculture (vegetation and wetland removal), overgrazing, erosion, aquatic alien macrophytes and dams. The Heinespruit passes close to Greytown which influences the water quality. Some irrigation and centre pivots are also present.*

The Mvoti River (U40A-03869) has high priority wetlands, notably the Mvoti Vlei (within the Mvoti Vlei Nature Reserve), but several other channelled valley bottom wetlands, seeps and meandering floodplains (with oxbows) occur. These wetlands are degraded by agriculture or floodplain manipulation (PES C). The Khamanzi (U40C-03982) is noted for low priority wetlands, mainly valley bottom wetlands in the tributaries which have an average PES of C.

The SQ reaches in the Middle Mvoti reach are in a B or B/C PES. Much of the Mvoti flows through a gorge and is highly confined. Predominant impacts are non-flow related: Mostly overgrazing, informal agriculture and some erosion. The Hlimbitwa and tributaries upstream of U40G-03843 are mostly C PES with the main impacts being forestry, overgrazing and instream dams.

No priority wetlands were noted in the zone, although many seeps occur in the U40F.

The SQs are in a B/C and C PES in the lower reaches of the Mvoti. The ain impacts are non-flow related, especially sedimentation, overgrazing, trampling and vegetation removal.

Several narrow channelled valley bottom wetlands were noted as very high priority.

U5 Nonoti: *The three U5 rivers (Zinkwazi, Nonoti and Mdlotane) and the U3E (Mhlali) are all subjected to similar land use activities of which the dominant activity is dry land formal agriculture (sugar cane). The impacts are therefore flow related, non-flow related (agriculture and settlements) as well as water quality related (agricultural and township runoff, WWTW effluents).*

Low priority wetlands (mainly unchannelled valley bottom wetlands) are noted in the Nonoti River but are reduced in extent by sugar cane fields (D PES).

STATUS QUO ASSESSMENT: ESTUARIES

As part of the National Biodiversity Assessment 2011 a desktop national health assessment was concluded for nearly 300 estuaries in South Africa. For the purposes of this report a summary of existing information on existing pressures on the 64 estuaries within the study area was provided

and included degree of flow modification, level of development in the estuary functional zone (i.e. below the 5 m contour), fishing effort, and pollution levels.

The NBA 2011 pressure assessment indicated that while only one estuary, the Isipingo Estuary, was under very high flow modification pressure, nearly 20% were subjected to a moderate degree of flow modification. Many of these flow modifications were linked to elevated base flows as a result of WWTW discharges. About 23% of the estuaries in WMA 11 have significant development pressures in the estuary functional zone (under the 5 m mean sea level contour), while more than 70% show moderate levels of development pressure. Activities linked to development pressures in WMA 11 include infilling of the floodplain for sugar cane faming, residential development, parking lots and golf courses. Approximately 5% of the estuaries in WMA 11 are under significant fishing pressure, while about 50% have moderate fishing pressures on them. Nearly 20% of the systems in WMA 11 have no fishing pressure on them. About 23% of the estuaries in WMA 11 are under significant pollution pressure; while more than 72% show moderate levels of pollution pressure. Activities linked to pollution pressure in WMA 11 include discharges from WWTW, agricultural return flow, stormwater runoff and discharges from industry.

A desktop health assessment (augmented with recent EWR findings) of the PES of the estuaries of WMA 11 indicate that only about a third of the systems in the region was still in a good state, i.e. B PES. An additional 58% of the estuaries in WMA 11 were in a fair state (33% in a C PES and 14% in a D PES), while about 9% (6 estuaries) were judged to be in a very poor condition.

Integrated Units of Analysis (IUA)

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

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

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

The following 29 IUAs were delineated in the Mvoti to Umzimkulu Catchment:

IUA	Delineation	IUA	Delineation
IUA T4	*Mtamvuna*	*IUA U6-3*	*Mbokodweni*
IUA T5-1	*Upper Umzimkulu Mountain Zone*	*IUA CC*	*Coastal Cluster*
IUA T5-2	*Middle Umzimkulu and Mzimkulwana Tributary*	*IUA U2-1*	*Mgeni: Upstream of Midmar Dam*
IUA T5-3	*Umzimkulu*	*IUA U2-2*	*Mgeni: Midmar Dam to Albert Falls Dam*
IUA U8-1	*Mzumbe*	*IUA U2-3*	*Mgeni Downstream of Albert Falls Dam to Msunduze Confluence*
IUA U8-2	*Mtwalume*	*IUA U2-4*	*Msunduze*

IUA	Delineation	IUA	Delineation
IUA SC	Southern Coastal	IUA U2-5	Mgeni downstream of the Msunduze Confluence to Inanda Dam
IUA U1-1	Mkomazi Mountain Zone	IUA U2-6	Downstream of Inanda Dam to Estuary
IUA U1-2	Middle Mkomazi	IUA U3-1	Mdloti upstream of Hazelmere Dam
IUA U1-3	Mkomazi Gorge Zone	IUA U3-2	Mdloti downstream of Hazelmere
IUA U1-4	Lower Mkomazi	IUA U3-3	Tongati
IUA U7	Lovu	IUA U4-1	Mvoti Upper Reaches
IUA U6-1	Upper Mlazi	IUA U4-2	Mvoti Middle Reaches
IUA U6-2	Lower Mlazi	IUA U4-3	Mvoti Lower Reaches
		IUA NCC	Northern Coastal Cluster

HOTSPOTS

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

The rivers where hotspots dominate are the:

- *Mvoti and Mkomazi Rivers due to the potential for large dam development in the near future.*
- *Mgeni due to its WRUI importance and existing dam developments.*
- *Msunduze due to its water quality issues.*

BIOPHYSICAL NODES

To determine the number of river biophysical nodes, the following were taken into account:

- *46 desktop biophysical nodes are short rivers consisting of one SQ only and will be dealt with through estuarine requirements.*
- *5 SQs fall within dams and were deleted as nodes.*
- *This left a total of 237 river biophysical nodes.*

To calculate the number of desktop biophysical nodes (preliminary at this stage), the following were taken into account:

- *8 desktop nodes were allocated for Rapid III assessments, becoming key biophysical nodes. The hotspot identification and the availability of a yield model guided the allocation.*
- *6 desktop nodes were allocated for Intermediate assessments of which 3 nodes are existing EWR sites. The hotspot identification, previous EWR studies and the availability of a yield model guided the allocation.*
- *5 desktop nodes were allocated for Comprehensive assessments of which 3 are existing EWR sites. The hotspot identification, previous EWR studies and the availability of a yield model guided the allocation*
- *37 desktop nodes would be addressed by yield modelling for the above Rapid, Intermediate and Comprehensive EWR sites.*
- *3 nodes are excluded as the desktop model would not be applicable due to an Interbasin Transfer (IBT).*

This resulted in a total of 178 river desktop biophysical nodes. The key biophysical nodes are preliminary and consist of 19 EWR sites and 37 nodes which are addressed by yield modelling for the EWR sites.

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TERMINOLOGY AND ACRONYMS

CD: RDM	*Chief Directorate: Resource Directed Measures*
DSS	*Decision Support System*
DEAT	*Department of Environmental Affairs and Tourism*
DWA	*Department Water Affairs (Name change applicable after April 2009*
DWAF	*Department Water Affairs and Forestry*
D:RQS	*Directorate: Resource Quality Services*
DM	*District Municipality*
DMA	*Durban Metropolitan Area*
EC	*Ecological Category*
EGSA	*Ecological Goods and Services Attributes*
EI	*Ecological Importance*
EIS	*Ecological Importance and Sensitivity*
ES	*Ecological Sensitivity*
EWR	*Ecological Water Requirements*
ER	*Economic Region*
FEPA	*Freshwater Ecosystem Priority Area*
GIS	*Geographic Information System*
GDP	*Gross Domestic Product*
GRU	*Groundwater Response Unit*
ha	*hectares*
IBA	*Important Birding Areas*
IDP	*Integrated Development Plan*
IEI	*Integrated Environmental Importance*
IUA	*Integrated Unit of Analysis*
IBT	*Interbasin Transfer*
ISP	*Internal Strategic Perspective*
IAP	*Invasive Alien Plant*
KZN	*KwaZulu-Natal*
LM	*Local Municipality*
MC	*Management Class*
MM	*Metropolitan Municipality*
MEA	*Millennium Ecosystem Assessment*
MMTS	*Mooi-Mgeni Transfer Scheme*
NBA	*National Biodiversity Assessment*
NFEPA	*National Freshwater Ecosystem Priority Area*
NSDP	*National Spatial Development Perspective*
NWRCS	*National Water Resource Classification System*
PES	*Present Ecological State*
PSP	*Professional Service Provider*
Quat	*Quaternary catchment*
REC	*Recommended Ecological Category*
RDM	*Reserve Determination Methods*
RQO	*Resource Quality Objectives*
RU	*Resource Unit*
SAM	*Social Accounting Matrix*
SASA	*South African Sugar Association*
SCI	*Socio-Cultural Importance*
SANBI	*South African National Biodiversity Institute*

SASA	*South African Sugar Association*
SIC	*Standard Industrial Classification*
SQ	*Sub quaternary*
TWQR	*Target Water Quality Range*
WWTW	*Waste Water Treatment Works*
WIM	*Water Impact Model*
WMA	*Water Management Area*
WRCS	*Water Resource Classification System*
WRPM	*Water Resource Planning Model*
WRUI	*Water Resource Use Importance*
WRYM	*Water Resource Yield Model*
WTP	*Water Treatment Plant*
WULA	*Water User Licence Application*

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to Umzimkulu Water Management Area (WMA) are able to sustain their level of uses and be maintained at their desired states. The determination of the Management Classes (MC) of the significant water resources in Mvoti to Umzimkulu WMA will ensure that the desired condition of the water resources, and conversely, the degree to which they can be utilised is maintained and adequately managed within the economic, social and ecological goals of the water users (DWA, 2011a). The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the Comprehensive Reserve, classify all significant water resources and determine the Resource Quality Objectives (RQOs) in the Mvoti to Umzimkulu WMA. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 STUDY AREA OVERVIEW

The Mvoti to Umzimkulu WMA (WMA 11) encompasses a total catchment area of approximately 27,000 km^2 and occurs largely within Kwazulu-Natal. A small portion of the Mtamvuna River and the upper and lower segments of the Umzimkulu River straddle the Eastern Cape, close to the Mzimvubu and Keiskamma WMA in the south (DWA, 2011a).

The WMA extends from the town of Zinkwazi, in the north to Port Edward and on the south along the KwaZulu-Natal coastline and envelopes the inland towns of Underberg and Greytown up until the Drakensberg escarpment. The WMA spans across the primary catchment "U" and incorporates the secondary drainage areas of T40 (Mtamvuna River in Port Shepstone) and T52 (Umzimkulu River). Ninety quaternary catchments constitute the water management area and the major rivers draining this WMA include the Mvoti, Mgeni, Mkomazi, Umzimkulu and Mtamvuna (DWA, 2011a).

Two large river systems, the Umzimkulu and Mkomazi rise in the Drakensberg. Two medium-sized river systems the Mgeni and Mvoti rise in the Natal Midlands and have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements. Several smaller river systems (e.g. Mzumbe, Mdloti, Tongaat, Fafa, and Lovu Rivers) also exist within WMA 11 (DWAF, 2004a). Several parallel rivers arise in the escarpment and discharges into the Indian Ocean and the water courses in the study area display a prominent southeasterly flow direction (DWA, 2011a).

The WMA is very rugged and very steep slopes characterise the river valleys in the inland areas for all rivers and moderate slopes are found but comprise only 3% of the area of the WMA (DWAF, 2004a).

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

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

information for decision making regarding the different levels of investigation for Reserve, Classification and RQO determination.

1.4 PURPOSE AND OUTLINE OF THIS REPORT

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

- **Section 2 – 7** *of the report outlines the various multi-disciplinary methodologies adopted during this task and provides the findings of the various Status Quo assessments for WMA 11.*
- **Section 8** *provides information on the delineated Integrated Units of Analysis (IUAs).*
- **Section 9** *outlines the general approach to identifying Hotspots in WMA 11 and the results of this process is provided in* **Section 10***.*
- **Section 11** *outlines the process of selecting final biophysical nodes for which EWRs will be assessed and the level of EWR assessment is also discussed.*
- *References are listed in* **Section 12***.*

2 STATUS QUO ASSESSMENT: WATER RESOURCES

2.1 INTRODUCTION

This section deals with the status quo assessment of both the available decision support systems (DSS) for the Mvoti to the Umzimkulu WMA and the water resources in the study area.

2.2 APPROACH

2.2.1 Decision Support System

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

2.2.2 Water resources

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

2.3 DESCRIPTION OF WATER RESOURCES

The WMA consists of two large river systems (Umzimkulu and Mkomazi), two medium-sized river systems (Mgeni and Mvoti) and several smaller river systems (e.g. Mzumbe, Mdloti, Tongaat, Ifafa, Lovu) which flow from west to east discharging to the sea. The larger rivers rise in the Drakensberg, the medium rivers in the Natal Midlands and the smaller rivers close to the coast. The medium-sized rivers rising in the Natal Midlands have been largely modified by human activities, mainly intensive agriculture, forestry and urban settlements.
The Key Areas are:

- *Mvoti (Tertiary catchments U40 and U50).*
- *Mdloti (Tertiary catchment U30).*
- *Mgeni (Tertiary catchment U20).*
- *Mlazi and Lovu (Tertiary catchments U60 and U70).*
- *Mkomazi (Tertiary catchment U10).*
- *South Coast (Tertiary catchment U80).*
- *Mtamvuna (Tertiary catchment T40); and*
- *Umzimkulu (Tertiary catchments T51 and T52).*

Groundwater resources vary since the geology consists of a diverse assemblage of rock types and structural environments, ranging from highly metamorphosed rocks of the natal Metamorphic Province, to sedimentary deposits of The Natal Group and Karoo SuperGroup, and alluvial and coastal deposits of Quaternary age. Faulting has resulted in a complex geological setting in the coastal region. The geology results in a aquifers being of a fractured nature in the Natal group and Dwyka tillites, fractured and weathered in the Karoo Supergroup (excluding the Dwyka tillites), and Natal Metamorphic Province, and primary in the Alluvial and Coastal deposits.

The geology of the WMA is shown in Figure 2.1, and the geology and its role in distinguishing groundwater response units is shown in Table 2.1.

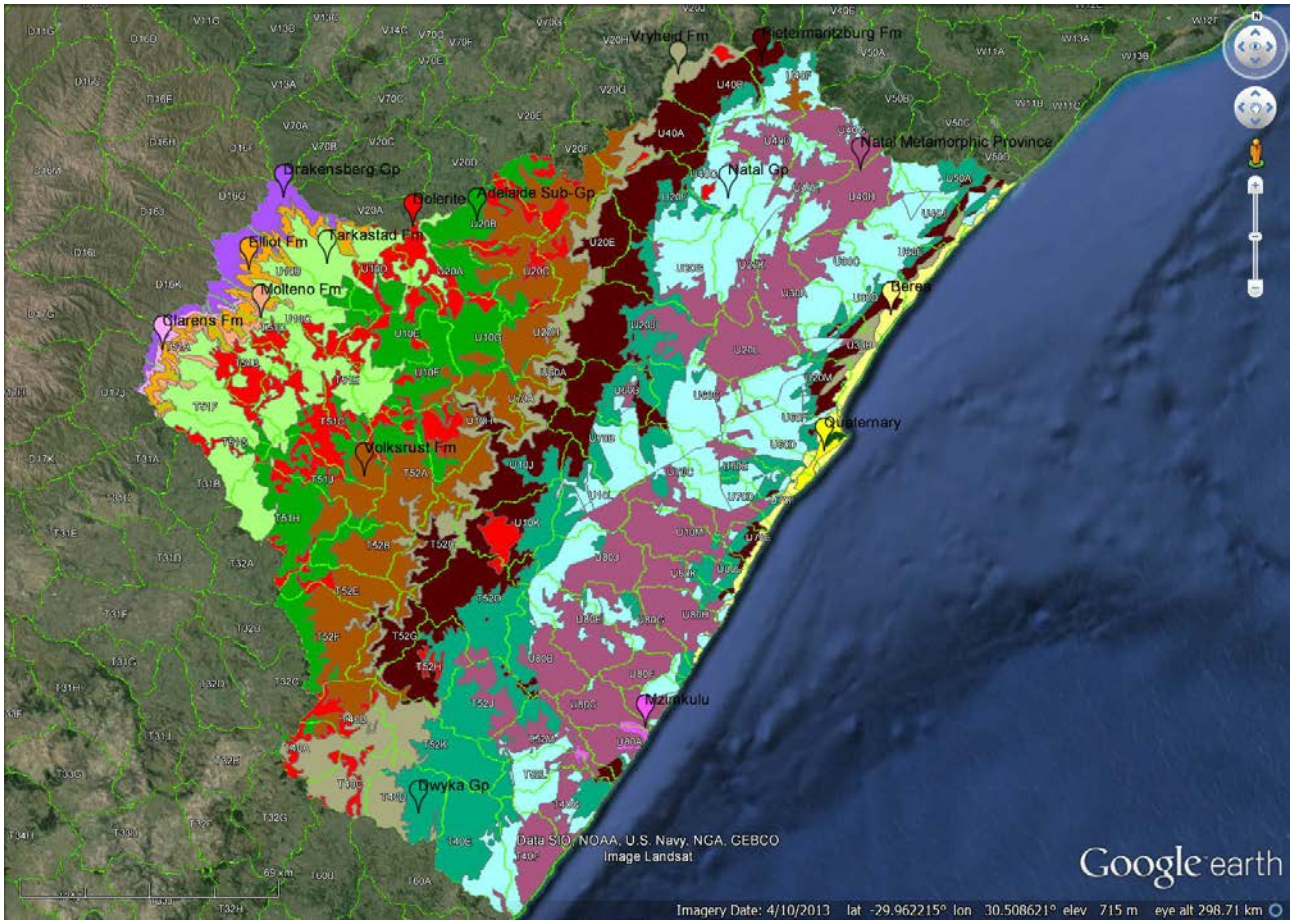


Figure 2.1 Geology of the study area

Table 2.1 Hydrogeological units in the study area

Stratigraphic Unit		Era	Lithology	Hydrogeology	Borehole Yields (l/s)
Maputaland Group	*Quaternary*	*Quaternary*	*Unconsolidated sands, silts and clays*	*High yielding*	
	Berea red sands		*unconsolidated sands and clays, calcified and cemented*	*Low yielding due to elevated position*	
Karoo Supergroup	*Dolerite*	*Jurassic*	*Intrusive basaltic dykes and sills*	*Associated with fracturing and higher yields in country rock*	*0.5-2*
	Drakensberg Group	*Jurassic*	*Basalt*	*Fractured. Associated with springs*	
	Clarens Formation	*Triassic*	*Sandstone, shale and mudstone*	*Moderate yielding fractured and weathered aquifer*	*0.5-2*
	Elliot Formation	*Triassic*	*Mudstone siltstone shale*		
	Molteno Formation	*Triassic*	*Sandstone shale*		
	Tarkastad Subgroup	*Triassic*	*Sandstone mudstone*		
	Adelaide subgroup	*Permian*	*Mudstone sandstone*		
	Volksrust Formation	*Permian*	*Shale*	*Moderate yielding*	

Stratigraphic Unit		Era	Lithology	Hydrogeology	Borehole Yields (l/s)
				with deep weathering, providing storage	
	Vryheid Fomration	Permian	Sandstone shale	Higher yielding than karoo argillaceous formations	
	Pietermaritzburg Formation	Permian	Shale siltstone	Moderate to low yielding	
Karoo Supergroup	Dwyka Group	Carboniferous-permian	Tillite	Fractured, low yielding	0.1-0.5
Natal Group		Ordovician-Silurian	Sandstone	Fractured and faulted	0.1-0.5
Natal Metamorphic Province	Mapumulo terrane	Mokolian	Gneiss, amphibolite, granulite	Fractured and weathered	0.1-0.5
	Margate terrane		Gneiss, granite		
	Mzimkulu Formation		Marble, granulite		

2.3.1 Mvoti Key Area

Land use in the Mvoti Key Area consists mostly of communal land inland (Mapamulo), commercial timber in the upper reaches of the catchment, dryland and irrigated sugar cane along the coastal strip, and urban areas of Stanger and Greytown. The water resources of the Mvoti catchment are poorly developed and have not kept pace with the water requirements. As a result the requirements far exceed the available resources and the catchment can be considered to be stressed.

2.3.2 Mdloti Key Area

The Mdloti Key Area includes both the Mdloti and the Tongati rivers. The major dams in the area include Hazelmere Dam on the Mdloti River and the smaller Dudley Pringle Dam in the Tongati River catchment.

Land use in the Mdloti Key Area consists mostly of dryland and irrigated sugar cane, mostly on communal land. The small urban areas of Tongaat, Canelands, Verulam and Umhlanga are located in this Key Area. Water is transferred out of the catchment to the Mvoti catchment.

The water quality of the catchment is generally poor due to point source pollution, especially along the coastal strip. The inland regions generally enjoy better water quality but erosion and resultant sedimentation is a problem. However, the point sources of pollution problems are known and DWA's regional office is addressing these.

2.3.3 Mgeni Key Area

The Mgeni River system is largely regulated and developed. The catchment is currently serviced by the following four major dams on the Mgeni River as well as the Mooi-Mgeni transfer scheme:

- *Midmar Dam*
- *Nagle Dam*
- *Albert Falls Dam*
- *Inanda Dam*

The water requirements in the Key Area are currently approximately in balance with the available yield. Water quality in the lower Mgeni River and in the Msunduzi River is generally poor. This is due to the dense human population in and around Durban and Pietermaritzburg, some of which is not serviced with adequate sanitation.

2.3.4 Mlazi and Lovu Key Area

The catchment is dominated by irrigation and afforestation, with irrigation being by far the dominant water user. Much of this irrigation use is for intensive vegetable farming to supply Durban and Pietermaritzburg. This is important from a food supply perspective. The catchment is largely unregulated. However, large farm dams are present in the upper reaches of the Lovu River. The Shongweni Dam on the Mlazi River has silted up over the years and is now only used for recreational and educational purposes. The water quality in the catchment is poor, especially the Mlazi River.

2.3.5 Mkomazi Key Area

The two largest water users in the catchment are industry, with SAPPI-SAICCOR's large water requirement of 44 million m^3/annum at the mouth of the Mkomazi River, and the irrigation sector. Forestry and dryland sugar cane are also significant in the area.

Despite the large natural runoff of the Mkomazi catchment, the catchment is stressed and there is no water available for new water allocations. The catchment is unregulated and development of major water resources infrastructure is reserved for the transfer of water to the Mgeni River System. A feasibility study is currently being undertaken on the proposed developments on the Mkomazi River.

2.3.6 South Coast Key Area

The South Coast Key Area is a largely undeveloped area with limited water requirements. Forestry and dryland sugar cane are also very limited in the area and are not significant factors from a water resources point of view. The catchment as a whole is experiencing a small deficit, which is experienced by some of the coastal resorts and the Sezela sugar mill. Water shortages have been experience in the urban sector are due to the seasonality of the tourism industry. The water-related infrastructure (including the water resources) cannot cope with the large influx of holiday-makers in December.

2.3.7 Mtamvuna Key Area

The Mtamvuna Key Area is a largely undeveloped catchment. The only significant water requirement is that of the coastal towns which are mostly supplied through transfers from the Umzimkulu River. There are large areas of dryland sugar cane in the catchment but the reduction in runoff due to this has little impact on the available yield because of its location along the coast. Irrigation in the catchment is insignificant.

2.3.8 Umzimkulu Key Area

This Key Area is characterised by relatively large rural use and extensive afforestation, which has a significant impact on the low flow in the catchment. The catchment is unregulated.

2.4 STATUS QUO ASSESSMENT

2.4.1 Decision Support System

A review of the various past and current studies in the study area was conducted in order to confirm the availability and status of both the hydrology and water resource models available. In the case where there are gaps the WR2005 could be considered as a source of information, however there are several known problems with the WR2005 study data sets for this WMA, such as that no farm dams were taken into account during the calibration process.

The models available for the different catchments in WMA 11 as well as the confidence of the models are presented in Table 2.2. The higher confidence models were done recently and with recent landuse data, while the medium confidence models were based on older analyses and landuse data, while still being relatively high resolution models.

Table 2.2 Models available for the different catchments in WMA 11

Key Area	Rivers	Quaternaries	Best available models	Confidence of models
Mvoti	Nonoti and Zinkwazi	U50A	WRSM2000	Low
	Mvoti	U40A to U40J,	WRYM	Medium
Mdloti	Mhlali	U30E	WRSM2000	Low
	Tongati	U30C and U30D	WRSM2000	Low
	Mdloti	U30A and U30B	WRYM	Low
Mgeni	Mgeni	U20A to U20M,	WRYM and WRPM	High
Mlazi and Lovu	Umbilo and Mhlathuzana	U60F	WRSM2000	Low
	Mlazi	U60A to U60D	WRSM2000	Low
	Mbokodweni	U60E	WRSM2000	Low
	Manzimtoti and Little Manzimtoti	U70F	WRSM2000	Low
	Lovu	U70A to U70D	WRSM2000	Low
	Msimbazi, Mgababa and Ngane	U70E	WRSM2000	Low
Mkomazi	Mkomazi	U10A to U10M	WRYM and WRPM (in process)	High
South Coast	Mahlongwana and Mahlongwa	U80L	WRSM2000	Low
	Mpambanyoni	U80J and U80K	WRSM2000	Low
	Mzinto, Mkhumbane, Sezela and Mdesingane	U80H	WRSM2000	Low
	Fafa	U80G	WRSM2000	Low
	Mtwalume	U80E and U80F	WRSM2000	Low
	Mnamfu, KwaMakosi, Mfazazana, Mhlungwa and Mzimayi	U80D	WRSM2000	Low
	Mzumbe	U80B and U80C	WRSM2000	Low
	Ntshambili, Koshwana, Domba, Mhlangamkulu and Mtentweni	U80A	WRSM2000	Low
Umzimkulu	Umzimkulu	T51A to T51J T52A to T52M	WRYM	High
Mtamvuna	Mbango, Boboyi, Zotsha, uMhlanga, Vungu, Bilanhlolo and Mvutshini	T40G	WRSM2000	Low
	Mbizana, Kaba, Little Mpenjati, Kandandlovu, Tongazi, Kuboboyi, Sandlundlu, Zolwane	T40F	WRSM2000	Low
	Mtamvuna	T40A to T40E	WRSM2000	Low

2.4.2 Water Resources

The Mvoti to Umzimkulu WMA was divided into twenty nine water resource zones based on similar water resource operation, location of significant water resource infrastructure (including proposed infrastructure) and distinctive functions of the catchments in context of the larger system. The significant resources of the proposed water resource zones are summarised in Table 2.3.

Table 2.3 Mvoti River catchment water resource zones

Catchments	Water Resource Zone	Description	Major impoundments	Quaternary catchments
North Coast Rivers	NC	North Coast	-	U30E U50A
Mvoti	U4-1	Upper Mvoti	-	U40A - U40D
	U4-2	Middle Mvoti	-	U40E - U40G
	U4-3	Lower Mvoti	-	U40H - U40J
Mdloti	U3-1	Upper Mdloti	Hazelmere Dam	U30A
	U3-2	Lower Mdloti	-	U30B
Tongati	U3-3	Upper Tongati	Dudley Pringle Dam	U30C
	U3-4	Lower Tongati	-	U30D
Mgeni	U2-1	Mgeni - Upstream of Midmar Dam	Midmar Dam	U20A - U20C
	U2-2	Mgeni - Midmar to Albert Falls Dam	Albert Falls Dam	U20D - U20E
	U2-3	Mgeni - Albert Falls Dam to Msunduze Confluence	Nagle Dam	U20F – U20G
	U2-4	Msunduze	Henley Dam	U20H U20J
	U2-5	Mgeni - Msunduze confluence to Inanda Dam	Inanda Dam	U20K – U20L
	U2-6	Mgeni - Inanda Dam to Estuary	-	U20M
Central Coast Rivers	CC	Central Coast	-	U60F U70E U70F
Mlazi	U6-1	Upper Mlazi	Shongweni Dam	U60A - U60C
	U6-2	Lower Mlazi		U60D
Mbokodweni	U6-3	Mbokodweni		U60E
Lovu	U7-1	Lovu	Nungwane Dam Illovo Dam	U70A - U70D
Mkomazi	U1-1	Mkomazi Mountain Zone		U10A – U10F
	U1-2	Middle Mkomazi		U10G – U10K
	U1-3	Lower Mkomazi		U10L U10M
South Coast Rivers	SC	South Coast		T40F T40G U80A U80D U80G - U80L
Mzumbe	U8-1	Mzumbe		U80B U80C
Mtwalume	U8-2	Mtwalume		U80E U80F
Umzimkulu	T5-1	Upper Umzimkulu Mountain Zone		T51A – T51J
	T5-2	Middle Umzimkulu and Mzimkhulwana tributary		T52A – T52H
	T5-3	Lower Umzimkulu		T52J – T52M
Mtamvuna	T4-1	Mtamvuna		T40A – T40E

The potential and current use of groundwater was based on a desktop investigation conducted as part of this study. It was considered by dividing the region into groundwater response units of similar hydrostratigraphy, recharge and surface groundwater interactions (Figure 2.2 and Table 2.4), based on an initial delineation by quaternary catchment. Quaternaries were grouped together to consider groundwater response units of similar response and characteristics.

Structural domains were also considered in dividing groundwater regions, since the coastal domain of the karoo Supergroup rocks in densely faulted, hence has a significantly higher groundwater potential than the same litholgies in the inland domain. The coastal and coastal hinterland have been affected by tilt block faulting and horst and graben structures. Extensional normal faulting, and wrench faulting give rise to some high yielding boreholes in otherwise low yielding terrain. These faults trend ENE, N-S and SW-NE. The faulting is parallel to the coast and extends almost as far inland as Ixopo, Pietermaritzburg and Greytown, and lies within the Natal Group, Natal Metamorphic Province and coastal Karoo rocks.

The groundwater regions (referred to as Groundwater response Units (GRUs)), identified were:

- *Drakensberg Escarpment: (GRUs 4 and 10): This region consists of predominantly argillaceous rocks of the Tarkastad subgroup, and the Molteno and Elliot Formations of the Karoo Supergroup, capped by Clarens sandstones and Drakensberg Basalt. The basal sandstones of the Tarkastad subgroup ofen form an escarpment of higher elevation than the underlying Adelaide subgroup. On the the high lying Drakensberg Escarpment, springs are common, especially along the Clarens/Drakensberg contact.*
- *Middelveld Karoo: (GRUs 1, 5, 6, 11, 14, 22, 27, and 30): This region consists of predominantly argillaceous rocks of the Ecca Group and Adelaide subgroup, and arenaceous rocks of the Vryheid Formation, which lies in between the Volsrust and Pietermaritzburg formations. It lies at a lower elevation than the Drakensberg Escarpment region. The Vryheid Formation forms an escarpment within this region. The median yield in the Vryheid Formation is slightly higher, 1.2 l/s compared to 0.9 l/s in the rest of the region. Fractures within the mudstones and shales tend to close once they are dewatered due to the ductility of the rock, making them prone to over exploitation. Fractures also tend to close up due to the oxidation of iron pyrite. Higher yields are associated with dolerite intrusions.*
- *Dwyka Tillites: (GRUs 2, 7, 12, 16, 28, 31, and 36): This region is underlain by fractured rocks of the Dwka Group. The median yield is only 0.15 l/s and at least 40% of boreholes are dry, consequently, this is the poorest aquifer in the study area*
- *Natal Group: (GRUs 8, 15, 20, 23, 29, and 33): This region is underlain by fractured aquifers with well developed jointing and faulting. Fault zones are of high importance for establishing high yielding boreholes. The emdina yield is 0.5 l/s and 80-90% of boreholes are successful. The Natal Group forms elevated plateaux and sheer cliffs and deep incised ravines. Many of the outcrops are fault bounded. Springs often occur at the contact between the Natal Group and the underlying Natal Metamorphic Province*
- *Natal MetaMorphice Province: (GRUs 3, 9, 13, 17, 19, 24, 32, and 35): This aquifer is crystalline and consists of fractured overlain by a saturated clayey weathered zone. The region is also highly faulted. The median yield is 0.4 l/s and success rates are 70%.*
- *Coastal Karoo: (GRUs 18, 21, 25, 26, and 34): This region consists of varied Karoo lithologies from Dwyka Group to the Vryheid Formation, faulted against Natal Group sandstones. Borehole yields are higher than in land due to the density of block faulting. On the coast the rocks are overlain by unconsolidated Quaternary sediments of the Berea red sands.*

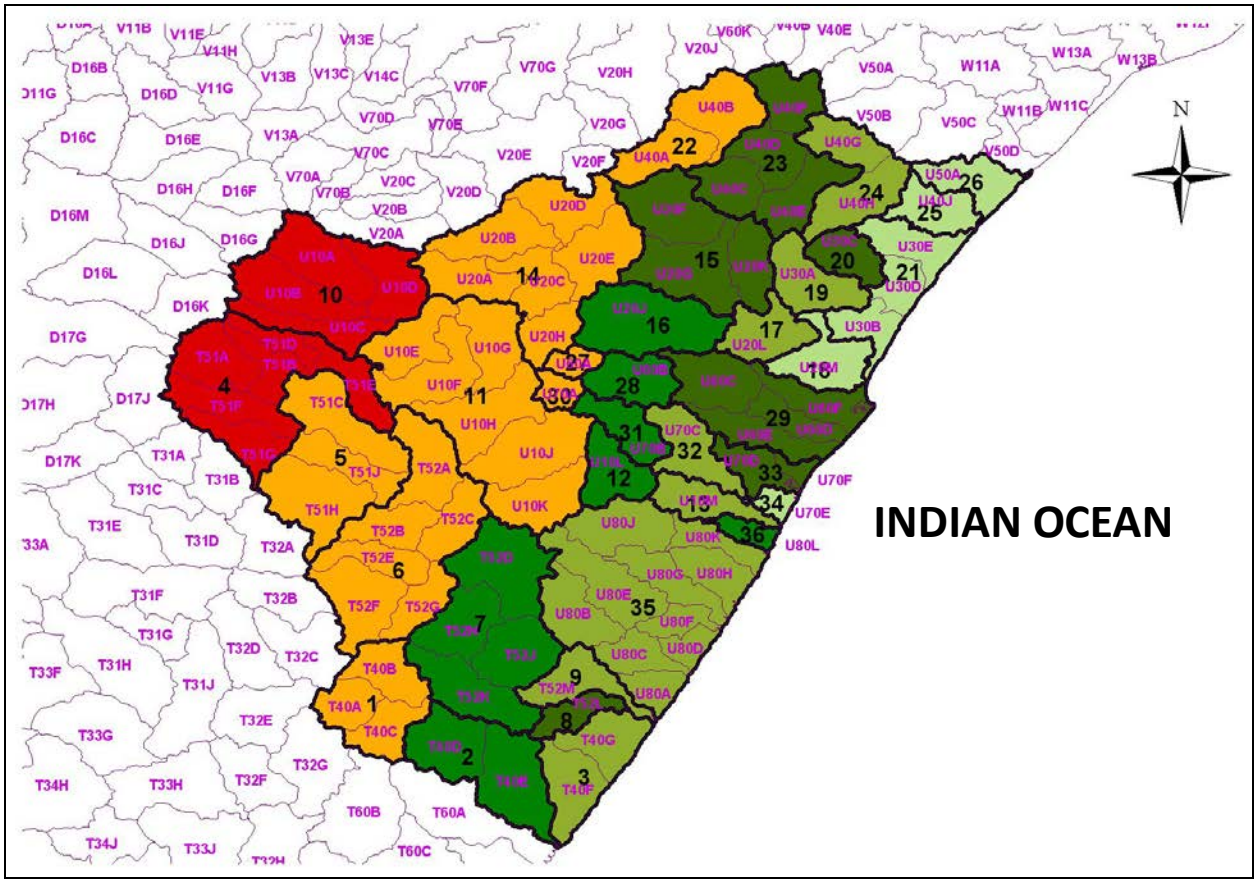


Figure 2.2 Groundwater Response Units in WMA 11

Table 2.4 Summary of Groundwater Response Units

GRU	Primary Geology	Catchment	Quats	Description
1	*Volksrust, Vryheid*	*Mtamvuna*	*T40A, T40B, T40C*	*Upper Mtamvuna*
2	*Dwyka*		*T40D, T40E*	*Lower Mtamvuna*
3	*Natal metamorphic province, Margate Terrane*	*South coast rivers*	*T40F, T40G*	*South coast*
4	*Drakensberg, Clarens, Elliot, Molteno, Tarkastad*	*Umzimkulu*	*T51A-B, T51D-E, T51F-G*	*Upper Umzimkulu escarpment zone*
5	*Adelaide, Volksrust*		*T51C, T51H, T51J*	*Upper Umzimkulu middelveld zone*
6	*Volksrust, Vryheid, Pietermaritzburg*		*T52A-C, T52E-G*	*Middle Umzimkulu*
7	*Dwyka*		*T52D, T52H-K*	*Middle Umzimkulu*
8	*Natal Group*		*T52L*	*Lower Umzimkulu*
9	*Natal Metamorphic Province*		*T52M*	
10	*Drakensberg, Ellliot, Molteno, Tarkastad*	*Mkomazi*	*U10A-D*	*Mkomazi Drakensberg Escarpment*
11	*Adelaide, Volksrust, Vryheid, Pietermaritzburg*		*U10E-K*	*Mkomazi middelveld*
12	*Dwyka*		*U10L*	*Lower Mkomazi*
13	*Natal Metamorphic Province*		*U10M*	
14	*Adelaide, Volksrust, Vryheid*	*Mgeni and Msunduze*	*U20A-E, U20H*	*Mgeni to Albert Falls, and upper Msunduze*
15	*Natal Group*		*U20F-G, U20K*	*Mgeni-Msunduze*

GRU	Primary Geology	Catchment	Quats	Description
16	Pietermaritzburg, Dwyka	Msunduze	U20J	Lower Msunduze
17	Natal metamorphic Province	Mgeni	U20L	Mgeni to Inanda dam
18	Natal Group, faulted coastal Karoo		U20M	Lower Mgeni
19	Natal Metamorphic Province, Natal group	Mdloti	U30A	Upper Mdloti
20	Natal Metamorphic Province, Natal group	Tongati	U30C	Upper Tongati
21	Coastal faulted Karoo	Tongati and Mdloti, north coast rivers	U30B, U30D-E	Lower Mdloti and Tongati
22	Vryheid, Pietermaritzburg	Mvoti	U40A-B	Upper Mvoti
23	Natal Metamorphic Province, Natal group		U40C-F	Middle Mvoti
24	Natal Metamorphic Province		U40G-H	
25	Natal Group, faulted coastal Karoo		U40J	Lower Mvoti
26	faulted coastal Karoo	North coast rivers	U50A	North coast
27	Volksrust, Vryheid, Pietermaritzburg	Mlazi	U60A	Upper Mlazi
28	Pietermaritzburg, Dwyka		U60B	
29	Natal Group, Dwyka		U60C-F	Lower Mlazi
30	Volksrust, Vryheid, Pietermaritzburg	Lovu	U70A	Upper Lovu
31	Pietermaritzburg, Natal Group		U70B	Middle Lovu
32	Natal Group, Natal Metamorphic Province		U70C	
33	Natal Group, Dwyka		U70D-F	Lower Lovu
34	Pietermaritzburg, Dwyka	Central coast rivers	U70E	Central coast
35	Natal Metamorphic Province	South and central coast rivers	U80A-K	South and Central coast rivers
36	Dwyka		U80L	

2.4.3 North Coast Rivers

NC: North Coast Rivers (U50A, U30E)

Two of the coastal quaternaries on the North Coast with similar properties (land use, small rivers originating within the quaternary) were grouped into the North Coast water resource zone. The storage regulation in this water resource zone is low and the only dams in the area include one or two small instream dams.

The area is predominantly a sugar cane farming area with most of the zone covered with dry land sugar cane plantations. There are a few small coastal towns, some slightly inland and a few rural villages. Return flows from Waste Water Treatment Works (WWTW) enter river systems in one or two cases.

The water resource zone is underlain by the coastal Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.5. Some groundwater is utilised by a municipality and rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.6.

Table 2.5 U50A and U30E: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U30E	*290*	*1008*	*89.6*	*79.6*	*28.3*	*19.2*	*60.4*
U50A	*298*	*1047*	*94.4*	*85.3*	*18.9*	*9.8*	*75.5*

1 Mean Annual Precipitation

Table 2.6 U50A and U30E: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U50A	*12.42*	*7.45*	*6.21*	*0.24*	*Municipal*
U30E	*17.63*	*8.82*	*4.41*	*0.02*	*Rural*

2.4.4 Mvoti River System

U4-1: Upper Mvoti (U40A, U40B, U40C, U40D)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The dams are of such nature that no releases are made for downstream users. Greytown is located in the upper reaches of the zone and the discharges from the town's WWTW enter the river system, affecting both the flow and water quality of the river system. The proposed Mvoti Poort Dam site is located at the lower end of the zone. There is however a more favourable dam site, lower down in the Mvoti River System (IsiThundu Dam Site), which is likely to be developed first.

The main land use activities in the zone include extensive forestry and significant amount sugar cane plantations and irrigation (sugar cane, maize etc.) also occurs. There are a few low density settlements and rural settlements located in the lower reaches.

The water resource zone is underlain by the Middelveld Karoo and Natal Group groundwater region. The aquifer recharge and discharge is given in Table 2.7. Insignificant volumes of groundwater are utilised in the water resources zone there is some potential for groundwater development in the area as shown in Table 2.8.

Table 2.7 U40A, U40B, U40C, U40D: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U40A	*317*	*915*	*92.5*	*86.0*	*26.5*	*20.1*	*65.9*
U40B	*388*	*865*	*55.9*	*48.8*	*25.7*	*19.1*	*29.7*
U40C	*264*	*876*	*60.9*	*54.5*	*25.2*	*19.2*	*35.2*
U40D	*267*	*862*	*63.3*	*52.5*	*29.6*	*19.2*	*33.3*

Table 2.8 U40A, U40B, U40C, U40D: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U40A	*2.83*	*1.41*	*1.31*	*0*	*-*

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U40B	3.78	1.89	1.75	0	-
U40C	3.22	1.61	1.48	0	-
U40D	5.06	1.52	1.52	0	-

U4-2: Middle Mvoti (U40E, U40F, U40G)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The dams are of such nature that no releases are made for downstream users. The proposed IsiThunda Dam site is located at the lower end of the zone, which is the most favourable dam site for development in the Mvoti River catchment, with a high likelihood of being developed in the short to medium term. The main land use in the zone is forestry and sugar cane (dryland and irrigated).

The water resource zone is underlain by the Natal Group and Natal Metamorphic Province groundwater regions. The aquifer recharge and discharge is given in Table 2.9. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.10.

Table 2.9 U40E, U40F, U40G: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U40E	318	835	61.0	51.7	28.7	20.0	31.7
U40F	290	838	52.8	45.4	26.1	19.1	26.2
U40G	253	890	66.4	55.4	30.7	19.8	35.6

Table 2.10 U40E, U40F, U40G: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T40E	19.93	9.96	9.34	0.04	Rural
T40F	15.96	4.79	3.42	0.02	Rural
T40G	10.52	4.21	3.61	0.03	Rural

U4-3: Lower Mvoti (U40H, U40J)

The storage regulation in this water resource zone is low but could however be impacted by future surface water resource developments planned upstream in the catchment i.e. the development of IsiThunda Dam. The town Kwadukuza (Stanger) is located in the lower end of the zone and water is abstracted directly from the Mvoti River (run of river abstraction) for supplying the town.

There is some dryland sugar cane and subsistence farming occurring in the area and there are a vast amount of low density and rural settlements located throughout the zone.

The water resource zone is underlain by the Natal Metamorphic Province and Coastal Karoo groundwater regions. The aquifer recharge and discharge is given in Table 2.11. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.12.

Table 2.11 U40H and U40J: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U40H	*361*	*916*	*74.2*	*63.9*	*29.2*	*19.8*	*44.2*
U40J	*279*	*988*	*80.7*	*70.6*	*28.8*	*19.5*	*51.2*

Table 2.12 U40H, U40J: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U40H	*19.47*	*5.84*	*3.89*	*0.08*	*Rural*
U40J	*18.67*	*9.33*	*6.53*	*0.00*	-

2.4.5 Mdloti and Tongati River System

U3-1: Upper Mdloti (U30A)

The water resource zone is regulated by the Hazelmere Dam located at the lower end of the zone. The raising of Hazelmere Dam has been approved, which will take place in the near future.

There is some dryland sugar cane located in the upper reaches of the zone. There are a large amount of low density settlements and rural settlements spread throughout the zone.

The water resource zone is underlain by the Natal Metamorphic Province groundwater region. The aquifer recharge and discharge is given in Table 2.13. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.14.

Table 2.13 U30A: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U30A	*376*	*956*	*80.9*	*70.5*	*29.3*	*19.3*	*51.1*

Table 2.14 U30A: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U30A	*30.87*	*12.35*	*10.49*	*0.04*	*Rural*

U3-2: Lower Mdloti (U30B)

The water resource zone is regulated by the upstream Hazelmere Dam. The raising of Hazelmere Dam, which will take place in the near future will have a further impact on river flows in the zone.

A large portion of the zone is occupied by urban areas (Verulam) and numerous WWTW discharges enter the Mvoti River from various WWTWs (Phoenix, Umhlanga, temporary WWTW from the King Shaka Airport) affecting both flow and water quality of the river. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on

the WWTW return flows entering the river system in the future. A significant portion of the zone is also covered by sugar cane (dryland and irrigated). There are a large amount of low density settlements and rural settlements spread throughout the zone.

The water resource zone is underlain by the Coastal Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.15. Minimal groundwater is utilised, with a potential for groundwater development shown in Table 2.16.

Table 2.15 U30B: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U30B	*221*	*971*	*84.8*	*74.1*	*30.3*	*20.1*	*54.1*

Table 2.16 U30B: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U30B	*6.09*	*3.04*	*1.22*	*0.00*	-

U3-3: Upper Tongati (U30C)

The storage regulation in this water resource zone is low with no significant dams present. There are no surface water resource developments planned in the zone area.

There is some dry land sugar cane located in towards the northern end of the zone. There are a large amount of low density settlements and rural settlements spread throughout the zone.

The water resource zone is underlain by the Natal Group groundwater region. The aquifer recharge and discharge is given in Table 2.17. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.18.

Table 2.17 U30C: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U30C	*242*	*988*	*86.2*	*76.0*	*28.8*	*19.2*	*56.7*

Table 2.18 U30C: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U30C	*16.60*	*8.30*	*4.98*	*0.05*	*Rural*

U3-4: Lower Tongati (U30D)

The water resource zone is regulated by the Dudley Pringle Dam. A Tongaat town and industries are located in the zone area discharges from the Tongaat WWTW enter the Tongati River affecting both flow and water quality of the river. There are no surface water resource developments planned in the zone area.

The area is predominantly a sugar cane farming area with most of the zone covered with dry land sugar cane plantations.

The water resource zone is underlain by the Coastal Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.19. Insignificant volumes of groundwater are utilised, with some potential for groundwater development as shown in Table 2.20.

Table 2.19 U30D: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U30D	*181*	*975*	*84.1*	*73.7*	*29.1*	*19.3*	*54.4*

Table 2.20 U30D: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U30D	*6.36*	*3.82*	*1.53*	*0.00*	-

2.4.6 The Mgeni River System

U2-1: Mgeni – Upstream of Midmar Dam (U20A, U20B, U20C)

The water resource zone is regulated by the Midmar Dam located at the lower end of the zone and there are also a number of small farm and instream dams. There is an interbasin transfer that transfers water from the Mooi River System (Mearns Weir) to the Midmar Dam catchment (Mpofana River, a tributary of the Lions River that flows into Midmar Dam) and is referred to as the Mooi-Mgeni Transfer Scheme (MMTS). This has resulted in increased flows in the effected rivers. The second phase of the MMTS is in the process of being constructed i.e. Spring Grove Dam in the Mooi River catchment, which will transfer additional volumes of water into the Midmar Dam catchment. Water is abstracted from Midmar Dam to supply Msunduzi (Pietermaritzburg) and surrounding areas.

The Mpophomeni semi-urban is located in the zone, almost adjacent to the Midmar Dam. The main land use activities in the zone include forestry, cultivation and irrigation.

The water resource zone is underlain by the Middelveld Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.21. Minimal volumes of groundwater are utilised in the water resources zone and there is some potential for groundwater development in the area as shown in Table 2.22.

Table 2.21 U20A, U20B, U20C: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20A	*293*	*1006*	*136.6*	*129.1*	*24.9*	*18.4*	*110.7*
U20B	*353*	*984*	*98.6*	*91.8*	*26.4*	*19.6*	*72.2*
U20C	*279*	*928*	*92.9*	*86.3*	*26.8*	*19.9*	*66.4*

Table 2.22 U20A, U20B, U20C: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20A	*4.44*	*2.22*	*2.11*	*0.00*	-
U20B	*4.83*	*3.38*	*2.87*	*0.00*	-
U20C	*3.79*	*2.66*	*2.26*	*0.01*	*Livestock*

U2-2: Mgeni – Midmar to Albert Falls Dam (U20D, U20E)

The water resource zone is regulated by the upstream Midmar Dam, Albert Falls Dam located at the lower end of the zone and there are also a number of small farm and instream dams. The water resource zone is regarded as highly regulated. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. There are no surface water development options planned directly in the zone but the implementation of MMTS Phase 2 will have an impact on the water resources.

Howick town and industrial area are located in the zone, just downstream of Midmar Dam. Return flows from the Howick WWTW enter the Mgeni River affecting both the flow and the water quality. The main land use activities in the zone include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation.

The water resource zone is underlain by the Middelveld Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.23. Minimal volumes of groundwater are utilised in the water resources zone, with some potential for groundwater development in the area as shown in Table 2.24.

Table 2.23 U20D, U20E: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20D	*338*	*1027*	*99.4*	*93.0*	*25.1*	*18.8*	*74.2*
U20E	*390*	*962*	*70.6*	*65.1*	*22.9*	*17.8*	*47.3*

Table 2.24 U20D, U20E: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20D	*4.60*	*2.76*	*2.34*	*0.01*	*Livestock*
U20E	*5.30*	*2.65*	*2.44*	*0.03*	*Livestock*

U2-3: Mgeni –Albert Falls Dam to Msunduze Confluence (U20F, U20G)

The water resource zone is regulated by the upstream Midmar Dam and Albert Falls Dams as well as Nagle Dam located at the lower end of the zone from where water is abstracted for the eThekwini supply area. Nagle Dam is supported from the upstream dam and the zone is regarded as highly regulated. There are also a number of small farm and instream dams in the zone. There

are no surface water development options planned directly in the zone but the implementation of MMTS Phase 2 will have an impact of the water resources.

Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the zone. The main land use activities in the zone include extensive forestry and dry land sugar cane.

The water resource zone is underlain by the Natal Group groundwater region. The aquifer recharge and discharge is given in Table 2.25. Some volumes of groundwater are utilised in the water resources zone, with some potential for further groundwater development in the area as shown in Table 2.26.

Table 2.25 U20F, U20G: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20F	*435*	*975*	*72.5*	*67.6*	*22.5*	*17.8*	*49.7*
U20G	*494*	*887*	*62.8*	*53.3*	*28.2*	*18.2*	*35.2*

Table 2.26 U20F, U20G: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20F	*16.43*	*9.86*	*5.91*	*0.03*	*Livestock*
U20G	*27.35*	*19.15*	*19.15*	*0.16*	*Rural*

U2-4: Msunduze River (U20H, U20J)

The storage regulation in this water resource zone is low. Henley Dam is located in the upper reaches of the zone, which is a relatively small dam when compared to the dams located in the Mgeni System, and there are also a number of small farm and instream dams.

A large portion of the zone is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements. Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the zone. Discharges from the Darvill WWTW (Pietermaritzburg area) enter the Msunduze River and affect the flow and especially the water quality of the river. Umgeni water is currently investigating the potential of re-using effluent from the Darvill WWTW, which could have a future impact on the Msunduze River. The possibility of implementing such a project at this stage is uncertain.

The main land use activities in the zone include extensive forestry and dry land sugar cane.

The water resource zone is underlain by the Middelveld Karoo and Dwyka tillite groundwater regions. The aquifer recharge and discharge is given in Table 2.27. Some volumes of groundwater are utilised in the water resources zone, with some potential for further groundwater development in the area as shown in Table 2.28.

Table 2.27 U20H, U20J: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20H	*220*	*933*	*99.0*	*93.5*	*25.5*	*19.7*	*73.7*
U20J	*678*	*831*	*52.7*	*45.9*	*26.9*	*20.1*	*25.8*

Table 2.28 U20H, U20J: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20H	*2.99*	*1.50*	*1.38*	*0.67*	*Rural*
U20J	*14.11*	*7.06*	*6.00*	*0.12*	*Rural*

U2-5: Mgeni – Msunduze confluence to Inanda Dam (U20K, U20L)

The water resource zone is regulated by the upstream Midmar Dam and Albert Falls Dams, Nagle Dam as well as Inanda Dam located at the lower end of the zone and is regarded as highly regulated. Abstractions are made from Inanda Dam for supplying water to the eThekwini area and the dam is supported by the upstream dams. The water quality of the Mgeni River reduces after the confluence with the Msunduze River. There are no surface water development options planned directly in the zone but the implementation of MMTS Phase 2 will have an impact on the water resources as well as the potential implementation of the Darvill re-use project.

A large portion of the zone is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area. Areas in the upper reaches of the zone are covered by extensive cultivation (dryland sugar) and forestry and dry land sugar cane.

The water resource zone is underlain by the Natal Group and Natal Metamorphic Province groundwater regions. The aquifer recharge and discharge is given in Table 2.29. Some volumes of groundwater are utilised in the water resources zone, with some potential for further groundwater development in the area as shown in Table 2.30.

Table 2.29 U20K, U20L: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20K	*271*	*940*	*70.0*	*62.4*	*28.2*	*18.7*	*43.7*
U20L	*328*	*802*	*46.1*	*43.5*	*22.6*	*20.5*	*23.1*

Table 2.30 U20K, U20L: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20K	*14.18*	*8.51*	*7.23*	*0.07*	*Rural*
U20L	*12.90*	*9.03*	*7.05*	*0.26*	*Rural*

U2-6: Mgeni – Inanda Dam to Estuary (U20M)

The water resource zone is regulated by the upstream Midmar, Albert Falls Dams, Nagle and Inanda Dam and is regarded as highly regulated. Inanda Dam is supported by the upstream dams in the Mgeni River and compensation releases are also made from Inanda Dam for environmental purposes. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. The implementation of the upstream MMTS Phase 2 as well as the potential implementation of the Darvill re-use project will have an impact on the water resources in the zone.

A large portion of the zone is semi urban area and urban in the lower reaches (eTheweni municipal area). There are a number of discharges form WWTW within the eThekwini municipal areas that enter the Mgeni River in the zone that affect both the flow and the water quality of the river.

The water resource zone is underlain by the Coastal Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.31. Insignificant volumes of groundwater are utilised in the water resources zone and there is a potential for further groundwater development in the area as shown in Table 2.32.

Table 2.31 U20M: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U20M	*360*	*917*	*71.1*	*59.7*	*31.3*	*20.1*	*39.6*

Table 2.32 U20M: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U20M	*27.00*	*16.20*	*8.10*	*0.00*	*-*

2.4.7 Central Coastal Rivers

CC: Central Coast (U60F, U70E, U70F)

Three of the coastal quaternaries in the central part of the study area with similar properties (land use, small rivers originating within the quaternary) were grouped into the Central Coast water resource zone. The storage regulation in this water resource zone is low and the only dams in the area include one or two small Instream dams.

The area is predominantly urban with some semi-urban and rural settlements. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

The water resource zone is underlain by the Natal Group and Coastal Karoo groundwater regions. The aquifer recharge and discharge is given in Table 2.33. Minimal volumes of groundwater are utilised, with a potential for further groundwater development as shown in Table 2.34.

Table 2.33 U60F, U70E, U70F: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U60F	*272*	*964*	*78.3*	*67.5*	*25.3*	*15.1*	*52.4*
U70E	*87*	*996*	*84.2*	*74.1*	*25.0*	*15.0*	*59.2*
U70F	*59*	*994*	*84.8*	*73.8*	*25.5*	*15.0*	*58.9*

Table 2.34 U60F, U70E, U70F: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U60F	*15.83*	*7.91*	*3.96*	*0.00*	*-I*
U70E	*2.09*	*1.26*	*0.50*	*0.05*	*Rural*
U70F	*2.26*	*1.13*	*0.79*	*0.00*	*-*

2.4.8 Mlazi and Mbokodweni River Systems

U6-1: Upper Mlazi (U60A, U60B, U60C)

The water resource zone is regulated by the Shongweni Dam located at the lower end of the zone and there are also a number of small farm and instream dams. There are no future surface water developments planned in the zone.

The main landuse activities include cultivation (dryland sugar cane, maize), irrigation and forestry located in the upper half of the zone. There are some low density settlements as well as semi-urban and urban areas with industries located lower half of the zone. Discharges from the Hopewell and Hammersdale (industrial area) and WWTW discharge entering the river systems affect both the flow and especially the water quality of the river.

The water resource zone is underlain by the Karoo Middelveld, Dwyka tillite and groundwater regions. The aquifer recharge and discharge is given in Table 2.35. Some groundwater is utilised the water resources zone, with a potential for further groundwater development as shown in Table 2.36.

Table 2.35 U60A, U60B, U60C: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U60A	*105*	*980*	*76.0*	*70.3*	*16.0*	*10.1*	*60.2*
U60B	*316*	*822*	*57.7*	*45.8*	*22.4*	*10.5*	*35.3*
U60C	*365*	*771*	*54.2*	*40.1*	*23.6*	*9.5*	*30.5*

Table 2.36 U60A, U60B, U60C: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U60A	*1.43*	*0.71*	*0.66*	*0.01*	*Rural*
U60B	*5.40*	*3.24*	*3.01*	*0.01*	*Livestock*
U60C	*25.07*	*12.53*	*10.65*	*0.06*	*Livestock*

U6-2: Lower Mlazi (U60D)

The water resource zone is regulated by the upstream Shongweni Dam and there are no future surface water developments planned in the zone.

The middle to upper reach of the zone is occupied by scattered rural villages and the middle to lower reach by semi-urban and urban areas. Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river. There is also a hazardous landfill site in the upper reaches of the tributaries which also affect the water quality of the Mlazi River, which is regarded as very poor. The lower end of the Mlazi River has been canalised and hence there is no estuary.

The water resource zone is underlain by the Natal Group groundwater region. The aquifer recharge and discharge is given in Table 2.37. Insignificant volumes of groundwater are utilised, with a potential for groundwater development as shown in Table 2.38.

Table 2.37 U60D: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U60D	*185*	*885*	*66.6*	*55.0*	*26.9*	*15.3*	*39.7*

Table 2.38 U60D: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U60D	*11.54*	*3.46*	*2.42*	*0.00*	*-*

U6-3: Mbokodweni (U60E)

The storage regulation in this water resource zone is low and there are no major dams present. There are no future surface water development planned in the zone. There is some sugar cane (dryland) located in the upper reaches. The middle to upper reach of the zone is occupied by scattered rural villages and the middle to lower reach by semi-urban areas, urban areas (Umlazi, Isipingo) as well as industrial areas close to the coast (Prospecton Industrial area). Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river.

The water resource zone is underlain by the Natal Group groundwater region. The aquifer recharge and discharge is given in Table 2.39. Insignificant volumes of groundwater are utilised, with a potential for groundwater development as shown in Table 2.40.

Table 2.39 U60E: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U60E	*280*	*904*	*69.7*	*57.9*	*26.4*	*15.3*	*42.6*

Table 2.40 U60E: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U60E	*16.62*	*6.65*	*3.32*	*0.03*	*Rural / Livestock*

2.4.9 Lovu River Systems

U7-1: Lovu (U70A, U70B, U70C, U70D)

The storage regulation in this water resource zone is low and the only dams include a number of small farm and instream dams. There are no future surface water developments planned in the zone.

There are extensive forestry and also sugar cane plantations located in the middle to upper reach of the zone with Richmond town and adjacent township also located in the upper reach. The middle to lower reach of the zone is occupied by scattered rural villages. Discharges from the Richmond and township area enter the river systems affecting both the flow and especially the water quality of the river.

The water resource zone is underlain by the Middelveld Karoo, Dwyka tillite, Natal Metamorphic Province and Natal Group groundwater regions. The aquifer recharge and discharge is given in Table 2.41. Minimal volumes of groundwater are utilised the water resources zone, with a potential for groundwater development as shown in Table 2.42.

Table 2.41 U70A, U70B, U70C, U70D: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U70A	*114*	*1039*	*86.4*	*80.9*	*15.2*	*9.8*	*71.1*
U70B	*272*	*849*	*61.4*	*49.5*	*26.8*	*15.5*	*34.0*
U70C	*350*	*857*	*63.4*	*51.7*	*27.1*	*15.6*	*36.1*
U70D	*208*	*936*	*74.6*	*63.7*	*25.7*	*15.3*	*48.5*

Table 2.42 U70A, U70B, U70C, U70D: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U70A	*1.55*	*0.62*	*0.57*	*0.00*	*-*
U70B	*12.36*	*4.94*	*4.20*	*0.01*	*Rural*
U70C	*22.94*	*11.47*	*9.75*	*0.01*	*Livestock*
U70D	*13.70*	*4.11*	*2.88*	*0.06*	*Rural*

2.4.10 The Mkomazi River System

U4-1: Mkomazi Mountain Zone (U10A, U10B, U10C, U10D, U10E, U10F)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. The proposed Smithfield Dam site is located at the lower end of the zone and is likely to be developed in the future. The DWA is currently in the process of conducting a feasibility study for the Mkomazi River Development

Project (Smithfield Dam) and the purpose of the project is to augment the Mgeni River supply area. The construction of Smithfield Dam will have a noticeable effect on the river flows downstream of the dam

The middle to upper reach of the zone is mainly a mountainous area, where nature reserves (Lotheni, Vergelegen, Kamberg, Highmore Nature Reserves, Mkomazi National Park) and the Sani Pass Tourism area are located. There is some agriculture and community water. The main activities in the middle to lower end of the zone include forestry, cultivation, irrigation, grazing, community water use from low density rural settlements and Bulwer Town is located in the lower end of the zone. In general there are few impacts on the river systems and the water quality can be regarded as good.

The water resource zone is underlain by the Drakensberg Escarpment and Middelveld Karoo groundwater regions. The aquifer recharge and discharge is given in Table 2.43. Some groundwater is utilised in the water resources zone and there is some potential for further groundwater development in the area as shown in Table 2.44.

Table 2.43 U10A, U10B, U10C, U10D, U10E, U10F: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U10A	*418*	*1285*	*180.8*	*178.7*	*27.9*	*25.8*	*152.9*
U10B	*392*	*1174*	*155.2*	*151.2*	*30.1*	*26.7*	*124.4*
U10C	*267*	*1089*	*136.0*	*131.3*	*32.0*	*27.3*	*103.9*
U10D	*337*	*997*	*116.3*	*111.0*	*31.8*	*26.4*	*84.5*
U10E	*327*	*1032*	*124.1*	*118.5*	*31.1*	*26.2*	*92.3*
U10F	*379*	*965*	*89.7*	*83.8*	*23.2*	*17.8*	*65.9*

Table 2.44 U10A, U10B, U10C, U10D, U10E, U10F: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U10A	*7.12*	*2.14*	*1.82*	*0.00*	*-*
U10B	*6.78*	*2.03*	*1.73*	*0.03*	*Rural / Livestock*
U10C	*4.44*	*1.33*	*1.13*	*0.02*	*Rural / Livestock*
U10D	*5.50*	*1.65*	*1.40*	*0.01*	*Rural*
U10E	*4.83*	*1.45*	*1.38*	*0.07*	*Rural*
U10F	*5.51*	*1.65*	*1.57*	*0.19*	*Rural*

U4-2: Middle Mkomazi (U10G, U10H, U10J, U10K)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource zone.

The land use activities in the zone include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. The small town Ixopo is also located in the zone.

The water resource zone is underlain by the Middelveld Karoo groundwater region. The aquifer recharge and discharge is given in Table 2.45. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.46.

Table 2.45 U10G, U10H, U10J, U10K: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U10G	*353*	*983*	*97.8*	*93.0*	*22.3*	*17.6*	*75.3*
U10H	*458*	*926*	*88.3*	*83.5*	*22.1*	*17.3*	*66.2*
U10J	*505*	*880*	*54.7*	*49.0*	*23.4*	*17.9*	*31.0*
U10K	*364*	*795*	*42.4*	*37.8*	*21.9*	*17.9*	*19.9*

Table 2.46 U10G, U10H, U10J, U10K: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U10G	*4.89*	*1.47*	*1.25*	*0.03*	*Rural*
U10H	*6.23*	*2.49*	*2.49*	*0.20*	*Rural*
U10J	*6.87*	*2.06*	*1.65*	*0.02*	*Rural*
U10K	*4.95*	*3.47*	*3.47*	*0.00*	*-*

U4-3: Mkomazi George Zone (U10L, U10M)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource zone.

The landuse activities are predominantly community water use from low density rural settlements and there is also an abstraction for Sappi Saiccor in the lower end of the zone.

The water resource zone is underlain by the Dywka tillite and Natal Metamorphic Province groundwater regions. The aquifer recharge and discharge is given in Table 2.47. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development shown in Table 2.48.

Table 2.47 U10L, U10M: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U10L	*307*	*760*	*43.2*	*35.2*	*27.0*	*19.7*	*15.5*
U10M	*280*	*860*	*56.2*	*48.9*	*26.7*	*20.4*	*28.5*

Table 2.48 U10L, U10M: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U10L	*12.41*	*4.96*	*4.96*	*0.03*	*Rural*
U10M	*9.70*	*2.91*	*1.75*	*0.17*	*Rural*

2.4.11 Southern Coastal Rivers

SC: South Coast (T40F, T40G, U80A, U80D, U80G, U80H, U80J, U80K, U80L)

Nine of the coastal quaternaries in the central part of the study area with similar properties (land use, small rivers originating within the quaternary) were grouped into the South Coast water resource zone. The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams.

Landuse activities in the water resources zones generally include cultivation (mostly sugar cane with some orchards) and some forestry plantations slightly inland. Rural settlements are usually located more inland with semi-urban and urban areas towards the coast. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

The water resource zone is underlain by Natal Metamorphic Province and Dwyka tillite groundwater regions. The aquifer recharge and discharge is given in Table 2.49. Some groundwater is utilised for rural supply, with a potential for further groundwater development as shown in Table 2.50.

Table 2.49 T40F, T40G, U80A, U80D, U80G, U80H, U80J, U80K, U80L: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
T40F	*335*	*1069*	*111.1*	*107.5*	*17.7*	*14.3*	*93.3*
T40G	*300*	*1054*	*107.4*	*103.9*	*18.0*	*14.4*	*89.6*
U80A	*158*	*1034*	*90.2*	*80.1*	*24.1*	*14.8*	*65.5*
U80D	*120*	*1045*	*92.0*	*82.1*	*24.1*	*14.7*	*67.5*
U80G	*415*	*829*	*60.0*	*47.9*	*27.8*	*15.5*	*32.5*
U80H	*137*	*932*	*73.6*	*62.9*	*26.1*	*15.2*	*47.8*
U80J	*261*	*936*	*74.2*	*63.5*	*25.8*	*15.2*	*48.4*
U80K	*243*	*1010*	*85.5*	*75.9*	*24.4*	*14.9*	*61.2*
U80L	*371*	*838*	*61.4*	*49.1*	*27.7*	*15.5*	*33.7*

Table 2.50 T40F, T40G, U80A, U80D, U80G, U80H, U80J, U80K, U80L: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T40F	*15.96*	*4.79*	*3.42*	*0.02*	*Rural*
T40G	*10.52*	*4.21*	*3.61*	*0.03*	*Rural*
U80A	*5.42*	*2.71*	*1.50*	*0.37*	*Rural*
U80D	*3.57*	*1.43*	*1.24*	*0.11*	*Rural*
U80G	*14.60*	*5.84*	*4.59*	*0.10*	*Rural*

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U80H	8.45	2.53	2.53	0.03	Rural
U80J	17.75	5.32	4.50	0.09	Rural
U80K	5.89	1.77	0.96	0.07	Rural
U80L	2.58	0.77	0.35	0.05	Rural

2.4.12 Mzumbe and Mtwalume River Systems

U8-1: Mzumbe (U80B, U80C)

The storage regulation in this water resource zone is low with no significant dams present. There are no future surface water developments planned in the zone.

The water resource zone is predominantly rural with scattered rural villages located throughout. There is some forestry and cultivation located in the upper reach of the zone.

The water resource zone is underlain by Natal Metamorphic Province groundwater regions The aquifer recharge and discharge is given in Table 2.51. Some groundwater is utilised in the water resources zone, with a potential for groundwater development as shown in Table 2.52.

Table 2.51 U80B, U80C: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U80B	339	799	56.6	43.9	28.4	15.6	28.4
U80C	202	959	77.9	67.1	25.4	15.1	52.1

Table 2.52 U80B, U80C: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U80B	10.68	3.20	3.20	0.07	Rural
U80C	7.27	2.91	2.91	0.23	Rural

U8-1: Mtwalume (U80E, U80F)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. There are no future surface water developments planned in the zone.

Land use activities in the water resources zones generally include cultivation and some forestry in the middle and upper reaches. Rural villages are also scattered throughout the zone with semi-urban and urban areas located along the coast.

The water resource zone is underlain by Natal Metamorphic Province groundwater region. The aquifer recharge and discharge is given in Table 2.53. Some groundwater is utilised in the water resources zone, with a potential for groundwater development as shown in Table 2.54.

Table 2.53 U80E, U80F: Aquifer recharge and discharge

Quat	Area (km^2)	MAP[1] (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
U80E	415	829	60.0	47.9	27.8	15.5	32.5
U80F	137	932	73.6	62.9	26.1	15.2	47.8

Table 2.54 U80E, U80F: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
U80E	18.05	5.42	3.79	0.14	Rural
U80F	4.52	1.36	1.36	0.16	Rural

2.4.13 The Umzimkulu River System

T5-1: Upper Umzimkulu Mountain Zone (T51A, T51B, T51C, T51D, T51E, T51F, T51G, T51H)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. There are no surface water developments planned in the zone.

The upper reach of the zone is mainly a mountainous area below which the zone is mainly characterised by agricultural activities including extensive forestry, extensive irrigation, cultivation, dairy, cattle and sheep farming. Some parts of the zone are rural with some community water use from the scattered rural villages. Subsistence farming is practised in these areas. The towns Underberg and Himeville are also located in the zone and return flows as the volumes are not that large.

The water resource zone is underlain by Drakensberg Escarpment and Middelveld Karoo groundwater regions. The aquifer recharge and discharge is given in Table 2.55. Some groundwater is utilised in the water resources zone and there is some potential for further groundwater development in the area as shown in Table 2.56.

Table 2.55 T51A, T51B, T51C, T51D, T51E, T51F, T51G, T51H: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
T51A	328	1255	166.4	166.1	5.7	5.9	160.0
T51B	210	1175	145.2	144.7	6.5	6.1	138.4
T51C	462	948	91.6	89.8	9.0	7.5	82.3
T51D	142	1229	159.1	159.0	6.3	6.0	152.8
T51E	256	953	92.6	90.9	9.1	7.5	83.4
T51F	307	1137	129.8	128.8	7.0	6.3	122.2
T51G	256	1082	117.3	115.7	7.6	6.5	109.0
T51H	520	943	90.7	88.8	8.9	7.5	81.3

Table 2.56 T51A, T51B, T51C, T51D, T51E, T51F, T51G, T51H: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T51A	*5.50*	*2.75*	*2.34*	*0.03*	*Livestock*
T51B	*3.71*	*2.23*	*1.89*	*0.02*	*Livestock*
T51C	*7.06*	*3.53*	*3.53*	*0.12*	*Rural*
T51D	*2.48*	*1.74*	*1.48*	*0.01*	*Livestock*
T51E	*4.14*	*1.66*	*1.41*	*0.10*	*Rural*
T51F	*5.08*	*3.05*	*3.05*	*0.03*	*Livestock*
T51G	*4.40*	*2.20*	*1.87*	*0.01*	*Livestock*
T51H	*7.58*	*3.79*	*3.22*	*0.00*	*-*

T5-2: Middle Umzimkulu and Mzimkhulwana tributary (T52A, T52B, T52C, T52D, T52E, T52F, T52G, T52H)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. A surface water development planned for the area is the Cwabeni off-channel dam with abstraction from a new weir on Umzimkulu River for regional water supply, which will have some effect on the flows.

The land use activities in the zone include extensive forestry concentrated in the higher rainfall areas, irrigation on the upper reaches, cultivation, cattle farming and subsistence farming. There is community water use by a number of rural settlements. The towns Creighton and UUmzimkulu are also located in the zone.

The water resource zone is underlain by the Middelveld Karoo and Dwyka tillite groundwater regions. The aquifer recharge and discharge is given in Table 2.57. Some groundwater is utilised by rural villages in the water resources zone, with a potential for further groundwater development as shown in Table 2.58.

Table 2.57 T52A, T52B, T52C, T52D, T52E, T52F, T52G, T52H: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
T52A	*382*	*902*	*89.1*	*86.8*	*8.9*	*7.5*	*79.3*
T52B	*256*	*877*	*84.1*	*81.8*	*9.3*	*7.6*	*74.2*
T52C	*261*	*832*	*75.4*	*73.2*	*9.8*	*7.8*	*65.3*
T52D	*531*	*792*	*54.5*	*46.4*	*16.4*	*8.4*	*38.0*
T52E	*233*	*899*	*92.8*	*86.2*	*13.7*	*7.4*	*78.7*
T52F	*418*	*904*	*93.9*	*87.2*	*13.4*	*7.4*	*79.8*
T52G	*221*	*899*	*92.8*	*86.2*	*13.7*	*7.4*	*78.7*
T52H	*344*	*779*	*47.4*	*44.6*	*7.5*	*4.3*	*40.4*

Table 2.58 T52A, T52B, T52C, T52D, T52E, T52F, T52G, T52H: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T52A	*5.20*	*2.60*	*1.95*	*0.15*	*Rural*
T52B	*3.48*	*1.74*	*1.48*	*0.00*	*-*
T52C	*3.55*	*2.48*	*2.29*	*0.00*	*-*
T52D	*7.71*	*3.86*	*3.86*	*0.03*	*Rural*
T52E	*3.17*	*1.58*	*1.35*	*0.00*	*-*
T52F	*5.68*	*2.84*	*2.42*	*0.00*	*-*
T52G	*3.01*	*1.50*	*1.38*	*0.00*	*-*
T52H	*5.05*	*2.53*	*2.33*	*0.00*	*-*

T5-3: Lower Umzimkulu (T52J, T52K, T52L, T52M)

The storage regulation in this water resource zone is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The upstream development of the Cwabeni off-channel dam with abstraction from a new weir on Umzimkulu for regional water supply will have some effect on the flows.

The land use activities include extensive forestry and sugar cane, Oribi George Nature Reserve, natural areas with grazing, and run of river abstraction or regional water supply to rural villages. The town Harding is also located in the zone. Industrial activities include limestone mining and the Illovo Umzimkulu sugar mill in the lower reach, which abstracts water directly from the Umzimkulu River just upstream of the estuary.

The water resource zone is underlain by the Dwyka tillite, Natal Group and Natal Metamorphic Province groundwater regions. The aquifer recharge and discharge is given in Table 2.59. Some groundwater is utilised for rural and municipal purposes in the water resources zone, with a potential for further groundwater development as shown in Table 2.60.

Table 2.59 T52J, T52K, T52L, T52M: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
T52J	*368*	*827*	*63.1*	*55.7*	*11.3*	*4.2*	*51.6*
T52K	*426*	*804*	*59.3*	*52.1*	*11.6*	*4.2*	*48.0*
T52L	*179*	*894*	*74.6*	*68.7*	*42.6*	*37.2*	*31.7*
T52M	*313*	*903*	*73.9*	*68.8*	*20.8*	*15.5*	*53.4*

Table 2.60 T52J, T52K, T52L, T52M: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T52J	*7.80*	*2.34*	*2.34*	*0.01*	*Rural*
T52K	*5.79*	*2.90*	*2.57*	*0.34*	*Municipal*
T52L	*13.41*	*6.71*	*6.37*	*0.20*	*Rural*
T52M	*12.29*	*4.92*	*3.93*	*0.15*	*Rural*

2.4.14 Mtamvuna River System

T4-1: Mtamvuna (T40A, T40B, T40C, T40D, T40E)

The storage regulation in this water resource zone is low with no noticeable dams located in the area. There are no surface water developments planned in the zone.

The land use activities include extensive forestry in the upper reaches and some cultivation in the lower reaches. The zone is predominantly rural with a large number of scattered rural and informal settlements supplied from regional water abstractions.

The water resource zone is underlain by the Middelveld Karoo and Dwyka tillite groundwater regions. The aquifer recharge and discharge is given in Table 2.61. Insignificant volumes of groundwater are utilised in the water resources zone, with a potential for future groundwater development as shown in Table 2.62.

Table 2.61 T40A, T40B, T40C, T40D, T40E: Aquifer recharge and discharge

Quat	Area (km^2)	MAP (mm/a)	Recharge (mm/a)	Baseflow (mm/a)	Aquifer recharge (mm/a)	Groundwater baseflow (mm/a)	Interflow (mm/a)
T40A	*208*	*997*	*117.0*	*113.1*	*6.9*	*3.6*	*109.6*
T40B	*278*	*981*	*115.0*	*109.2*	*9.6*	*3.6*	*105.7*
T40C	*237*	*831*	*84.4*	*77.0*	*11.6*	*3.9*	*73.0*
T40D	*372*	*816*	*58.9*	*51.6*	*11.0*	*4.2*	*47.4*
T40E	*486*	*822*	*64.1*	*56.7*	*15.5*	*8.3*	*48.5*

Table 2.62 T40A, T40B, T40C, T40D, T40E: Groundwater exploitation potential and current use

Quat	Harvest potential (million m^3/a)	Exploitation potential (million m^3/a)	Utilisable exploitation potential (Potable) (million m^3/a)	Current use (million m^3/a)	Main water use sector
T40A	*2.83*	*1.41*	*1.31*	*0.00*	*-*
T40B	*3.78*	*1.89*	*1.75*	*0.00*	*-*
T40C	*3.22*	*1.61*	*1.48*	*0.00*	*-*
T40D	*5.06*	*1.52*	*1.52*	*0.00*	*-*
T40E	*19.93*	*9.96*	*9.34*	*0.04*	*Rural*

3 STATUS QUO ASSESSMENT: ECONOMICS

3.1 INTRODUCTION

The economic analysis consists of the status quo of the current economic activities as well as the situational analysis of the current prevailing social economic position in the Mvoti to Umzimkulu Water Management Area (WMA) concerning the large water users such as irrigation agriculture, commercial forestry, sugar and saw mills and tourism as well as the other dependents. Although the tourism sector is an indirect water user and also not a large water user it is included in the analyses as the value of water to the sector in its natural environment, lies in the attraction that the water and environment has for the tourist and thus provides for the sustainability of the industry. This applies to the coastal as well as the inland tourists for the evaluation of their holiday and leisure environment.

Each catchment is divided into regions of economic activities, which takes into consideration climatic and topographic issues, and therefore is evaluated as Economic Regions (ER). The economic value of water use for each economic sector is determined.

This then provides a tool to create an appropriate economic baseline, against which to measure the possible impact of changes in water availability by means of scenarios. Thereby the macro-economic impact of any possible water reduction on the individual producers, the community and the economy in the Mvoti to Umzimkulu WMA can then be determined.

3.2 APPROACH

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

3.2.1 Macro-economic Models

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

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

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

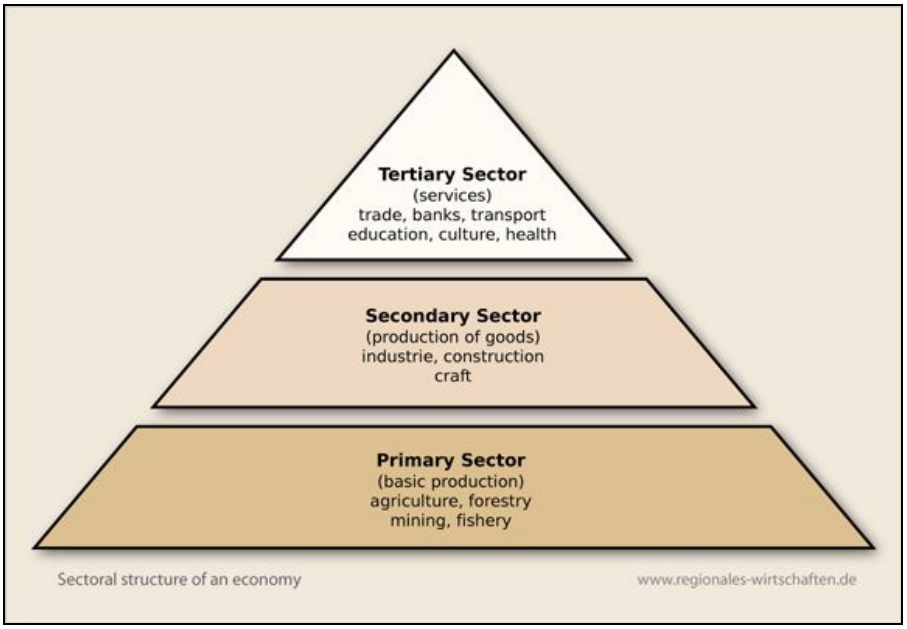


Figure 3.1 Sectoral structure of an economy

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

- *Commercial Forestry:*
  - *Saw mills;*
  - *Pulp factories; and*
  - *Wattle bark unit.*
- *Sugar cane – sugar mills.*

3.2.2 Water Impact Model (WIM)

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

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

The approach to calculate the macro-economy of each of the ERs in the WMA was to identify and establish the detailed water users in terms of volume used. The main inputs required for the irrigation agriculture and forestry model is the water volumes and number of hectares. Dry land sugar cane production was included as the sugar mills are large water users and the primary production feed into the secondary production sector. Specific crop production budgets were incorporated to the WIM underpinned by the SAM.

A WIM was constructed for the catchment which included the identified ERs. The output of the model provides direct, indirect and induced results for irrigation agriculture and commercial forestry. For agriculture the model can accommodate up to twenty different products and for forestry it provides for pine, gum and wattle sub-species. An example of the direct, indirect and induced effects explained by means of the agricultural sector is:

- *Direct effect: Refers to effects occurring directly in the agriculture sector such as the hectares cultivated impacts.*

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

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

- *GDP.*
- *Payments to Households, specifically low income households and total households.*
- *Employment creation.*

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

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

3.2.3 Production Economic Modelling

The main and large water industries in the secondary sectors were the sugar mills and saw mills, as well as the pulp and beverages factories. The inputs used for the production modelling for the secondary and tertiary sectors were estimated income and direct employment. For the tertiary sector, tourism impacts were determined. Inputs required were the estimated number of beds sold, income per annum and there direct employment created. These inputs were then added to the economic model. In the model a SAM structure that consists of the Standard Industrial Classification (SIC) synthesise the production value. This production was then multiplied by the different economic production multipliers to produce the economic parameters. As in the WIM, output economic parameters are:

- *GDP.*
- *Payments to Households.*
- *Employment Creation.*

3.3 DESCRIPTION OF ECONOMICS

3.3.1 Economic Regions

For purposes of the study the following production regions have been identified in the relevant quaternary sub-catchments. These regions conform to the ERs and secondary catchments of WMA 11 and are referred to as ERs in the report:

- *ER 1: Mvoti (U40, U50).*
- *ER 2: Mdloti (U30).*
- *ER 3: Mgeni (U20).*
- *ER 4: Mlazi and Lovu (U60, U70).*
- *ER 5: Mkomazi (U10).*
- *ER 6: Mpambanyoni to Mzumbe or South Coast (U80).*
- *ER 7: Umzimkulu (T51-T52).*
- *ER 8: Mtamvuna (T40).*

Refer to Figures 8.2 to 8.4 for representative secondary catchments.

3.3.2 Land Use

The economic significance of water uses in the Mvoti to Umzimkulu WMA is dominated by primary sectors such as irrigated agriculture and commercial forestry, subsequently by secondary industries in particular saw and sugar mills as well as a pulp and paper factories. Tertiary flow of the economy represents the tourism sector.

The Mvoti to Umzimkulu (WMA) has distinct socio-economic characteristics. The WMA covers the very important economic hubs of eThekwini Metropolitan Municipality (Durban) and Msunduzi Local Municipality (Pietermaritzburg) which together represent more than 60% of the industrial output of the KwaZulu-Natal (KZN) Province.

It is also a very important agricultural region hosting large sugar cane production areas throughout the WMA with the accompanying sugar mills. A large variety of other agricultural products are produced varying from beef and dairy production in the inland areas to crop and horticultural production in both the coastal and inland areas.

This area also includes some of the most popular tourist and holiday areas in the country varying from a number of coastal holiday towns/resorts, Durban beaches and inland tourist destinations such as the Drakensberg region and very popular game parks.

The Durban port together with the N3 highway, accompanying railway and fuel lines are the most important transport nodes in the country.

There are two major cities in the WMA, namely Durban and Pietermaritzburg, and a number of minor urban settlements spread along the coastline, including holiday towns such as Uvongo, Margate, Port Edward, Port Shepstone and Ballito, as well as inland towns such as Ixopo, Underberg, Himeville, Richmond and Greytown.

Most of the land is used for forestry, agriculture and grassland with some areas devoted to game and nature parks. The agriculture found in this WMA includes vast production of sugar cane (both dry land and irrigated), bananas and other sub-tropical fruit (found on the south coast), citrus (farmed near Stanger and Darnall on the north coast and Richmond inland), and vegetables, beef and dairy pastures. Most irrigators utilise sprinkler irrigation systems, but there is some micro irrigation along the coastline and a few centre pivots can be found in the Nottingham Road area in the Mgeni catchment. There are a large number of game reserves and nature parks. The largest of these is the Drakensberg Reserve area and others of note are situated at Weenen and Karkloof.

Although the Mgeni catchment is, in terms of the KZN region, an important component, the other catchments all make an important contribution to the provincial economy which will be expressed as economic regions:

- *Mvoti catchment is an important sugar producing area complimented by commercial forestry and mixed farming in the upper reaches of the river. The larger towns are Stanger, Darnell and Greytown.*
- *Mdloti catchment is also an important catchment in terms of sugar cane production and includes the town of Tongaat.*
- *Mgeni catchment hosts large timber and sugar cane plantations feeding the saw and sugar mills and includes urban centres such as Howick, Pietermaritzburg and Wartburg.*

- *Mlazi and Lovu catchment include the southern area of the eThekwini Metropolitan and is for the rest mostly rural with some sugar cane production in the inland areas.*
- *Mkomazi catchment is at this stage relatively undeveloped, but with the planned dam to supplement Durban's water supply the situation might change. A fair amount of forestry occurs in the catchment and a large chemical cellulose producing factory is located at the mouth of the Mkomazi River.*
- *Mpambanyoni to Mzumbe or upper South Coast is overwhelmingly rural in the inland area with some mixed farming and commercial forestry. On the coastal side there are large sugar production estates with a number of holiday resorts.*
- *Umzimkulu catchment starts in the Drakensberg area of Underberg, a mixed farming area followed by commercial forestry and communal land. Port Shepstone is the largest coastal town on the South Coast with a sugar cane mill.*
- *Mtamvuna River forms the boundary with the Eastern Cape Province. It is a very popular holiday area with some banana and sugar cane production.*

3.4 STATUS QUO ASSESSMENT

3.4.1 Socio Economic Situational Analysis

To have a complete picture of the Water Management Area (WMA) it is necessary that an analysis be provided of the socio economic situation. This is also important when assessing the impact of the water based economic activities and possible impact of identified scenarios at a later stage of the project.

The KwaZulu-Natal province is divided into 10 district municipalities, of which five are represented in the WMA. The five district municipalities in the WMA are:

- *Ethekwini*
- *UMgungundlovu*
- *Ugu*
- *ILembe*
- *Sisonke partially*

The following graph (Figure 3.2) provides an analysis of the population distribution in the 10 district municipalities in the province.

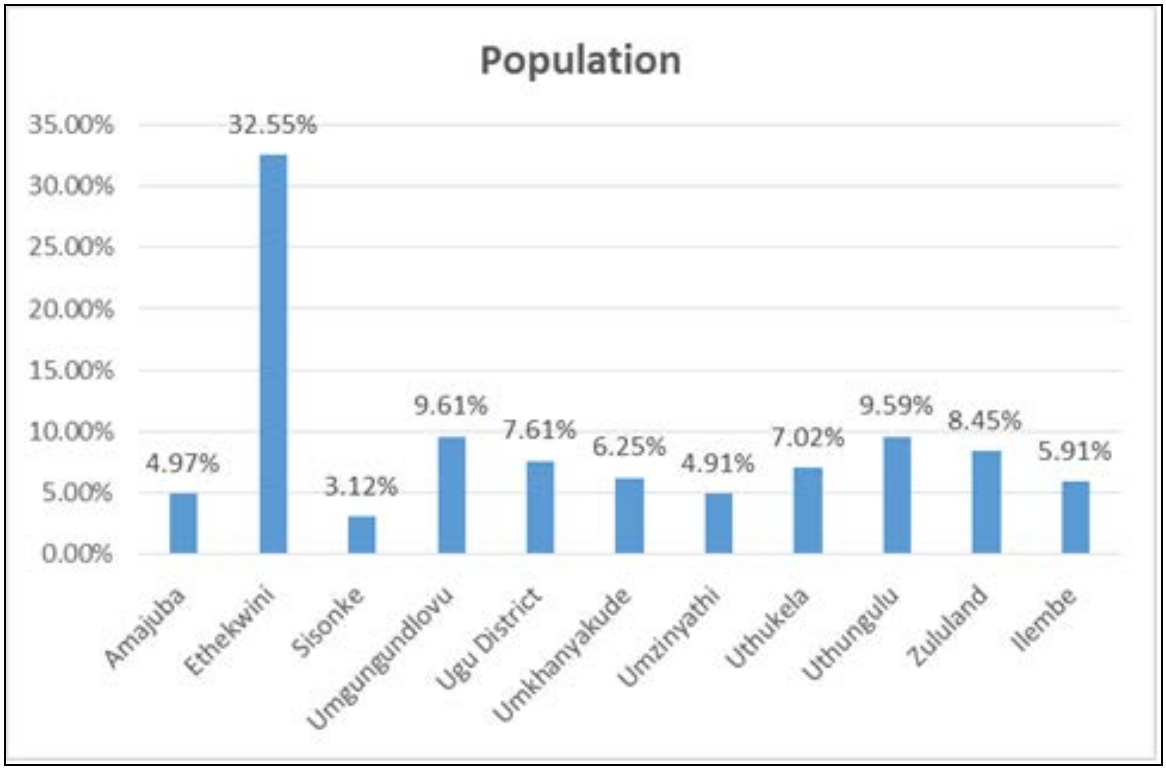


Figure 3.2 Distribution of the provincial population per district municipality[1]

From Figure 3.2 it appears that about 32.5% of the provincial population live in the Ethekwini municipal area. Out of the total provincial population around 58% is resident in the WMA.

According to the Statistics Sout Africa (2013) the provincial unemployment rate is around 21%, which converts to about 2.52 million individuals. Although no exact figures are available it is generally assumed that the unemployment rate in the rural areas is higher than in the urban areas. A country wide analysis per population group indicates the differences between the groups in terms of unemployment:

- *Blacks – 28.8%*
- *Coloureds – 23.3%*
- *Asians – 12.3%*
- *Whites – 7.2%*

The situation in KZN in terms of black unemployment is better that in the rest of the country as the provincial unemployment rate of 21% compares favorably with the national rate 25%. Although no provincial breakdown in terms of race groups are available.

It is of course primarily the socio-economic features of a province which shapes the developmental challenge. In KwaZulu-Natal, despite the concerted efforts of the Provincial Government to address the twin challenges of poverty and unemployment in the first two decades of democracy, poverty and unemployment rates have remained chronic and rising. KwaZulu-Natal remains a predominantly rural province, with dependency ratios and poverty levels highest in the rural areas, although the greatest numbers of poor people (poverty density) are to be found in the major urban centres.

[1] *Provincial Growth and Development Strategy.*

The following Table provides an indication of the household sizes and number of female headed households in the five district municipality areas falling in the WMA.

Table 3.1 Number of members per household and female headed households

District Municipality	Number of members per Household	Female Headed Households
Ethekwini	*3.04*	*37.8%*
Sisonke	*4.02*	*46.7%*
UMgungundlovu	*3.88*	*45.6%*
Ugu District	*4.36*	*53.5%*
ILembe	*4.39*	*48.4%*

Table 3.1 shows that the households with the smallest number of members are in Ethekwini, which is a mostly urban area with the rural municipalities, the higher number. An indication of the poor state of households is the large number headed by females, varying between 37.8% and 53.5% per district municipality. According to a 2005 estimation, 54% of the population can be classified as poor, with 23% of these below the so called poverty line. In terms of household income the province compares negatively with the average national figure, the provincial average annual household income is R83 050 compared to the national figure of R103 195[2].

The analysis above indicates that inequalities exist in the provincial economy and there is also a legacy of inequitable spatial development. This has had a negative impact on public and private sector investment as highlighted by the provincial National Spatial Development Perspective (NSDP). This is also evident in the lopsided economic and social costs for poor communities in locations far from employment and other opportunities. It is also evident in the very large proportion of the population residing in the Ethekwini area and therefor the importance of the economic contribution of the region.

The above socio economic realities must be taken into account when evaluating the dependency on water based economic activities in terms of employment and payments to households, specifically low income households. This applies for the base line situation as well as the evaluation of scenarios.

3.4.2 Economic Baseline

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

As an example the production of irrigation sugar cane is directly dependant on the availability of irrigation water which has a backward linkage to the suppliers of required agricultural commodities, and forward linkages to the sugar mills products of which is to be exported or used in the manufacturing in other products such as Coca-Cola. All of these in turn again have backward linkages.

[2] *Source: Stats SA 2011 Census*

The land use of the different sectors to be assessed is discussed below.

3.4.3 Physical Data

Irrigation Area

The irrigation data used was obtained from a number of sources. The total irrigated hectares were sourced from Water Resources of South Africa, and the economic contribution was calculated using the Conningarth internal database and production budgets updated to 2012 prices. The final areas were brought in line with the data received from the Water User Associations.

In Table 3.2 the total irrigation hectares, as used per economic region in the analysis for the WMA are presented.

As irrigation agriculture is very dynamic and the crop composition differs from year to year it was necessary to group some of the crops together and reduce the number of crops to ten crop types. Depending on the importance of the specification of crops, twenty different crop types can be presented and individual results produced.

Table 3.2 Summarised crop areas under irrigation in the WMA (adapted by Mosaka Economists (2005))

Crop	ER 1	ER 2	ER 3	ER 4	ER 5	ER 6	ER 7	ER 8	Total
	Number of hectares (ha)								
Bananas	-	*305*	-	*48*	*305*	*302*	*466*	*282*	**1 709**
Citrus (Valencias)	-	-	-	-	*686*	*38*	*311*	*31*	**1 066**
Dry land sugar cane	*18 562*	*19 833*	*32 071*	*20 370*	*6 059*	*31 379*	*16 424*	*5 850*	**150 547**
Irrigated sugar cane	*1 438*	*3 767*	*4 029*	*1 131*	*1 981*	*781*	*1 126*	-	**14 253**
Maize	*3 236*	-	*645*	*81*	*610*	-	-	-	**4 571**
Pastures	*719*	*1 018*	*2 015*	-	*2 438*	*101*	*1 359*	-	**7 650**
Potatoes	-	-	*322*	*162*	*991*	-	*466*	-	**1 941**
Soya beans	*863*	-	*322*	-	-	-	-	-	**1 185**
Wheat	*431*	-	*242*	*113*	-	-	-	-	**786**
Winter Vegetables	*503*	-	*483*	*81*	*610*	*38*	*155*	-	**1 870**
Total	**25 753**	**24 923**	**40 129**	**21 985**	**13 679**	**32 639**	**20 308**	**6 163**	**185 578**

The most dominant crop is sugar cane with a total of approximately 164 000 ha of which dry land agriculture constitutes almost 90%. About 7 700 ha of pastures is being cultivated in the WMA. The most hectares identified were in the Mgeni ER with about 40 000 ha.

Commercial Forestry

Different sources show different areas being under commercial plantation in the Mvoti to Umzimkulu WMA as areas are harvested and replanted. In Table 3.3 the commercial forestry areas are presented per economic region.

Table 3.3 Commercial forestry areas (adapted by Mosaka Economists (2005))

Tree Species	ER 1	ER 2	ER 3	ER 4	ER 5	ER 6	ER 7	ER 8	Total
	Number of ha								
Pine	*29 108*	*495*	*26 720*	*10 418*	*16 334*	*9 733*	*22 884*	*6 792*	**122 484**
Gum	*13 949*	*237*	*12 804*	*4 992*	*16 881*	*10 059*	*23 650*	*7 019*	**89 592**
Wattle	*14 583*	*248*	*13 386*	*5 219*	*3 245*	*1 934*	*4 546*	*1 349*	**44 510**
Total	**57 640**	**980**	**52 910**	**20 630**	**36 460**	**21 726**	**51 080**	**15 160**	**256 586**

The WMA comprises of almost 50% pine followed by 35% gum (Eucalyptus) and the remainder of the tree species being wattle. The major percentage of commercial forestry is situated in the Mvoti, Mgeni and Umzimkulu ERs. After trees are refined to saw logs, the logs are transported to saw and/or paper mills for further synthesising to the wood and paper products which is exported in certain instances.

Industry: Sugar and Saw Mills

Sugar Mills

Between the sugar mills and the sugar cane producers there exists a symbiotic relationship, they are interdependent on one another. The mill is the only buyer of cane; the mill cannot produce if there is no cane. The sugar cane is transported from the farms to the sugar mills where the cane is processed into raw sugar and bagasse. There are nine sugar mills in the WMA as defined in Table 3.4 (adapted from the South African Sugar Association (SASA)).

Table 3.4 Sugar mills occurring in WMA 11

Economic Region	Sugar Mill
1. Mvoti	*Darnall Mill, Noodsberg Mill and Union Co-op (Dalton) Mill*
2. Mdloti	*Gledhow Mill, Maidstone Mill (Tongaat)*
4. Mlazi and Lovu	*Eston Mill*
6. South Coast	*Sezela Mill*
7. Umzimkulu	*Umzimkulu Mill*

The mill door price that was used to determine the turnover for the different ERs was approximately R4 300/ton raw sugar estimated for January 2013.

Saw Mills

During the research it became clear that the saw mills in the ERs differ in size, but more importantly it was very difficult to isolate the region that acted as the source for a specific sawmill, as saw logs were moved from one mill to the other and across ER boundaries. A theoretical sawmill model per ER was therefore developed to accommodate the wood produced per specific region. The average growth per hectare per annum was multiplied with the number of hectares per economic region, which was used as the input for the saw mill model; an average recovery rate was used together with the average mill door price to establish a turnover per region. However it was ensured that no double counting took place and that the final results were represented correctly in the appropriate region.

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

- *Average Annual Mass Increase – Gum – 12.91 tons per ha;*
- *Average Annual Mass Increase – Pine – 16.72 tons per ha; and*
- *Average Annual Mass Increase – Wattle – 12.59 tons per ha.*

The respective turnovers for the three regions and employment, as used in the WIM model are presented in Table 3.5.

Table 3.5 Estimated saw mill turnovers (2012 prices)

Economic Region	Annual turnover (R mil)
1. Mvoti (U40,U50)	*R 593*
2. Mdloti (U30)	*R 10*
3. Mgeni (U20)	*R 545*
4. Mlazi and Lovu (U60, U70)	*R 212*
5. Mkomazi (U10)	*R 437*
6. Mpambanyoni to Mzumbe or South Coast (U80)	*R 260*
7. Umzimkulu (T51-T52)	*R 612*
8. Mtamvuna (T40)	*R 182*
Total	**R 2 852**

Pulp factories

There were two pulp factories in the WMA one of which, the Sappi Tongaat pulp mill has been out of production since November 2012. The other is the Sappi Saiccor factory at the mouth of the Mkomazi River producing chemical cellulose for the export market. As only the output of the Saiccor factory (800 000 ton products) was available, an estimation of the annual turnover was done based on the average mill door price as mentioned in the international price. Sappi do not publish this price in its annual 2012 report or were not prepared to provide it. Applying this methodology provided an estimate of at least R6.6 billion annual turnover for the 2012 financial year.

Beverage factories

In the WMA there are a number of large beverage factories representing large water users. They include factories such as United National Breweries and SA Breweries (Prospecton plant). The soft drink factories include Amalgamated Beverage Industries, Tiger Brands and Coca Cola Fortune. There are also a number of bottled water companies identified in Durban, Pietermaritzburg and on the Dolphin Coast. The estimated turnovers of the beverage factories are shown below (Table 3.6).

Table 3.6 Estimated beverage turnovers (2012 prices)

Economic Region	Annual turnover (R mil)
1. Mvoti (U40,U50)	*R 0.0*
2. Mdloti (U30)	*R 5.0*
3. Mgeni (U20)	*R 72.0*
4. Mlazi and Lovu (U60, U70)	*R 5 881.7*
5. Mkomazi (U10)	*R 0.0*
6. Mpambanyoni to Mzumbe or South Coast (U80)	*R 0.0*
7. Umzimkulu (T51-T52)	*R 643.5*
8. Mtamvuna (T40)	*R 0.0*
Total	**R 6 602.2**

Eco-tourism

Tourism data was collected with the help of tourism accommodation internet sites as well as information received from KZN Tourism in the form of South Africa KwaZulu-Natal - 2012 Statistics of our Tourism (www.zulu.org.za) and Tourism KwaZulu-Natal (October 2012) by STR Global, Ltd (Table 3.7). The tourists in ERs 3, 5 and 7 mainly visited the game parks and nature reserves. Those in ERs 1, 2, 4, 6 and 8 were mostly holiday tourists visiting the coastal towns and cities. It must be kept in mind that this study is not a tourism verification study but a study to allocate available data to specific economic regions.

Table 3.7 Estimated bed nights per ER

Economic Region	Number of bed nights
1. Mvoti	*256 750*
2. Mdloti	*1 553 655*
3. Mgeni	*1 279 189.*
4. Mlazi and Lovu	*1 299 905*
5. Mkomazi	*100 124*
6. Mpambanyoni to Mzumbe or South Coast	*986 347*
7. Umzimkulu	*352 667.*
8. Mtamvuna	*1 103 559*
Total	**6 932 197**

3.5 ECONOMIC REGIONS

The following section will discuss the economic results of the different regions. In certain instances the data of prominent sectors were included for background information. As already explained the results are presented using the following macro-economic parameters:

- *GDP.*
- *Payments to Households.*
- *Employment Creation.*

We also present another variable that provides an indication of the number of people in the region whom are dependent on jobs created and sustained by the water. As the direct employment is in the region the dependency on the water based activities is at four dependents per employee we therefore multiplied direct employment with four to provide a number. This is obviously an undercount as a certain percentage of the indirect and induced jobs will also be in the region. This will specifically apply to the large urban areas of Durban and Pietermaritzburg.

3.5.1 ER 1: Mvoti

The most dominant sector that influences the economic outcome in the Mvoti catchment is commercial forestry. This also affects the secondary sector, namely the saw and pulp industry which forms part of it. Dry land sugar cane of 18 562 ha is mostly cultivated in the area and maize with 3 236 ha is the second largest crop. The sugar cane is transported to the applicable sugar mills for further processing and has the highest turnover of the economic sectors in the Mvoti ER. The macro-economic parameters representing the water based activities in the region are presented in Table 3.8.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R161.4*	*R 253.1*	*R414.5*	*2 582*	*1 906*	*4 488*	*R480.6*	*R 125.6*
Irrigation agriculture	*R241.1*	*R 380.9*	*R622.0*	*4 623*	*3 026*	*7 649*	*R723.4*	*R 188.8*
Commercial forestry	*R289.3*	*R 259.2*	*R548.6*	*3 472*	*2 410*	*5 882*	*R470.9*	*R 167.7*
Industry	*R1 153.3*	*R1 309.1*	*R2 462.3*	*4 266*	*10 847*	*15 114*	*R2 323.9*	*R 850.2*
Tourism	*R 96.7*	*R85.2*	*R181.9*	*804*	*666*	*1 470*	*R149.1*	*R52.6*
Total	**R 1 941.9**	**R 2 287.5**	**R 4 229.4**	**15 746**	**18 856**	**34 603**	**R 4 147.8**	**R 1 385.0**

In total 15 746 direct employment opportunities are provided in the region by the water dependent economic activities, the total employment opportunities comes to 34 603. At four dependents per employee at least 63 000 (15 746 x4). Industry is the largest employment provider with 4 266 direct opportunities in the ER with another 10 847 indirect and induced opportunities. The irrigation agriculture sector is the second largest direct job creator followed by commercial forestry.

3.5.2 ER 2: Mdloti

The Mdloti ER is characterized by mostly dry land as well as irrigated sugar cane with about 24 000 ha being cultivated. Tourism contributes a major part in the ER with 3 256 of bed nights sold. Table 3.9 presents the macro-economic parameters which represents the water based activities in the region.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R172.5*	*R 270.4*	*R442.9*	*2 759*	*2 037*	*4 795*	*R513.6*	*R 134.2*
Irrigation agriculture	*R255.7*	*R 389.8*	*R645.5*	*3 769*	*3 005*	*6 774*	*R745.4*	*R 194.7*
Commercial forestry	*R4.9*	*R 4.4*	*R9.3*	*59*	*41*	*100*	*R8.0*	*R 2.9*
Industry	*R1 241.4*	*R1 399.5*	*R2 640.9*	*909*	*11 432*	*12 341*	*R2 487.4*	*R 913.6*
Tourism	*R 585.3*	*R 515.6*	*R 1 100.9*	*4 863*	*4 033*	*8 896*	*R 902.1*	*R 318.5*
Total	**R 2 259.9**	**R 2 579.6**	**R 4 839.5**	**12 359**	**20 547**	**32 906**	**R 4 656.4**	**R 1 563.8**

The analysis shows the large overall dependency in the area on the wellbeing of irrigation agriculture. In the case of direct employment creation 3 769 opportunities are created by irrigation and at an average dependency of four people per employment opportunity is estimated over 13 000 people in the region depend on irrigation. For the water based activities in total the dependency is over 50 000 people.

3.5.3 ER 3: Mgeni

The Mgeni ER economic activities are mainly divided between sugar cane, commercial forestry and eco-tourism. Factories such as Küsel Sawmill and Tekwani Saw Mill are also located in this ER. The macro-economic parameters representing the water based activities in the region are presented in Table 3.10.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R278.9*	*R 437.2*	*R716.2*	*4 461*	*3 293*	*7 754*	*R830.4*	*R 217.0*
Irrigation agriculture	*R396.6*	*R 618.6*	*R1 015.3*	*6 752*	*4 843*	*11 596*	*R1 174.0*	*R 306.7*
Commercial forestry	*R265.6*	*R 238.0*	*R503.5*	*3 187*	*2 212*	*5 399*	*R432.2*	*R 153.9*
Industry	*R294.7*	*R 328.1*	*R622.8*	*3 034*	*2 640*	*5 674*	*R585.4*	*R 217.9*
Tourism	*R 481.9*	*R 424.5*	*R 906.4*	*4 004*	*3 320*	*7 324*	*R 742.7*	*R 262.2*
Total	**R 1 717.8**	**R 2 046.4**	**R 3 764.2**	**21 438**	**16 309**	**37 747**	**R 3 764.9**	**R 1 157.8**

In terms of dependency about 21 400 direct employment opportunities created by the different sectors reflects that about 85 000 individuals are dependent on the continuation of the activity. Irrigation agriculture is the largest water use economic sector in the ER creating the most indirect and induced jobs.

3.5.4 ER 4: Mlazi and Lovu

The Mlazi and Lovu ER economic activities are mainly divided between sugar cane, commercial forestry and eco-tourism. Table 3.11 presents the macro-economic parameters which represents the water based activities in the region.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R177.2*	*R 277.7*	*R454.9*	*2 833*	*2 092*	*4 925*	*R527.4*	*R 137.8*
Irrigation agriculture	*R208.1*	*R 321.6*	*R529.7*	*3 352*	*2 458*	*5 810*	*R610.1*	*R 159.4*
Commercial forestry	*R103.6*	*R92.8*	*R196.3*	*1 243*	*862*	*2 105*	*R168.5*	*R60.0*
Industry	*R3 082.4*	*R3 757.1*	*R6 839.5*	*5 559*	*32 556*	*38 115*	*R6 720.8*	*R 2 335.6*
Tourism	*R 489.7*	*R 431.4*	*R 921.1*	*4 069*	*3 374*	*7 443*	*R 754.8*	*R 266.5*
Total	**R 4 060.9**	**R 4 880.6**	**R 8 941.5**	**17 056**	**41 343**	**58 399**	**R 8 781.5**	**R 2 959.3**

In terms of direct dependency the 5 559 in industry reflects a number of over 22 000 individuals depending on the continuation of the activity. The tourism sector is the second largest employment creator of the sectors analysed. Adding the other economic activities the number increases to about 68 000 (17 000 x 4 dependants per household) as far as dependency on water is involved. This is only taking into consideration the direct jobs and immediate dependants and not calculating the indirect and induced numbers. The total job opportunities created is estimated at 58 399.

3.5.5 ER 5: Mkomazi

The Mkomazi ER is being cultivated mainly with sugar cane but also with about 2 500 ha of pastures. Almost equal gum and pine quantities are planted for the total of 36 460 ha. The macro-economic parameters representing the water based activities in the region are presented in Table 3.12.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R 52.7*	*R82.6*	*R135.3*	*843*	*622*	*1 465*	*R156.9*	*R41.0*
Irrigation agriculture	*R174.4*	*R 285.2*	*R459.6*	*3 677*	*2 434*	*6 111*	*R533.5*	*R 139.5*
Commercial forestry	*R167.8*	*R 146.6*	*R314.4*	*1 637*	*1 361*	*2 998*	*R266.2*	*R94.5*
Industry	*R3 082.5*	*R3 400.7*	*R6 483.2*	*3 248*	*26 850*	*30 098*	*R6 063.9*	*R 2 263.5*
Tourism	*R 37.7*	*R 33.2*	*R 70.9*	*313*	*260*	*573*	*R 58.1*	*R 20.5*
Total	**R 3 840.4**	**R 4 307.4**	**R 8 147.8**	**9 659**	**34 360**	**44 019**	**R 7 718.8**	**R 2 797.7**

Irrigation agriculture involves a high number of employment opportunities, namely 3 677 and total job opportunities of above 6 000. The indirect and induced impact due to the industrial activities creates a 26 850 job opportunities especially due to the large income the SAICCOR pulp mill generates which have creates a number of large backwards linkages in the form of indirect and induced effects. In total in access of 40 000 people are dependent on the water if only the direct job opportunities is used in the calculation.

3.5.6 ER 6: Mpambanyoni to Mzumbe or South Coast

Commercial forestry, sugar cane and holiday tourists visiting Scottburgh and other holiday destinations are part of the economic activities in the economic region. Table 3.13 presents the macro-economic parameters which represents the water based activities in the region.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R272.9*	*R 427.8*	*R700.7*	*4 364*	*3 222*	*7 587*	*R812.5*	*R 212.3*
Irrigation agriculture	*R302.5*	*R 469.1*	*R771.5*	*4 921*	*3 551*	*8 472*	*R893.0*	*R 233.3*
Commercial forestry	*R100.0*	*R87.3*	*R187.3*	*976*	*811*	*1 787*	*R158.6*	*R56.3*
Industry	*R674.9*	*R 772.4*	*R1 447.3*	*1 652*	*6 475*	*8 128*	*R1 369.5*	*R 497.9*
Tourism	*R 371.6*	*R 327.3*	*R 698.9*	*3 088*	*2 560*	*5 648*	*R 572.7*	*R 202.2*
Total	**R 1 721.9**	**R 2 083.9**	**R 3 805.8**	**15 001**	**16 619**	**31 621**	**R 3 806.3**	**R 1 202.1**

The results indicate the agricultural activities which includes the dryland sugar cane and irrigation agriculture to be the highest direct employer as well as the largest total job creator in the ER. The industries have highest indirect and induced effect to all of the economic activities with an estimated 6 475 jobs which totalled the impact of the industrial activities at 8 128 jobs opportunities. If the 15 000 direct jobs are used to estimate dependency at four per employee the total is over 75000 dependents.

3.5.7 ER 7: Umzimkulu

Dry land sugar cane is cultivated in the Umzimkulu ER with also a large plantation of commercial forestry of 51 080 hectares in the area. In the upper reaches close to the Drakensberg irrigation

widely practised with dairy production the dominant product. The macro-economic parameters representing the water based activities in the region are presented in Table 3.14.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R142.8*	*R 223.9*	*R366.8*	*2 284*	*1 687*	*3 971*	*R425.3*	*R 111.1*
Irrigation agriculture	*R211.9*	*R 337.1*	*R548.9*	*3 618*	*2 681*	*6 299*	*R638.4*	*R 166.9*
Commercial forestry	*R235.1*	*R 205.4*	*R440.4*	*2 294*	*1 907*	*4 201*	*R372.9*	*R 132.3*
Industry	*R847.4*	*R 984.3*	*R1 831.7*	*3 547*	*8 259*	*11 806*	*R1 754.4*	*R 631.7*
Tourism	*R 132.9*	*R 117.0*	*R 249.9*	*1 104*	*915*	*2 019*	*R 204.8*	*R 72.3*
Total	**R 1 570.0**	**R 1 867.7**	**R 3 437.7**	**12 847**	**15 448**	**28 296**	**R 3 395.7**	**R 1 114.3**

The employment creation of the different economic activities all has almost the same direct employment opportunities in this ER except tourism. Most of the low household income is being generated by the industry sector. Using again only the direct jobs the dependency on water based activities is in excess of 50 000 at four dependents per employee.

3.5.8 ER 8: Mtamvuna

The Mtamvuna ER reflects dry land sugar cane, commercial forestry and tourism with holiday destinations such as Margate, Ramsgate and Port Edward. Table 3.15 presents the macro-economic parameters which represents the water based activities in the region.

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

Economic activity	GDP (R mil)			Employment (Numbers)			Household income (R mil)	
	Direct	Indirect and induced	Total	Direct	Indirect and induced	Total	Total	Low
Dry land sugar cane	*R 50.9*	*R79.8*	*R130.6*	*814*	*601*	*1 414*	*R151.5*	*R39.6*
Irrigation agriculture	*R 64.1*	*R98.7*	*R162.7*	*1 111*	*751*	*1 862*	*R188.8*	*R49.3*
Commercial forestry	*R 69.8*	*R61.0*	*R130.7*	*681*	*566*	*1 247*	*R110.7*	*R39.3*
Industry	*R 87.6*	*R96.3*	*R183.9*	*1 289*	*766*	*2 055*	*R171.7*	*R64.5*
Tourism	*R 415.8*	*R 366.2*	*R 782.0*	*3 454*	*2 864*	*6 319*	*R 640.7*	*R 226.2*
Total	**R 688.1**	**R 701.8**	**R 1 389.9**	**7 349**	**5 548**	**12 897**	**R 1 263.3**	**R 419.0**

The Mtamvuna is the economic region which generates has the least economic activities. However, it is a highly popular tourism area which reflects in where the most of the direct job opportunities are created with an estimated 3 454 jobs, nearly 50%. The economic activities of the industry as well as irrigation agriculture create above 1 000 jobs. Using again only the direct jobs the dependency on water based activities is in excess of 30 000 at four dependents per employee

3.5.9 Regional Comparison

To determine the key sectors in the different ERs, the most dominant sector was identified and will be taken into account for the operational scenarios analysis (Table 3.16). In addition, the other sectors will be ranked in accordance with their importance relating to their economic prominence in their different ERs in the catchment.

Table 3.16 Dominant sector in the ERs

Most dominant economic sector								Total
ER1	ER2	ER3	ER4	ER5	ER6	ER7	ER8	
Industry (sugar and saw mills)	*Industry (pulp and sugar mills)*	*Industry (sugar and saw mills)*	*Industry (sugar and saw mills) and tourism*	*Industry (pulp and sugar mills)*	*Industry (sugar and saw mills)*	*Irrigation agriculture and commercial forestry. Industry (sugar and saw mills)*	*Industry (Sugar and saw mills) and tourism*	*Industry*

In all the ERs, excluding ER 7, agricultural related industry (i.e. sugar and saw mills) is prominent. Irrigation agriculture with commercial forestry dominates in ER 7 and tourism also features ER 4 and ER 8. The dominant activity for the total catchment is the agricultural related industry.

4 STATUS QUO ASSESSMENT: WATER QUALITY

4.1 INTRODUCTION

This chapter is focussed on the methods by which the water quality Status Quo was determined on a DESKTOP level, as required by the first step of the Water Resources Classification System (WRCS) process. Figure 4.1 below shows how the assessment of the Status Quo of water quality fits into both the steps of the WRCS, the Reserve or Ecological Water Requirements (EWR) process and the Integrated Steps (Louw and Scherman, 2012; and shown in the Inception Report (DWA, 2012a) for the study).

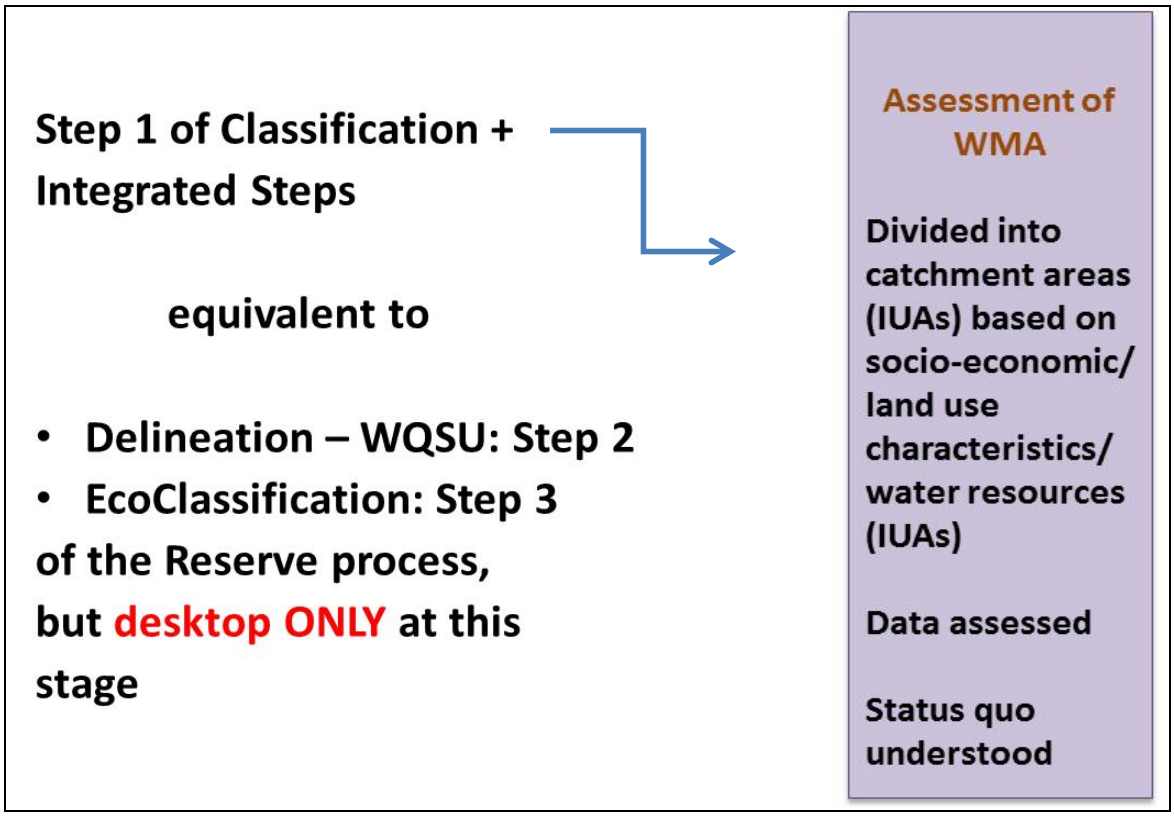


Figure 4.1 Schematic demonstrating the link between the Status Quo assessment step and the Reserve and WRCS

The aim of the task is to identify water quality hotspots on a desktop level, i.e. areas of large (3), serious (4) or critical (5) impacts (ratings: 0-5), with associated reasons, and then to map the water quality hotspots. These hotspots, together with all other information gathered for the study, would then be used to delineate Integrated Units of Analysis (IUAs).

Due to the size of the Water Management Area (WMA), it was necessary to split the WMA for water quality assessment purposes. According to DWAF (2004a) eight key areas exist within WMA 11 and include:

- *Mvoti (Tertiary catchments U40 and U50).*
- *Mdloti (Tertiary catchment U30).*
- *Mgeni (Tertiary catchment U20).*
- *Mlazi and Lovu (Tertiary catchments U60 and U70).*
- *Mkomazi (Tertiary catchment U30).*
- *Mpambanyoni to Mzumbe or South Coast (Tertiary catchment U80).*

- *Umzimkulu (Tertiary catchments T51 and T52); and*
- *Mtamvuna (Tertiary catchment T40).*
- *Additional delineation identified for the study: U10 (Mkomazi)*

Water services authorities in the area include the following (DWA, 2011b):

- *Amajaba District Municipality (DM)*
- *eThekwini Metropolitan Municipality (MM)*
- *Ilembe (DM)*
- *Msunduzi Local Municipality (LM)*
- *Newcastle (LM)*
- *Sisonke (DM)*
- *Ugu (DM)*
- *Umgungundlovu (DM)*
- *uMhlathuze (DM)*
- *uMkhanyakude (DM)*
- *Umzinyathi (DM)*
- *uThukela (LM)*
- *uThungulu (DM)*
- *Zululand (DM)*

The agriculture found in this WMA includes large amounts of sugar cane (both dryland and irrigated), bananas (found on the south coast), citrus (farmed near Richmond, Stanger and Darnall on the north coast), vegetables and beef and dairy pastures. The majority of irrigation utilises sprinkler irrigation systems with a growing number of centre-pivot schemes. There is also some micro irrigation along the coastline. There is substantial industrial development in the urban areas of Durban, Stanger and Pietermaritzburg. There are no significant mining concerns or power stations situated in this WMA. There are a number of game reserves and nature parks. The largest of these is the Drakensberg Reserve area and others are uMngeni Valley, Karkloof, Krantzkloof, Vernon Crookes, Oribi Gorge, Mtamvuna and Coleford. Two new reserves have been mooted around Pietermarizburg as a result of the settlement of the KwaXimba Land Claim and in response to the growing perception of the significant growth potential presented by tourism in KwaZulu-Natal (taken from DWAF, 2004a).

The water quality assessment below will therefore be per tertiary catchment, i.e. T40, T51 and T52, U10 through to U80. The assessment will focus on rivers for which information are available, and will attempt to identify water quality issues and hotspots per river system.

4.2 APPROACH

The approach can be summarized as follows:

- *Define the study area (as shown in the Section 4.1).*
- *Collect land-use data – a land-use map such as that shown as Figure 4.2 may be used.*
- *Conduct an extensive literature review (but not yet data analysis at this stage), using the following types of available data:*
  - *Reserve data: Available previous riverine Reserve determinations are detailed in DWA (2012a).*
  - *Outputs (Present Ecological State (PES) maps and Fact Sheets) of the national PES/EI/ES project for WMA11 (DWA, 2012b).*
  - *The 2012 Green Drop Report for WMA11 (DWA, 2012c).*

- *The water quality scores of the Water Resource Use Importance (WRUI) conducted for this study (WRP, 2012).*
- *Information sources such as the eThekwini Unicity River Quality Indices of 2011 which reflect the effectives of sanitation.*

- *Identify driving forces in terms of water quality per area.*
- *Develop a general picture of water quality for the study area, for example: The following summary covers the general water quality state in WMA 11 (taken from the National Water Resources Strategy of 2004, DWA (2004b)):*
  - *The quality of surface water in WMA 11 was of a high standard under natural conditions.*
  - *There is wash-off from areas with insufficient sanitation infrastructure and services, resulting in unacceptable bacteriological pollution, particularly at rural villages and dense settlements.*
  - *Intensive farming operations impacts on water quality in some catchments, particularly the Mnsunduze, lower Mgeni and Mlazi rivers.*
  - *There is localised bacteriological pollution of streams in some rural areas.*
  - *Quality of groundwater is generally of a very high standard, with no pollution of groundwater recorded.*
  - *Note the importance of the Durban-Pietermaritzburg metropolitan and industrial area in socio-economy of the WMA, and already over-commitment of water from Mgeni River System as the source of water supply to the region.*
  - *Note that the DWA Development Strategy to Control Eutrophication in SA (2003), prepared by the Directorate: Water Quality Management, identified all estuaries, including all farm dams and watercourses in WMA 11, as having infrequently severe eutrophication problems due to sewage discharge, and non-point source pollution respectively.*

The rest of the document will show background, a water quality summary, results of the desktop assessment and identified hotspots per area.

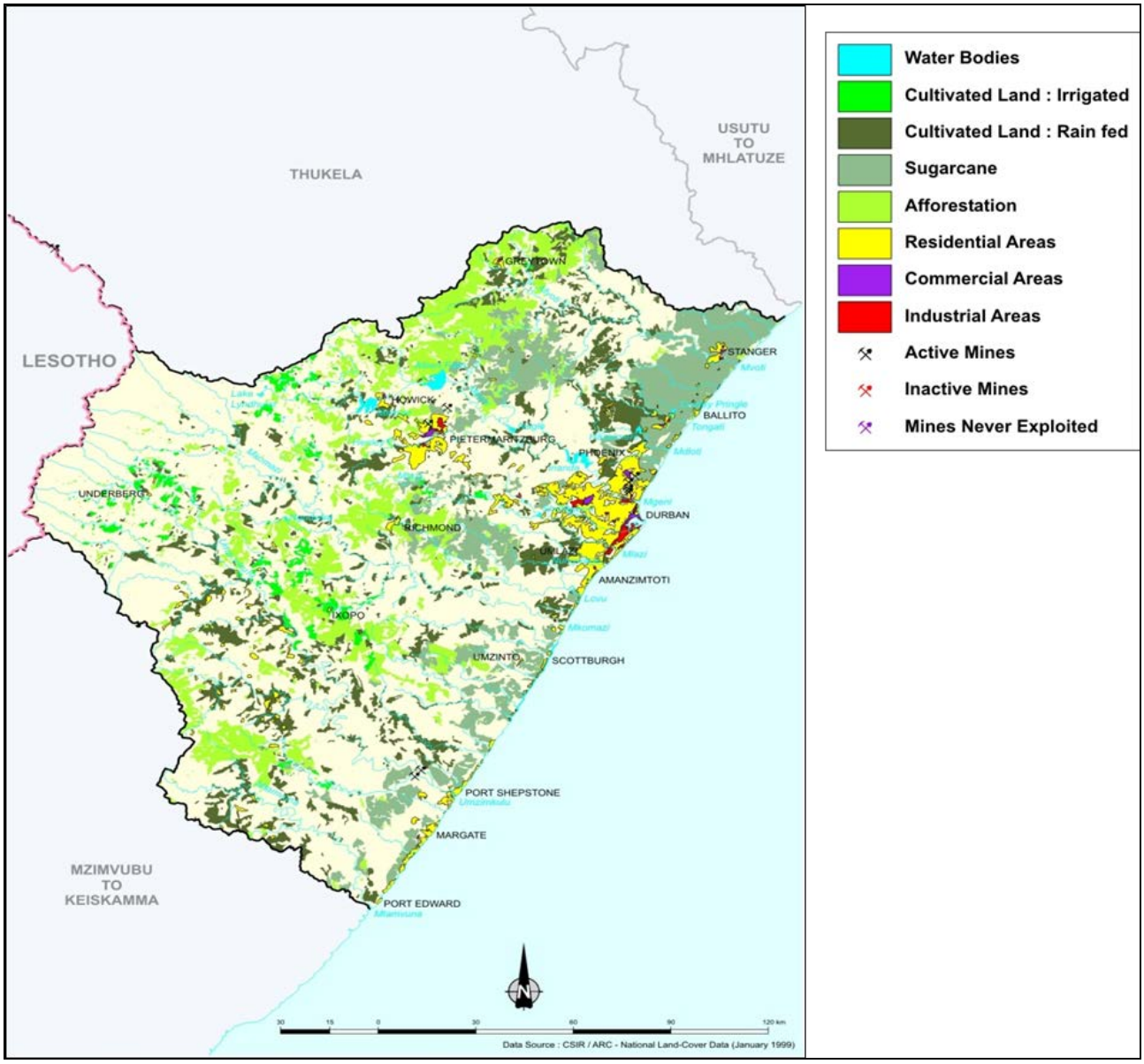


Figure 4.2 Land-use map of WMA 11

4.3 WATER QUALITY ASSESSMENT PER TERTIARY CATCHMENT

4.3.1 U10: Mkomazi catchment

The Mkomazi catchment drains an area from the Great Escarpment around Sani Pass, i.e. the headwaters of the Mkomazi, to the Indian Ocean at Umkomaas. The catchment is broadly characterised by having the headwaters in an area which is under conservation and then passes through alternating bands of subsistence farming and commercial agriculture (including commercial plantations) (DWAF, 1999a). Overgrazing and high population densities in the upper, middle and lower parts of the catchment have resulted in increased sediment yields, with extensive commercial forestry populations in the headwaters (DWAF, 1999a). Main urban centres include Bulwer, Mpendle, Ixopo, Richmond, Donnybrook and Umkomaas on the coast. There is therefore little urban development in most of the Mkomazi catchment, with most of the residential and industrial development associated with the towns of Umkomaas on the coast and Ixopo and Richmond inland.

The upper section of this catchment includes the Luhane River, which lies in the Bulwer area in the upper foothills of the Drakensberg and is an upstream tributary of the Mkomazi River. The study

area is under no pressure from urban development, and forestry is the only major impact in the area, which may negatively affect the water quality of the stream. Impacts from forestry decrease and become non-existent as the upper reaches of the catchment becomes more mountainous. The Luhane River seems to be in a relatively pristine condition, and scarce fish species (eels and mountain catfish) are expected to occur (Jeffares and Green, 2009).

Green Drop ratings

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

- *Bulwer WWTW nearest the Luhane River, Sisonke DM:* **High Risk***, with non-compliance with effluent quality discharge standards. Note that the WWTW is a distance away from the rivers being evaluated.*
- *Ixopo WWTW on the Xobho River, Sisonke DM:* **Low Risk***.*
- *Umkomaas WWTW on the Mkomazi River, eThekwini MM:* **Low Risk***.*

Water quality status quo

Primary impacts in the area are elevated sediment loads due to activities such as overgrazing and high population numbers, resulting in elevated instream turbidity (Umgeni Water, 1998). However, no major water quality issues or hotspots were identified in tertiary catchment U10 and the water quality of the Mkomazi is considered Good (DWAF, 1999b). The major water quality concern for the Mkomazi catchment is microbiological water quality (DWAF, 2008a).

Conclusion: Water quality hotspots

No water quality hotspots were identified in this catchment area.

4.3.2 U20: Mgeni catchment

Flow regulation in the Mgeni catchment via the Midmar, Albert Falls, Nagle and Inanda dams, has an important impact on the quality of the system. It alters sediment transport and nutrients, resulting in an enhancement of cyanobacterial growth. Note that within the Mgeni catchment, Inanda Dam and the section of river above the dam experiences the highest incident of aquatic plant invasion. However, a number of interventions were undertaken by Umgeni Water during 2009 to control the weeds that had by then spread to most dams in their area of jurisdiction. The control status in 2009/2010 was that infestations had either been eradicated (mostly through biocontrol agents) or were under control (Mgeni Annual Report 2009/2010).

Note that the Mgeni River catchment is the socially and economically important catchment in the region due to the growth of coastal metropolitan areas.

The water quality of the Mgeni River remained good for many years, largely due to the self-purification and assimilative capacity of the upper Mgeni River, as well as the succession of dams which also had positive impacts on water quality. Overall, the water quality of the streams of the upper Mgeni River were described as being good with no signs of significant pollution evident during the 2005 study of Simpson and Graham (2005). The main land-use in the upper areas were agriculture and forestry, with urban areas downstream Midmar Dam, e.g. Howick and Hilton. Note that these urban areas include both formal and informal type settlements, with associated deteriorations in water quality due to return flows and runoff from agriculture and urban/peri-urban areas.

Water released from the lower layers of Nagle Dam also resulted in higher nitrate, phosphate and turbidity levels than in the dam itself. The confluence of the Mgeni and Msunduze rivers is below Nagle Dam. The Msunduze River flows eastwards to Henley Dam, Edendale and Pietermaritzburg (WRC, 2002). The Msunduze River catchment upstream of Pietermaritzburg has moderate to serious erosion problems, especially in the Henley Dam catchment. Serious faecal (sewer reticulation and inadequate on-site latrine problems) and general urban pollution arises from Pietermaritzburg, with potentially very serious industrial pollution and significant nutrient enrichment (DWAF, 2004a).

Forestry and large-scale sugar cane production with related erosion potential is found in the central area of the uMngeni catchment, with limited, reasonably well-controlled pollution from cattle feedlots and poultry operations. There is some intensive vegetable production with resultant nutrient and pesticide problems. Cultivation on steep slopes is common in the moderately populated areas in the Valley of a Thousand Hills which results in moderate to high erosion and some faecal contamination. Dense urban and industrial use occurs downstream of Inanda Dam, with serious faecal and varied industrial contamination likely (DWAF, 2004b).

Although the Durban Metropolitan Area (DMA) is actually in the Mlazi catchment, water use for eThekwini Municipality and the DMA is from the Mgeni River. The DMA has 14 rivers of which the most significant resource is the Mgeni River. Most of these rivers are sources of potable water, but their functioning has been heavily modified over time. Several of the Metro rivers (e.g. Mdloti, Ohlanga, Mgeni, Umbilo, Umhlatuzana, Mlaza, Isipingo and Little aManzimtoti) receive sewage effluent after treatment, making them vulnerable to nutrient enrichment or eutrophication. The extent of the impact is a measure of the environmental capacity of the river to assimilate the pollutant load from these point sources and from runoff from non-point sources. The excessive growth of water hyacinth (Eicchornia crassipes) or water lettuce (Pistia stratiotes) and sometimes algal blooms in the coastal reaches is a visible manifestation of the imbalance in some of these systems. Water quality is particularly exacerbated in areas of continuous flow from WWTWs, e.g. during winter low flows in the Little aManzimtoti, Umbilo, and Ohlanga and potentially in the Mgeni, Mlaza and Mdloti through flow regulation in the main channel downstream of the Inanda, Shongweni and Hazlemere dams respectively. Several sewage works, which service the DMA, discharge their final return flow directly into the main channel of the nearest river, e.g. the Tongathi, Mdloti, Ohlanga, Mgeni, Umbilo, Umhlatuzana, Mlaza, Isipingo, Mbokodweni and Little aManzimtoti rivers. This has resulted in instances of bacterial contamination and eutrophication of river systems. Eutrophication is manifest as abundant growths of Eichhornia crassipes (water hyacinth) in the Mdloti, Ohlanga, Mgeni, and Isipingo rivers and of Pistia stratiotes (water lettuce) in the aManzimtoti and Little aManzimtoti rivers (Information taken from http://www.ceroi.net/reports/durban/issues/fshwater/state.htm).

Green drop ratings

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

- *Darvill WWTW on the Mnsunduze River, eThekwini MM:* **Low Risk***.*
- *Howick WWTW on the Mgeni River, eThekwini MM:* **Low Risk.**

Water quality status quo

Water quality deteriorates downstream from Midmar Dam, which meets its user requirements. Deterioration is mainly linked to an increase in nutrients, linked to agricultural activities, particularly

dairies, piggeries and maize production. There is also increased pollution from growing settlements such as Mphophomeni (WRC, 2002).

The water quality in the Msunduze downstream of Henley Dam is seriously affected by sewer infrastructure problems, including ingress of rainwater into the sewer system which results in surcharges, overloading Darvill WWTW. Pit latrines are also extensively used in the area. The Darvill WWTW is the single most important contributor of nutrients to the downstream system, with poorly managed subsistence agriculture, overgrazing and poor sanitation systems downstream (WRC, 2002). The water quality of the middle and lower Msunduze is very poor, with a high faecal coliform content and nutrient enrichment, resulting in significant risks of health effect if the water is used for drinking and contact recreation, e.g. the annual Dusi canoe marathon.

The nutrient concentrations in the lower Msunduze River are also very high and contribute significantly to the eutrophication processes of the lower Mgeni River.

Conclusion: Water quality hotspots

Water quality hotspots across U20 are shown in Table 4.1 below.

Table 4.1 Water quality hotspots in Catchment U20

SQ reach	River name	Water quality impact (rating)	Water quality issues
U20C-04340	*Nguklu*	*Large (3)*	*Elevated nutrient loads.*
U20E-04243	*Mgeni*	*Large (3)*	*Elevated nutrient loads; urban run-off.*
U20F-04224	*Mpolweni*	*Large (3)*	*High nutrient load.*
U20G-04194	*Mkabela*	*Large (3)*	*High nutrient load; toxics may be present.*
U20G-04215	*Cramond Stream*	*Large (3)*	*High nutrient load; toxics may be present.*
U20G-04240	*Mgeni*	*Large (3)*	*High nutrient load.*
U20G-04385	*Mgeni*	*Large (3)*	*High nutrient load; urban impacts.*
U20J-04364	*Msunduze*	*Serious (4)*	*Industrial discharges; elevated nutrients and salts.*
U20J-04391	*Msunduze*	*Critical (5)*	*WWTW; industrial discharges; elevated nutrients and salts.*
U20J-04401	*Msunduze*	*Critical (5)*	*Industrial discharges; elevated nutrients and salts.*
U20J-04461	*Slang Spruit*	*Critical (5)*	*Urban and industrial discharges.*
U20J-04488	*Mshwati*	*Large (3)*	*Urban impacts; nutrient elevations.*
U20L-04435	*Mgeni*	*Large (3)*	*Urban impacts; nutrient elevations.*
U20M-04396	*Mgeni*	*Serious (4)*	*Urban impacts; nutrient elevations; aquatic plants in upstream dam so low DO levels; treated effluent coming in from the Piesang in the north (below Inanda). Note the input of the Mhlangane River, which is a hotspot identified by eThekweni MM.*
U20M-04639	*Palmiet*	*Large (3)*	*Elevated nutrients.*
U20M-04642	*Palmiet*	*Serious (4)*	*Elevated nutrients and industrial discharges.*
U20M-04653	*Palmiet*	*Large (3)*	*Elevated nutrients.*

4.3.3 U30: Mdloti catchments

The Mdloti River drains a catchment in which there is little industrial development. Most of the catchment remains undeveloped grassland, with sugar cane being the dominant crop (Archibald et al., 1980). Enrichment can therefore occur during times of fertilizer use. Sand-mining activities were also reported during 2005/2006 around Hazelmere Water Works (i.e. U30A), which would lead to increased sediment levels in the rivers, with associated impacts on water quality and habitat availability for biota. There are a large amount of low density settlements and rural settlements spread throughout the Mdloti catchment, e.g. the small urban areas of Tongaat, Canelands, Verulam and Umhlanga.

Urban development is associated with Verulam and surrounds (i.e. U30B), including discharges from a number of WWTWs. Population densities are moderate in the upper parts of the IUA but increase in the lower parts of the IUA particularly in the area around the town of Tongaat (in U30D). Discharges from the Tongaat WWTW enter the Tongati River affecting both flow and water quality of the river. There is a belt of commercial farming between Tongaat and the coast. A significant portion of the Lower Mdloti IUA is therefore covered by sugarcane (dryland and irrigated).

Green drop ratings

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

- *Verulam WWTW on the Mdloti River/Estuary, eThekwini MM:* **Low Risk**.
- *Tongaat Central WWTW on the Tongati River/Estuary, eThekwini MM:* **Medium Risk**.
- *Umhlanga/Phoenix WWTW at the head of the Ohlanga Estuary, eThekwini MM:* **Medium Risk**.
- *Frasers WWTW on the Mhlali Estuary (downstream of the N2 crossing):* **No Risk**, *as effluent is now being diverted to Tongaat Central WWTW (Taljaard, CSIR, pers. comm., July 2013)*

Water quality status quo

The water quality of the catchment is generally Poor along the coastal strip due to point source pollution. The water quality state of the inland regions is generally better, although erosion and resultant sedimentation is a problem (DWAF, 2004a).

Conclusion: Water quality hotspots

Water quality hotspots across U30 are shown in Table 4.2. Note that hotspots that fall into reaches with estuary components are shown in red text.

Table 4.2 Water quality hotspots in Catchment U30

SQ reach	River name	Water quality impact (rating)	Water quality issues
U30A-04360	Mdloti	Large (3)	Elevated nutrients, industrial discharges and high sediment loads.
U30B-04465	Black Mhlashini	Large (3)	Elevated nutrients.
U30B-04475	Mdloti	Critical (5)	Elevated nutrients and blue-green algae; WWTW; ID by eThekwini MM as a hotspot.
U30B-04498	Ohlanga	Critical (5)	Elevated nutrients; WWTW (Phoenix return flows and Umhlanga WWTW at head of estuary).
U30D-04315	Tongati	Large (3)	Elevated nutrients and fertilizers; industrial discharges.

U30E-04207	Mhlali	Large (3)	Elevated nutrients; WWTW discharges.

4.3.4 U40: Mvoti catchment

The tertiary catchment, U40 (Mvoti River Catchment) is located in the Mvoti region and is comprised of the quaternary catchments U40A - J. The Mvoti River, which rises from the midlands, is the major river of this region, with numerous tributaries draining into it, namely: Hlimbitwa (tributaries Cubhu, Nseleni, Potspruit), Sikito (tributary Faye), Nsuze (tributary Pambela), Khamannzi, Mtize, Mvozana (tributary Intinda) and Heinespruit. The Mvoti Catchment consists of 27 sub-quaternary (SQ) catchments, extending across three District Municipalities (iLembe, UMgungungdlovu, Umzinyathi).

Land use in the Mvoti Catchment consists mainly of dryland and irrigated sugar cane plantations along the coast and timber plantations (forestry) in the upper reaches, including banana plantations. Communal lands occur inland around Mapamulo and extensive invasive alien vegetation has transformed the catchment. On average, 43.6% natural vegetation cover remains in U40, with 17 of the 27 sub-quaternary (SQ) catchments comprising less than 50% natural cover, indicating extensive transformation. The DWA Water Quality Review Report (2009) indicates good water quality in the upper reaches of the Mvoti River at Mistley (U40B2), whereas a decline occurs further downstream of the Nsuze River at Glendal in the middle reaches (U40H3) with an increase in conductivity and nutrient concentrations. This is due to runoff and return flows from agriculture, urban areas and industrial discharges. To date, large-scale irrigation and resultant return flows have not caused an obvious deterioration in water quality. In conclusion, overall water quality for the catchment was assessed as Good relative to the ''fitness for water use'' quality requirements. Greytown is supplied water via Lake Merthley, the main storage dam in the catchment. KwaDukuzu's domestic and industrial water usage relies heavily on run-of-river yields and supplies from the uMdloti Catchment (U30) to the south.

Urban areas include Greytown, Stanger and KwaDukuzu.

Green drop ratings

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

- *Greytown WWTW on Heinespruit, uMzinyathi DM:* **Medium Risk***.*
- *KwaDukuzu WWTW proximate to the lower Mvoti River and Estuary, KwaDukuza LM***: Medium Risk** *(due to low microbiological compliance).*

No WWTWs within the Mvoti Catchment were categorized as critical or high risk plants.

Water quality status quo

Potential water quality issues raised in the Internal Strategic Perspective: Mvoti to Umzimkulu WMA (DWA, 2004a,c) include:

- *Erosion potential in the upper catchment owing to inadequate forestry practices.*
- *Faecal contamination around Greytown (Heinespruit River or SQ catchment U40B; i.e. the location of the WWTW) and agricultural run-off contamination (pesticides and nutrients).*
- *Potential impacts of pesticides and nutrients due to intensive agriculture.*
- *Serious erosion due to steep slopes and inadequate farming practices in the middle and lower reaches of the Mvoti Catchment, with some faecal contamination and potential of industrial effluent contamination in the lower reaches*

Nutrient loading evident in the catchment is most likely the result of non-point source pollution from the extensive sugarcane and banana plantations. The majority of the rivers reflect Good water quality status, although there are some water quality hotspots.

Conclusion: Water quality hotspots

Water quality hotspots across U40 are shown in Table 4.3.

Table 4.3 Water quality hotspots in Catchment U40

SQ reach	River name	Water quality impact (rating)	Water quality issues
U40B-03770	*Heinespruit*	*Serious (4)*	*Pesticides and nutrients; WWTW*
U40B-03832	*Mvozana*	*Large (3)*	*Elevated nutrients and salts*
U40H-04064	*Mvoti*	*Large (3)*	*Discharge from agriculture, urban and industrial areas*
U40J-03998	*Mvoti*	*Large (3), esp around KwaDukuzu*	*Sugar (Illovo) and paper mill effluents; WWTW so elevated nutrients; high turbidity levels; urban impacts (Stanger)*

4.3.5 U50: Nonoti catchment

The Nonoti river catchment is located in the Mvoti region, and encompasses the Nonoti River sub-quaternary catchment (SQ) as the main river, as well as the Zinkwazi and Mdlotane river SQ catchments to the north and south of the Nonoti River. These systems are situated within the iLembe DM.

Land use in the catchments consists primarily of dryland sugar cane agriculture, with little natural vegetation remaining in the sub-quaternary catchments, namely: 7.8% (Zinkwazi), 9.2% (Nonoti) and 11.2% (Mdlotane). The main towns are Darnall, Zinkwazi and Mdlotane. A WWTW is located at Darnall proximate to the Nonoti River.

Green drop ratings

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

- *Darnall WWTW next to the Nonoti River, iLembe DM:* **Medium Risk***.*

No WWTWs within this catchment were categorized as critical or high risk plants (DWA, 2012c).

Water quality status quo

Note that the Internal Strategic Perspective (ISP) for the Mvoti to Umzimkulu WMA highlights that intensive agriculture could result in pesticide and nutrient pollution (DWA, 2004a), which is probable for U50A due to intensive sugarcane plantations. According to the PES study (DWA, 2012b), there is a small impact on water quality in terms of nutrient loading, but no other water quality impacts occur. Nutrient loading is most likely due to the sugarcane plantations resulting in non-point source pollution. However, rivers generally reflect a Good water quality status.

Conclusion: Water quality hotspots

There are no water quality hotspots in U50A.

4.3.6 U60: Mlazi catchment

The U60 tertiary catchment, i.e. Mhlatuzana – Mlazi River Catchments, is located in the Mlazi/Lovu Region and is comprised of the quaternary catchments U60A – F. The key rivers of this region are (from north to south): Umbilo, Mhlatuzana, Mlazi (tributaries Mkuzane, Sterkspruit, Wekeweke), Sipingo, Mbokodweni (tributary Bovani). The Mhlatuzana – Mlazi Catchment consists of 14 sub-quaternary (SQ) catchments, extending across the eThekwini Metropolitan Municipality along the coastal region and the UMgungundlovu DC inland (Msunduzi, Richmnond, Mkhambathini LMs).

Land use in the catchment consists mainly of high density urban development (particularly along the coastal region), dryland and irrigated sugar cane plantations and forestry (timber plantations), as well as livestock grazing. The Mlazi River originates south west of Pietermaritzburg (U20J) with land use activities comprising agriculture, forestry and small rural and peri-urban settlements in the upper reaches (U60A). The Baynesfield, Mapstone Thornlea and Shongweni dams are sited on the Mlazi before joining the Sterkspruit and Wekeweke tributaries. Land use is predominantly rural and urban below the Shongweni Dam, which includes the industrial area near Durban airport. The estuary has been modified into a concrete canal before flowing into the Indian Ocean. The smaller coastal rivers, Mhlatuzana and Umbilo rivers, flow from the hills north of Durban, while the Sipingo drains into the Sipingo Estuary just south of the Mlazi. Urban and industrial land uses are predominant in these three catchments (WRC, 2002; Umgeni Water, 2012).

Green drop ratings

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

- *Camperdown WWTW, north of the Sterkspruit River, UMgungundlovu DM, Mkhambathini LM:* **Low Risk**.
- *Umbilo WWTW, Umbilo River, eThekwini MM:* **Moderate Risk** *(but 0% microbial compliance).*
- *Dassenhoek WWTW, Mlazi River, eThekwini MM:* **Low Risk**.
- *Hammarsdale WWTW, Sterkspruit River, eThekwini MM:* **Moderate Risk**.

Water quality status quo

This tertiary catchment is highly impacted, particularly in the middle and lower reaches of all the river catchments. On average, 45% natural vegetation cover remains in U60, with nine of the 14 SQ catchments comprising less than 50% natural cover, representing extensive transformation. Water quality is Poor in the lower reaches of the Mlazi River, although it is Good in the upper reaches. There are extensive nutrient inputs from agricultural activities in the upper reaches and four wastewater works in the middle and lower reaches, which has led eutrophication and invasion by aquatic weeds (water hyacinth). Faecal contamination is also an issue due to stormwater contamination and inadequate infrastructure. Water quality in both the Mhlatuzana and Umbilo rivers is Poor due to urban and industrial effluents, as well as the Sipingo due to high E. coli counts (WRC, 2002).

Water quality issues are caused by the following:

- *Non-point source pollution (pesticides, fertilizers) from agriculture (sugarcane plantations) in Wekeweke (U60C), Mbokodweni (U60E) and Mhlatuzana (U60F) catchments.*
- *Non-point source pollution from residential areas (urban and rural townships) e.g. stormwater run-off, washing in rivers. Water quality problems are particularly evident along the high density coastal development areas.*

- *Point source pollution from industrial discharge points (e.g. textile (dye) factories) and urban infrastructure (e.g. sewage, wastewater treatment works non-compliance).*
- *Nutrient concentrations are problematic in most catchments. The aquatic weed, water hyacinth, often signalling this impact on water quality.*
- *The presence of alien invasive plants within the riparian zone of rivers which can result in erosion and sedimentation.*
- *Dams are scattered throughout the catchment, sited on most rivers, which impact on the movement of sediment, temperature and oxygen levels in particular.*

Conclusion: Water quality hotspots

Water quality hotspots across U60 are shown in the Table 4.4.

Table 4.4 Water quality hotspots in Catchment U60

SQ reach	River name	Water quality impact (rating)	Water quality issues
U60C-4555	*Mlazi*	*Large (3)*	*Urban and industrial effluents, so high nutrient and salt load.*
U60C-4556	*Sterkspruit*	*Serious (4)*	*Elevated salts, nutrients, toxicants; ID by eThekwini MM as a hotspot.*
U60C-4613	*Wekeweke*	*Large (3)*	*Elevated nutrients and fertilizers.*
U60C-4697	*Sterkspruit*	*Large (3)*	*Urban and industrial effluents.*
U60D-4661	*Mlazi*	*Critical (5)*	*Elevated salts, nutrients, toxicants; ID by eThekwini MM as a hotspot.*
U60E-4792	*Mbokodweni*	*Serious (4) - esp Isipingo River*	*High organic and nutrient load; Isipingo River ID by eThekwini MM as a hotspot.*
U60F-4597	*Mhlatuzana*	*Critical (5)*	*Urban and industrial effluents, so high nutrient and salt load.*
U60F-4632	*Umbilo*	*Critical (5)*	*Urban and industrial effluents, so high nutrient and salt load.*

- *Serious water quality impacts have occurred on the uMlazi River (U60D-4661), where, below the Fongozi Stream, E. coli counts of up to 720 000 have been recorded due to leakage from sewerage works located at Mlazi township. The eThekwini SOR Report recorded high E. coli counts, nutrient loading (phosphate and nitrogen) and in some instances potentially toxic levels of unionised ammonias, including low dissolved oxygen concentrations in the lower reaches. Impacts at KwaNdengezi show high nutrient concentrations and moderate bacterial loads. Water quality below the N2 is poor, presenting high SRP and nitrogenous nutrients with bacterial loads evident (eThekwini SoR, 2006).*
- *Serious water quality impacts have occurred on the Mbokodweni River (U60E-4792). The eThekwini Unicity River Quality Index (2011) also classifies river reaches as Poor to Critical due to ineffective sanitation, while the eThekwini SOR (2006) states that it is highly polluted. The monitoring site above the Old Main Road and below the eThekwini Municipal Izimbokodweni sewer station is highly polluted with E. coli, phosphorus and unionised ammonia, with solid waste disposal occurring and a high density of aquatic water hyacinth (eThekwini SoR, 2006).*
- *Serious water quality impacts have occurred on the Umbilo River (U60F-4632), with high E. coli counts occur at Paradise Valley Nature Reserve and below the WWTW, with high nutrient loading and potentially toxic levels of unionised ammonias. Downstream of the confluence with the Umkhumbane numerous point and diffuse source pollution discharges have impacted water*

quality e.g. SRP concentrations were 24 times in excess of the Target Water Quality Range (TWQR). Nitrogenous nutrients were very high. Downstream of the Umbilo WWTW SRP concentrations were 44 times in excess of the TWQR, the toxic form of ammonia was within the chronic effect range and high faecal contamination (110 000 E. coli counts recorded per 100mL) (eThekwini SoR, 2006).

- *Critical water quality impacts have occurred on the Mhlatuzana (U60F-4597) SQ catchments. Above the Sipingo WWTW, E. coli counts of up to 10 000 000; and exceeding 100 000 60% of the time, have been recorded due to broken sewerage infrastructure. According to the eThekwini SoR (2006), discharged of effluents from the upstream WWTW is causing very poor water quality in the Sipingo (upstream of the confluence with Mbokodweni). The report also states that the Mhlatuzana is highly polluted, with high E. coli counts at Kenneth Stainbank Nature Reserve, high nutrient loading and potentially toxic levels of unionised ammonias due to point and non-point pollution. (Note that the upper Umhlatuzane catchment, at Lello Road Bridge, water quality conditions are very good). (eThekwini SoR, 2006). The eThekwini Unicity River Quality Index (2011) also classifies the Sipingo river reaches as Poor to Critical due to ineffective sanitation.*

4.3.7 U70: Lovu catchment

The Lovu River is the major river of this tertiary catchment, with several tributaries draining into it, namely: Serpentine, un-named tributary, Mgwahumbe and Nungwane. Several smaller systems lie along the coast, flowing into the Indian Ocean, namely (from north to south): aManzimtoti, Little aManzimtoti, Msimbazi, uMgababa and Ngane. The catchment consists of 16 sub-quaternary (SQ) catchments, extending across three district municipalities (uMgungungdlovu, Ugu, eThekwini).

Sugarcane plantations (irrigation) and forestry (afforestation), including informal cattle farming, are the predominant land uses in the Lovu Catchment, with Richmond and Amanzimtoti representing the main urban land use areas. Transformation of natural cover indicates extensive transformation. Two of the smaller Mgwahumbe SQ catchments are however still largely natural. E. coli, phosphates (SRP, i.e. Soluble Reactive Phosphate) and turbidity are problematic in the catchment, which is probably due to livestock farming, intensive sugarcane farming (Umgeni Water, 2011; 2012), sand mining and inefficient WWTWs. A summary of wastewater impacts are therefore as follows:

- *Non-point source pollution (pesticides, fertilizers, elevated salt and nutrient levels) from agriculture (mostly sugarcane plantations).*
- *Non-point source pollution from residential areas (urban and rural townships) e.g. stormwater run-off, washing in rivers.*
- *Point source pollution from industrial discharge points (sugar and paper mills etc.) and urban infrastructure (e.g. sewage, wastewater treatment works non-compliance).*
- *Sand mining activities, with concomitant erosion and sedimentation problems resulting in high turbidity. Erosion and sedimentation has been raised as an issue in the catchment (Umgeni Water, 2011).*
- *E. coli, SRP and turbidity are problematic in the catchment, which is probably due to livestock farming (E .coli), intensive sugarcane plantations (Umgeni Water, 2011; 2012), sand mining, sewage discharge and overgrazing.*
- *The presence of alien invasive plants within the riparian zone of rivers due to the removal of indigenous vegetation for agriculture and sand mining. In-stream dams are scattered throughout the catchment, which impact on the movement of sediment, temperature and oxygen levels in particular.*

Green Drop ratings

The 2012 Green Drop report for Wastewater Treatment Works (WWTW) that potentially impact on rivers (DWA, 2012c), did not indicate any non-compliance in terms of wastewater quality in quaternary catchments U70A, U70B and U70C (Umgungungdlovu DM: Richmond and Mkhambathini LMs). The 2012 risk assessment did not identify any critical or high risk plants in these three catchments either, or in U70D, U70E (Ugu DM, Vulamehlo LM), U70F (eThekwini) and U70F (Ugu DM, Vulamehlo LM and eThekwini respectively). In fact, the Richmond WWTW is operating more affectively, with no final effluent risks indicated (DWA, 2012a).

Water quality status quo

According to the PES study (DWA, 2012b), the majority of the sub-quaternary catchments (11 of the 16) have a small impact on water quality. The Lovu SQ catchment (U70B2-4655) has a moderate impact due to a combination of factors, e.g. nutrient loading, sand mining and waste disposal. The Lovu SQ catchment (U70D3-4905), including the Manzimtoti and Little Manzimtoti SQ catchments, are also moderately impacted due to nutrient loading and high density urbanization. The Ngane SQ catchment (U70E-5010has a large impact on water quality due to wastewater effluents from the WWTW in the lower reaches. The eThekwini Unicity River Quality Indices (2011) demonstrate that all the coastal rivers (includes the lower reaches of the Lovu River) are either in a poor or critical category due to ineffective sanitation, which is indicative of high density urban development along the coastline.

Conclusion: Water quality hotspots

Water quality hotspots across U70 are shown in the Table 4.5.

Table 4.5 Water quality hotspots in Catchment U70

SQ reach	River name	Water quality impact (rating)	Water quality issues
U70B-4655	*Lovu*	*Serious (4) - around Richmond only*	*WWTW and urban centre; fertilizers and pesticides.*
U70D-4905	*Lovu*	*Large (3)*	*Oil and diesel pollution; sugar mill; elevated nutrients.*

4.3.8 U80: South coast – Mpambanyoni to Mzumbi rivers

This extensive tertiary catchment is located in the Middle South Coast region extending from the Scottburg in the north (Mkomazi River) to just north of Port Shepstone in the south. The key rivers include, from north to south, Mahlongwana, aManghlongwa, Mpambanyoni (tributary Ndonyane), Mzimayi, Mzinto, Mkumbane, Sezela, Mdesingane, Fafa, Mvuzi, Mtwalume (tributaries Quha, uMngeni), Mnamfu, KwaMakosi, Mfazazana, Mhlungwa, Mhlabatshane, Mzimayi and Mzumbe (tributary Kwa-Malukaka). To the south of Mzumbe are several smaller coasal rivers, namely: Intshambili, Koshwana, Damba, Mhlangamkulu and Mtentweni. These rivers together comprise 12 quaternary catchments, namely U80A – U80L, which are further sub-divided into 33 sub-quaternary catchments that span two district municipalities (Sisonke and Ugu), although most of U80L covers the eThekwini MM.

Agricultural land uses, in the form of forestry (afforestation) and irrigated cultivation (sugarcane) is extensive in the catchment, with a number of small urban areas scattered along the coast and inland. Tribal land dominates (Mullins, Conningarth, pers. comm., February 2013). On average,

35.4% natural vegetation cover remains in U80, with 23 of the 33 SQ catchments comprising less than 50% natural cover, indicating significant transformation levels.

Two large impoundments are positioned within this catchment, namely the Umzinto Dam on the Mzinto River (SQ catchment U80H-5109) and the EJ Smith Dam on the Mzimayi River (SQ catchment U80H-5120). During summer low flow and peak holiday periods, these catchments are stressed due to domestic and industrial demands.

Urban centres include the following:

- *Freeland Park, Hazelwood, Kelso, Pennington, Umzinto and Park Rynie; supplied by the Umzinto Water Treatment Plant (WTP)*
- *Elysium, Ifafa, Mtwalume and Sezela; supplied by Mtwalume WTP.*

Green drop ratings

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

- *Scottburgh WWTW in the Mpambanyoni SQ catchment (U80K); uMdoni LM, Ugu DM:* **Low Risk**.
- *Pennington in the Mzinto SQ catchment (U80H), between the Mkhumbane and Mzinto rivers; uMdoni LM, Ugu DM:* **Medium Risk** *(due to low effluent and microbiological compliance).*
- *Umzinto WWTW in the Mzinto SQ catchment (U80H), upstream of the Mzimayi River; uMdoni LM, Ugu DM:* **Medium Risk** *(low effluent compliance).*

No WWTWs were categorized as critical or high risk plants.

Water quality status quo

Urban, agricultural (sugarcane) and industrial land use activities in the upper reaches of the Mzimayi River catchment (U80H) have caused increased nutrient concentrations in the past. Excess nutrients however still impact the system due to the surrounding informal settlements and poor sewage infrastructure, as recorded in the EJ Smith Dam. Algal counts exceeded the RQO threshold during 2010 in the Mtwalume River, while sand mining upstream of the Mtwalume WTP has caused an increase in turbidity levels (Umgeni Water, 2011). The Mzinto SQ catchment (U80H-5109) shows nutrient loading from high density urban development and agriculture, while the Mahglongwana SQ catchment (U80L-5020) is moderately impacted as a result of surrounding rural settlements and sand mining.

Note that the Illovo Sugar Mill is on the Sezela Estuary and impacts on the estuary rather than the river.

Conclusion: Water quality hotspots

Water quality hotspots across U80 are shown in the Table 4.6 below.

Table 4.6 Water quality hotspots in Catchment U80

SQ reach	River name	Water quality impact (rating)	Water quality issues
U80H-5109	*Mzinto*	*Serious (4)*	*Elevated nutrients; possible impact of WWTW*
U80H-5120	*Mzimayi*	*Large (3)*	*Possible impact of WWTW in Umzinto; low confidence*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U80L-5056	Mahglongwana	Large (3)	Elevated nutrients (including pesticides and fertilizers)

4.3.9 T40: Mtamvuna catchment

The Mtamvuna Key Area is a largely undeveloped catchment. The only significant water requirement is for domestic (both urban and rural areas) use, primarily for the coastal towns (e.g. Port Shepstone and Margate) which are mostly supplied through transfers from the Mzimkulu River (i.e. Port Shepstone). Other large towns include Port Edward and Izingolweni. There are large areas of dryland sugar cane in the catchment but the reduction in runoff due to this has little impact on the available yield because of its location along the coast. Irrigation in the catchment is insignificant. The Mtamvuna catchment therefore consists mostly of communal land which explains the large rural water requirement. There are also large areas of afforestation (DWAF, 2004a).

Green drop ratings

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

- *Margate WWTW in the Ugu DM, SQ catchment T40G-05739:* **Low Risk***.*
- *WWTW upstream of the Tongazi Estuary (T40F-05879: rating unknown.*

No WWTWs were categorized as critical or high risk plants according to DWA (2012c).

Water quality status quo

Due to the undeveloped nature of the catchment, water quality status is generally Good throughout the area.

Conclusion: Water quality hotspots

No water quality hotspots were identified in this catchment area.

4.3.10 T51 and T52: Umzimkulu catchment

The catchment is broadly characterised by having the headwaters in an area which is under conservation (i.e. the Ukhahlamba Drakensberg Park (Garden Castle Forest), a World Heritage Site) and then passes through alternating bands of subsistence farming and commercial agriculture (including commercial plantations, sugar cane and dairy farming) (DWAF, 1999a) until it reaches the Indian Ocean at Port Shepstone. The upper part of the catchment is therefore characterised by agricultural development and forestry, mainly under irrigation and fed by numerous farm dams. There are large areas if irrigated cropland in the Drakensberg foothills around Underberg. Tourism also plays a large role in the upper catchment.

The middle part of the catchment is predominantly rural tribal trust land and formed part of the previously independent Transkei, with scattered subsistence rural communities drawing water from run-of-river. In the lower middle reaches, there are a number of rural water supply schemes, drawing water from local streams, boreholes and springs. Lower down, the river enters the Oribi Gorge Nature Reserve, another World Heritage Site (DWA, 2011b).

Towns in the area include Underberg, Himeville, Creighton, Umzimkulu, Harding and Port Shepstone. The natural condition of much of the catchment (especially in the high and low

reaches) dampens the negative ecological effects of the human activities concentrated mainly in the mid-reaches.

Green drop ratings

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

- *Underburg WWTW; Sisonke DM:* **Medium Risk***.*
- *UuMzimkulu WWTW on the UMzimkulu River; Sisonke DM:* **Low Risk***.*
- *Harding WWTW on the Mzimkhulwana River; Ugu DM:* **Low Risk***.*

No WWTWs were categorized as critical or high risk plants in DWA (2012c).

Water quality status quo

A comprehensive assessment of the water quality situation of the Umzimkulu catchment area was undertaken, with data collected up to 1999, as part of the Southern KwaZulu-Natal Water Resources Prefeasibility Study (DWAF, 2002). This study found that water quality data indicated good water quality with no significant signs of pollution, or any adverse trends in water quality, for the Upper Umzimkulu Basin.

DWA (2011) noted specific concerns about the state of the river near the town of Umzimkulu in the Middle Umzimkulu Basin. It was recommended that a water quality study be undertaken in that area to identify potential pollution sources and management interventions to address local impacts.

Quality in the Mzimkhulwana River of the Lower Basin was found not to be as good as that in the other basins, probably due to agricultural use (DWA, 2011b).

The following paragraph is summarized from DWA (2011b): Despite the developments that have taken place in the catchment area, the water quality remains relatively good due to the non-polluting nature of the development in the area and the relative isolation of settlements from open water. The greatest water quality risk is the town of Umzimkulu which discharges effluent directly to the river. These issues are exacerbated by large-scale water abstraction from the system.

Conclusion: Water quality hotspots

No riverine water quality hotspots were found in this catchment area. Impacts of Port Shepstone and Mzimkulu Sugar Mill are on the estuary.

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

5.1 INTRODUCTION

The Mvoti to Umzimkulu Water Management Area (WMA 11) is one of four major WMAs located within KwaZulu-Natal, with an estimated total area of 34 966 km^2, or 37% of the total area of the province. It also covers seven district municipalities, notably the eThekwini Metropolitan and the uMgungundlovu District Municipalities, the economic and administrative heartlands of KwaZulu-Natal.

WMA11 contains a number of major river systems including the Mvoti, Tongaat, Mdloti, Mgeni, Mkomazi and Umzimkulu Rivers. The Mgeni River in particular functions as the main source of water for the Durban to Pietermaritzburg area, with a number of fully regulated large dams such as Midmar, Inanda, Albert Falls and Nagle dams. Other river systems in WMA 11 vary in terms of the level of development and rivers such as the Mkomazi and Umzimkulu remain largely undeveloped (DWAF, 2004a)

Based on Census 2011, a total population of just fewer than 7 million individual is located in the WMA 11 area. The average population density is 166 individuals per square kilometre (km^2). The spatial distribution of this population shows a sharp transition from low density rural populations with limited development to high density urban environments where water is largely sourced from formal systems.

WMA 11, because of the nature of the communities that it intersects, plays an important role in maintaining important Ecological Goods, Services and Attributes (EGSA) on-site as well as other users. An EGSA is a product that emerges from processes or features within largely natural environments, which enhances human wellbeing and is directly used by people. Natural capital and associated ecosystem services are now becoming scarce and the Millennium Ecosystems Assessment (MEA) partitions ecosystems services into four broad categories:

- *Provisioning services are the most familiar category of benefit, often referred to as ecosystem 'goods', such as foods, fuels, fibres, bio-chemicals, medicine, and genetic material, that are in many cases: directly consumed; subject to reasonably well-defined property rights (even in the case of genetic or biochemical material where patent rights protect novel products drawn from ecosystems); and are priced in the market.*
- *Cultural services are the less familiar services such as religious, spiritual, inspirational and aesthetic well-being derived from ecosystems, recreation, and traditional and scientific knowledge that are: mainly passive or non-use values of ecological resources (non-consumptive uses); that have poorly-developed markets (with the exception of ecotourism); and poorly-defined property rights (most cultural services are regulated by traditional customs, rights and obligations); but are still used directly by people and are therefore open to valuation.*
- *Regulating services are services, such as water purification, air quality regulation, climate regulation, disease regulation, or natural hazard regulation, that affect the impact of shocks and stresses to socio-ecological systems and are: public goods (globally in the case of disease or climate regulation) meaning that they "offer non-exclusive and non-rival benefits to particular communities" (Perrings, 2006); and are thus frequently undervalued in economic markets; many of these are indirectly used being intermediate in the provision of cultural or provisioning services.*

- *Supporting services are an additional set of ecosystem services referred to in the MEA, such as nutrient and water cycling, soil formation and primary production, that capture the basic ecosystem functions and processes that underpin all other services and thus: are embedded in those other services (indirectly used); and are not evaluated separately (Mander et al., 2007).*

5.2 APPROACH

In terms of generating data for this report the most important step was to provide an integrated assessment of the current population of all three areas. Analysis was undertaken using four primary tools. These were:
The 2001 census as adjusted and the 2011 census data that is available.

- *Geographic Information System (GIS) overlays of quaternary catchments and the census "sub place name" data. "Sub place name" data fields are the most detailed subsets of data released by Statistic South Africa. This allows for the population for each quaternary to be calculated and a profile of the population for each unit to be analysed. Data was analysed to select areas in which populations likely to be dependent on riverine goods and services were possibly or probably present.*
- *Cross check of the GIS data sets with available mapping to determine likely livelihood styles and profiles.*
- *Limited site visits to likely "hot spots"*

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

Further, each quaternary catchment of the Mvoti to Umzimkulu System has been examined in detail via the analysis of socio-cultural importance. The Socio Cultural Importance (SCI) was determined from (a) a site visit that covered points along the river, (b) extrapolation to sites not visited by reference to available literature as well as to exiting mapping. Given the size of the budget and the geographical scope of the work most of the information used to influence the score was derived from direct observation and consideration of the literature available. A limited number of direct interviews were held with people who are resident proximate to the river.

In order to generate the SCI model, information was extracted in a 'master spreadsheet' that incorporates all the SCI results. Each secondary catchment within the WMA has its own set of spreadsheets. Column descriptions in the SCI sheet in the master spreadsheet are as follows:

- *Column A: Sub quaternary (SQ) number: Individual code provided for each SQ by DWA and based on the codes used in the National Freshwater Ecosystem Priority Area (NFEPA) assessment.*
- *Column B: River: River name where available.*
- *Column C: Summarised comment on the SQ and river reach.*
- *Column D: Score for ritual usage. This was scored between 0 - 5. The question that was asked was "How much ritual use of the river takes place?" Typically this would be for ceremonial purposes or for spiritual/religious activities.*
- *Column E: Weighted score for Aesthetic Value: Ritual use is given a weighted score of 40 points. So a score of 3 out of 5 in Column D would result in a weighted score of 120.*

- *Column F Aesthetic Value: This was scored between 0 - 5. The question that was asked was "How important is the aesthetic value to people? Does the river stretch add value to people's life as an object of natural beauty? Would changing flows detract from this value?"*
- *Column G: Weighted score for Aesthetic Value: Aesthetic Value is given a weighted score of 20 points.*
- *Column H Resource Dependence: This was scored between 0 - 5. This refers to the goods and services delivered by the river system and peoples dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. It should be noted that commercial or "for financial gain" usage of resources is excluded from consideration in this instance. Both intensity and significance of use are valued and the higher of the two scores is adopted.*
- *Column I: Weighted score for Resource Dependence: Resource Dependence is given a weighted score of 100 points.*
- *Column J Recreational Use: This was scored between 0 - 5. The question that was asked was "Does the river stretch provide recreational facilities to people and would this be affected by changing flows?"*
- *Column K: Weighted score for Recreational Use: Recreational Use is given a weighted score of 50 points.*
- *Column L Historical/Cultural Value: This was scored between 0 - 5. The question that was asked was "Does the river have a strong cultural or historical value?"*
- *Column M: Weighted score for Historical/Cultural Value: Historical/Cultural Value is given a weighted score of 75 points.*
- *Column N: This is the overall SCI score derived by adding the weighted scores and dividing by the number of criteria and as a proportion of the overall maximum score.*

A key component of the SCI model is the category "Resource Dependence". This refers to the goods and services delivered by the river system and people's dependence on these components. This is usually a critical element of the SCI score and is designed to cater for river resource dependence by those who rely directly on such aspects for their survival. The categories "Recreational Use" and "Ritual Use" were also examined. The SCI model was compared to the evaluation of likely areas of importance with regard to goods and services.

5.3 DESCRIPTION OF EGSA

It should be noted that the objective in describing and valuing the use of aquatic ecosystems is to determine the way in which aquatic ecosystems are currently being used in each socio-economic zone, and to estimate the value generated by that use. This provides the baseline against which the socio-economic and ecological implications of different catchment configuration scenarios can be compared. It is important to point out that while EGSAs will be identified and described in qualitative terms, a baseline value can often only be described for some of these, as the information required is not available without investing in a costly survey. As such it is therefore more practical to measure changes in EGSA values relative to a reference point rather than computing a baseline value. For the purposes of this exercise the baseline value is described as a value of 1. The most important EGSA associated with the overall system and likely to be impacted by changes in operational and management scenarios are the following:

- *Recreational fishing.*
- *Subsistence fishing.*
- *Other recreational aspects associated with the rivers.*

- *Thatch grass harvesting.*
- *Reed harvesting.*
- *Other riparian vegetation usage.*
- *Sand mining.*
- *Waste water dilutions.*
- *Floodplain agricultural usage of subsistence purposes.*
- *The aesthetic value of the river and associated aquatic systems in their intersection with the recreation value of the Drakensberg.*
- *Dis-benefits associated with Malaria, Bilharzia, Black fly and livestock disease.*

5.4 STATUS QUO ASSESSMENT

The socio-economic profile was defined to place the wider catchment strategy in the existing socio-economic context. In Chapter 3 of this report some detail of the prevailing socio economic situation in the WMA is provided. Due to the large catchment area of the WMA, the profile was established at the district and local municipal level. The municipalities located within the WMA, and therefore part of the study, are highlighted in Table 5.1.

Table 5.1 District and local municipalities located within the WMA

District Municipality	Local Municipality	Demarcation Board Code
eThekwini Municipality		*Durban*
uMgungundlovu District Municipality (DC21)	*uMshwathi Municipality* *uMngeni Municipality* *Mpofana Municipality* *Impendle Municipality* *Msunduzi Municipality* *Mkhambathini Municipality* *Richmond Municipality* *KZDMA22*	*Kz221* *Kz222* *Kz223* *Kz224* *Kz225* *Kz226* *Kz227* *KZDMA22*
Sisonke District Municipality (DC43)	*Ingwe Municipality* *Kwa-Sani Municipality* *Greater Kokstad Municipality* *Ubuhlebezwe Municipality* *UUmzimkulu Municipality* *KZDMA43*	*Kz5a1* *Kz5a2* *Kz5a4* *Kz5a5* *Kz5a6* *KZDMA43*
iLembe District Municipality (DC29)	*Mandeni Municipality* *KwaDukuza Municipality* *Ndwendwe Municipality* *Maphumulo Municipality*	*Kz291* *Kz292* *Kz293* *Kz294*
Umzinyathi District Municipality (DC24)	*Endumeni Municipality* *Nquthu Municipality* *Msinga Municipality* *Umvoti Municipality*	*Kz241* *Kz242* *Kz244* *Kz245*
Ugu District Municipality (DC21)	*Vulamehlo Municipality* *Umdoni Municipality* *Umzumbe Municipality* *Umuziwabantu Municipality* *Ezingoleni Municipality* *Hibiscus Coast Municipality*	*Kz211* *Kz212* *Kz213* *Kz214* *Kz215* *Kz216*
Uthukela District Municipality (DC23)	*Emnambithi Municipality* *Indaka Municipality* *Umtshezi Municipality* *Okhahlamba Municipality* *Imbabazane Municipality* *KZDAM23*	*Kz232* *Kz233* *Kz234* *Kz235* *Kz236* *KZDMA23*

The socio-economic profile was established based on the desktop review of existing studies and information for the applicable district and local municipalities. Specifically, this included a review of the latest versions of the district and local municipal Integrated Development Plans (IDPs). These plans were further supplemented by the analysis of Census 2001 and 2011 (note: Census 2011 data was not initially available at the time of the study), Community Survey 2007 data and other applicable sources. Land-Use was determined via existing GIS coverage and DWA Internal Strategic Perspectives (ISP) developed for the WMA.

Socio-economic zones where established to provide a catchment level framework of socio-economic conditions against environmental factors, and act as a starting point for the identification of priority communities. These zones were also important for the delineation of Integrated Units of Analysis (IUAs). Criteria used for the establishment of socio-economic zones are summarised in Table 5.2.

Table 5.2 Criteria for the determination of socio-economic zones

Criteria	Variables
Urban / Rural Setting	*Urban and rural areas as defined by Census 2001 and 2011.*
Land-Use	*Land-use as defined by overview analysis of mapping.*
Land-Tenure	
Water and Aquatic Resources	
Tertiary Catchments	*Tertiary catchments as defined by watershed/catchment spatial data.*

The definition of socio-economic zones was undertaken using spatial data that reflects the criteria provided in Table 5.2, employing ArcMap 9. This included the establishment of separate layers for each criterion that depicted key variables. The definition of socio-econmic zones was undertaken via a qualitative assessment of the above criteria, and no formal classification was adopted.

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

An index or set of criteria was established to determine which areas and communities may be considered vulnerable and dependant on EGSA. For each criterion, a number of variables or thresholds were determined to permit the identification of specific areas/communities via spatial mapping. The criteria and thresholds are defined in Table 5.3.

Table 5.3 Criteria for the determination of priority communities with high EGSA dependence

Criteria	Variables/Indicator	Rationale
Rural Areas/Communities	*Rural areas as defined by Census 2001and as available for 2001.*	*Service delivery in rural areas is usually restricted and poorer communities are likely to be dependent on natural resources.*
	Population density of less than 500 people per km^2, or	*Population density as a determinant of urban/rural environment, with variable as defined by Statistics SA (Census, 2011).*
	Tribal Authority Land as defined in Census 2001.	*Tribal Authority lands is typically rural and historically has seen little investment in formal infrastructure, their communities are likely to be dependent on natural resources.*
Water Supply	*Where water supply to a significant percentage*	*The lack of formal water infrastructure restricts*

Criteria	Variables/Indicator	Rationale
	of local population (greater than 33%) is provided by natural resources. Census 2001 water supply criteria functions of key variables specifically (1) boreholes, (2) spring, (3) dam/pool/stagnant water, (4) river/stream, (5) water vendor and (6) other	*local communities to source water from natural sources.*
Sanitation	*Majority of local population dependant on (1) pit latrines, (2) bucket latrine or none (as defined by Census 2001).*	*Limited formal sanitation is provided to a significant percentage of the local population, which are therefore reliant on natural resources.*
Economic Development	*1. Poverty Lines 2. Income Levels 3. Economic Growth*	*Areas or communities where a significant proportion of the population (greater than 33%) are below the poverty line.*
Subsistence	*1. Areas or communities where subsistence agriculture is the primary land-use.*	*Areas or communities that are largely dependent on subsistence agriculture will likely be dependent on natural resources, with limited access to formal infrastructure.*
Recreation/ Tourism	*1. Popular fishing and recreational areas. 2. Tourism hot-spots. 3. Recreational hot-spots*	*Aquatic resources provide for recreational and tourism activities, specifically around fishing, water based recreational activities, and aesthetic value.*
Infrastructure Delivery	*Developed urban, freehold rural or communal tenure rural/closer settlement.*	
Land Tenure	*Communal or Freehold title.*	
Community Health	*Health indicators including malnutrition, infectious diseases, waterborne diseases and water quality related diseases.*	*Health status is a proxy determinant of the overall access and quality of ecosystem services due to its impacts on community heath.*

Census 2011 spatial data formed the basis for the classification of criteria and variables defined in Table 5.3 as it is the only data source with sufficient coverage of the MWA. The minimum level adopted for this study was determined by Census 2011 as the sub-place.

The identification of areas and communities was undertaken via a spatial mapping using ArcMap 9. This entails the generation of spatial layers for each of the criterion noted in Table 5.3. Priority areas and communities were determined using a combination and qualitative analysis and simple weighted factor analysis. The former is better suited on the identification of areas/communities based on expert judgement, while the latter allows for the determination of degrees of vulnerability of each area/community. Further analysis of the catchment per SQ generated an overview of the overall socio-economic condition that pertains and likely significance of dependence on EGSA. Criteria as per Table 5.3 were summarised in a single score entitled resource dependence and linked to overall socio-cultural importance assessment of the SQ. The score used was between 0 (no resource dependence significance) and 5 (extreme dependence of significant communities on riverine EGSA). Table 5.4 below sets out the SQs that have high scores (4) or very high scores (5). A full set of tables that reflect these scores, as well as the other SCI aspects is provided on a CD which will entail all such data for this project.

For the most part areas with high resource dependence and associated EGSA utilisation by communities are in areas that were contained within the former homelands of KwaZulu and parts of the Eastern Transkei. Development within WMA 11 is uneven and reflects much of the apartheid history that characterised planning for most of the latter half of the 20th century. So for example, the coastal belts in the lower reaches of the river systems are particularly highly developed and this reflects the degree to which the competitive advantages inherent in the coastal resort area were, turned into economic benefits and as a result became urbanised and well serviced. Fertile areas with higher rainfall were settled by colonial famers in the 19th century. These have more or less remained in the hands of commercial farming enterprises and although not as well developed in terms of services as some of the urban areas at least reflect a degree of

rural economic cohesion. Typically those areas demarcated as "tribal" or "homeland" areas were not as effectively developed and, following the dictates of apartheid planning, regarded as home to the more marginalised sectors of society. In these areas dependence on natural resources is high and therefore the demand for land and natural resources has the potential to lead to lead to erosion in the catchment and consequential sedimentation of the River. The Mkomazi River is a stark example of this. Although this cannot be conclusively proven without dedicated research over time, the link between poverty, population pressure and resource degradation has been demonstrated.

Table 5.4 SQs with high EGSA dependence

SQ number	River	Summary of Status Quo and linked EGSA Importance
U1 Mkomazi		
U10D-04349	*Mkomazi*	*River section is 9 km in extent. Extent is entirely rural with rural, scattered (hamlets) households located along much of the river extent. There is informal agriculture taking place. Evidence of significant dependence on EGSA among households proximate to river.*
U10J-04820	*Lufafa*	*River section is 33 km in extent. Extent is entirely rural with subsistence linked scattered households extending for 36% of the river extent. There is evidence of considerable subsistence agriculture.*
U10K-04899	*Xobho*	*River section is 36 km in extent. Extent is entirely rural with urban elements linked to Ixopo town which is located on the south bank of the river. Lower reaches of the river (50%) largely comprised of river-bank linked informal agriculture with settlement, although not in proximity to the river they are custodians of agricultural endeavours.*
U10M-04746	*Mkomazi*	*River section is 30 km in extent. Extent is rural inland, while it includes urban elements near the coast. The upper reaches (20%) are open terrain/natural vegetation due to the deeply incised river banks. The middle and lower 60% of the river extent is largely comprised of rural, scattered household settlement, that are located near the river bank where possible or on elevated areas where the bank slope is steep. There is evidence of, informal subsistence agriculture along the river bank near the settlements.*
U2 Mgeni		
U20K-04296	*Tholeni*	*River section is 20 km in extent, and is entirely rural. Upper reaches (10%) comprised of formal agriculture. Remaining river extent is comprised of extensive rural settlements (with low to moderate densities) and extensive informal agriculture and links to EGSA.*
U20L-04435	*Mgeni*	*River section is 16 km in extent, and entirely rural. Land-use is a mixture of rural settlement and open terrain. The former is restricted to gentle slopes along the river banks and entails low density households and informal agriculture. Open terrain/natural vegetation is restricted to steep river banks that limit human activities.*
U20M-04396	*Mgeni*	*River section is 45 km in extent, and contains rural and urban elements. Upper reaches (15%) comprised of open terrain/natural vegetation with some rural, low density settlements. A third of the river extent is within Inanda Dam which is surrounded by extensive low to moderate density settlements. Lower reaches of the river extent, comprised of deeply incised river valleys and extensive urban settlement on the plateaus, and on the river banks where slope is more gentle. River extends into the Springfield industrial area.*
U3 Mdloti and environs		
U30C-04272	*Mona*	*River section is 36 km in extent. Land-use is rural and nearly exclusively comprised of rural, scattered households along the entire extent of the river. Informal agriculture was noted along the river banks in proximity to the households. Other land-uses are limited to open terrain/natural vegetation.*
U30A-04228	*Mdloti*	*River section is 30 km in extent. Land-use is rural and nearly exclusively comprised of rural, scattered households along the entire extent of the river. Considerable informal agriculture was noted along the river banks in proximity to the households.*
U30A-04363	*Mwangala*	*River section is 15 km in extent. Land-use is rural and nearly exclusively comprised of rural, scattered households along the entire extent of the river. Informal agriculture lined to poorer households was noted along the river banks in proximity to the households. Other land-uses are limited to open terrain/natural vegetation where steep slopes limit land-use options.*
U30C-04227	*Tongati*	*River section is 36 km in extent. Land-use is rural and nearly exclusively comprised of rural, scattered households along the upper reaches (27%) of the river, as well as along the southern side of the river for its remaining extent. There is evidence of informal agriculture. Open terrain/natural vegetation is a dominant land-use and is located*

SQ number	River	Summary of Status Quo and linked EGSA Importance
		between the scattered households.
U4 Mvoti		
U40E-03985	*Mvoti*	*River section 26 km in extent, and entirely rural. Deeply incised valley but broad valley bottom therefore open terrain/natural vegetation dominant. Considerable rural, low density settlements located along river extent and informal agriculture noted. Poorly developed and impoverished.*
U6 Umlazi and environs		
U60E-4795	*Bivane*	*River section is 22 km in extent. Extent is entirely rural. Upper reaches (30%) is comprised exclusively of rural, low density settlements with extensive cultivation along the river banks. Lower reaches (70%) comprise of deeply incised valley bottoms with rural, low density settlements on the ridges. Links to EGSA evident.*
U7 Lovu and environs		
U70D-4905	*Lovu*	*River section is 10 km in extent, and contains rural and urban elements. Upper reaches (60%) comprised of rural, low to moderate density settlements nearly continuously along this stretch. Limited agriculture noted. Lower reaches include sugar cane (30%) and the system estuary (10%) and associated residential area (Illovo) linked to the system estuary. Moderate amenity value but high EGSA value.*
U70E-4942		*River section is 10 km in extent, and contains rural and urban elements. Entire river extent is comprised of rural, low density settlement and high density townships near the coast. There is limited formal agriculture (sugar) on the north bank of 30% of the river extent but the rest appears to be informal and subsistence utilisation.*
U8 Ifafa and environs		
U80C-5329	*Kwa-Malukaka*	*River section is 25 km in extent, and is entirely rural. The landform of much of the river extent (90%) is gentle and is largely comprised of rural settlements and extensive informal agriculture. Lower 10% is comprised of deeply incised river valleys limiting land-use to open terrain/natural vegetation.*
U80E-5028	*Mtwalume*	*River section is 60 km in extent, and is entirely rural. Upper reaches (33%) comprised for plantation forestry. Mid-reaches (33%) comprised of extensive rural settlement (low-density) although limited to due to steep river banks, however EGSA appears to be important given status of communities. Lower reaches (33%) comprised of open terrain/natural vegetation due to deeply incised river banks.*
U80F-5301	*Mgeni*	*River section is 17 km in extent, and is entirely rural. Upper reaches (11%) is comprised of natural forest. Thereafter river extends into open terrain/natural vegetation with a low density of rural villages (45% of river extent). Lower reaches (45%) comprised on formal agriculture (sugar). Additional settlements and extensive informal agriculture located at river confluence with high EGSA importance.*
U80L-5020	*aMahlongwa*	*River section is 30 km in extent, and is entirely rural. Extent is nearly exclusively comprised of rural settlements of varying density (low density to high density townships). Informal agriculture present and abundant. High EGSA importance. Natural vegetation/open terrain noted on the system estuary, with a residential area (formal, established) on the south bank of the estuary.*
T4 Mtamvuna		
T40A-5487	*Goxe*	*River section is 29 km in extent, and is entirely rural. Seven rural settlements noted (scattered, low density households) noted on the remainder of the river extent, including evidence of significant informal agriculture near the settlements and on the river banks. Remaining land-use is open terrain/natural vegetation between the settlements.*
T40B-5337	*Weza*	*River section is 30 km in extent, and is entirely rural. The lower reach (50%) is comprised of near continuous rural settlements (scattered, low density households), including evidence of significant informal agriculture near the settlements and on the river banks.*
T40C-5530	*Mtamvuna*	*River section is 5 km in extent, and is entirely rural. The river extent shows rural settlements (scattered, low density households), but significant informal agriculture on the river banks.*
T40C-5566	*Ludeke*	*River section is 10 km in extent, and is entirely rural. The river extent shows rural settlements (scattered, low density households), but significant informal agriculture on the river banks.*
T40C-5589	*Ku-Ntlamvukazi*	*River section is 20 km in extent, and is entirely rural. Upper reaches (25%) is comprised of open terrain/natural vegetation. Six rural settlement noted on the remainder of the river extent, including evidence of significant informal agriculture near the settlements and on the river banks.*
T40C-5600	*Ludeke*	*River section is 17 km in extent, and is entirely rural. Upper reaches (15%) is comprised of open terrain/natural vegetation. Multiple rural settlements noted) noted on the*

SQ number	River	Summary of Status Quo and linked EGSA Importance
		remainder of the river extent, including evidence of significant informal agriculture near the settlements and on the river banks.
T40D-5615	*Tungwana*	*River section is 10 km in extent, and is entirely rural. The river extent shows limited rural settlements, but significant informal agriculture on the river banks. Density of such settlement is low therefore there is considerable open terrain/natural vegetation along the river extent and some evidence of high use of EGSA.*
T40D-5719	*Londobezi*	*River section is 15 km in extent, and is entirely rural. The river extent is comprised of rural settlements on the upper 40% of the river extent, including evidence of significant informal agriculture near the settlements and on the river banks.*
T40E-5601	*Mtamvuna*	*River section is 44 km in extent, and is entirely rural. The river extent is comprised of rural settlement (on much of the west river bank. There is evidence of informal agriculture. There is extensive formal agriculture on the lower reaches (35%) of the river but limited to the east bank, and opposite the rural settlements. Upper reaches (34%) comprised of open terrain/natural vegetation due to steep river valley, which extends through into much of the river extent.*
T40E-5767	*Hlolweni*	*River section is 24 km in extent, and is entirely rural. The upper reaches (45%) comprised of rural settlements (scattered, low-moderate density households) with extensive informal agriculture.*
T40E-5869	*Mtamvuna*	*River section is 15 km in extent, and is entirely rural with urban elements at the river mouth. The upper reaches (20%) are open terrain/natural vegetation linked to a nature reserves. Much of the remaining (70%) of the south-west bank is a township (low to moderate density households). The north-east bank is comprised of formal smallholding and residential areas. The Wild Coast Sun is located at the Estuary suggesting tourism/recreational activities.*
T40F-5770		*River section is 9 km in extent, and entirely rural. Upper 20% comprised of open terrain. Mid reaches (33%) extend through the township of KwaNzimakwe (moderate density, large) with informal farmland along the river banks. Low reaches comprised of formal farmland, and some residential areas.*
T5 Umzimkulu		
T51H-04808	*Gungununu*	*River section is 30 km in extent. Extent is entirely rural but with a significant presence of townships totalling 10 and accounting for approximately 75% of the river extent. There is significant presence of informal agriculture in proximity to the townships and along the river banks. Remaining land-use is predominantly open terrain/natural vegetation with a limited presence of plantations forestry but linkage to EGSA.*
T51H-04923	*Malenge*	*River section is 30 km in extent. Extent is entirely rural but with a significant presence of townships totalling 11 and accounting for approximately 50% of the river extent. There is significant presence of informal agriculture in proximity to the townships and along the river banks.*
T51J-04844	*Ngwangwane*	*River section is 17 km in extent. Extent is entirely rural but with a significant presence of townships totalling 5 and accounting for approximately all of the north bank of river. There is significant presence of informal agriculture in proximity to the townships and along the river banks.*
T52A-04690	*Umzimkulu*	*River section is 20 km in extent. Extent is entirely rural but with the presence of 4 townships largely limited to the south bank of river. There is low presence of informal agriculture in proximity to the townships and along the river banks.*
T52F-05104	*Little Bisi*	*River section is 31 km in extent. Extent is entirely rural but with the presence of 6 townships interspersed throughout the river extent. There is evidence of informal agriculture in proximity to the villages, and near the river banks.*
T52F-05190	*Mbumba*	*River section is 20 km in extent. Extent is entirely rural but with the presence of 4 townships located in proximity to the river. There is evidence of informal agriculture in proximity to the villages.*
T52F-05139	*Little Bisi*	*River section is 13 km in extent. Extent is entirely rural but with the presence of 4 townships located within 2 km of the river. There is evidence of informal agriculture in proximity to the villages. Other than the townships, the river extent is nearly exclusively open terrain/natural vegetation but with high potential EGSA use.*
T52H-05121	*Bisi*	*River section is 18 km in extent. Extent is entirely rural with a small urban element linked to the town of Ibisi and two neighbouring townships, accounting for 30% of the river extent. Land-use on the remaining river extent is comprised of open terrain/natural vegetation with informal extensive agriculture near the towns.*
T52K-05467	*Mzim-khulwana*	*River section is 77 km in extent. Extent is entirely rural with the presence of 3 townships extending along 25% of the river extent. There is evidence of considerable informal agriculture linked to these townships.*

5.5 EGSA ZONES

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

The land use based zones are:

- *Commercial Agriculture and plantation: This is largely given over to zones dominated by commercial farming entities. Utilisation of EGSA tends to be low and restricted often to farm workers or incidental recreational aspects.*
- *Subsistence agriculture: These areas are dominated by subsistence agriculture but in areas where population densities are relatively low. Utilisation of EGSA tends to be higher here and the populations that make use are often poor and marginal. For the most part these are areas that were part of the former homelands of KwaZulu and the Transkei.*
- *Rural Closer Settlement – Subsistence: These are the former homeland areas that have generally higher population densities than the purely subsistence areas. In some instance densities are high enough to be categorised as closer settlement/informal urban. Utilisation of EGSA tends to be higher here and the populations that make use are often poor and marginal. However, the population densities are such that resources tend to be under pressure.*
- *High Density Formal Urban: These are the SQs heavily influenced by the cities of Durban and Pietermaritzburg as well as a number of other hinterland towns and the highly developed coastal belt. The utilisation of EGSA tends to be low as the populations tend to be urbanised and alienated from direct use of the resources.*
- *Drakensberg/Recreational/Dams/Game Farms. These are SQs within the Drakensberg mountain belt, game farms as well as SQs dominated by dams. Recreational usage tends to dominate EGSA.*

6 STATUS QUO ASSESSMENT: ECOLOGICAL WETLAND STATE

6.1 INTRODUCTION

Wetlands are amongst the most impacted and degraded of all ecological systems. Global assessments indicate that a large proportion of wetlands have been destroyed and the majority of remaining wetlands are degraded or under threat of degradation (Finlayson and Spiers, 1999). Begg (1988) estimated that about 50% of KZN's wetlands had been lost, primarily to commercial agriculture.

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

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

What is a Wetland?

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

Wetlands are essentially an expression of the presence of surface or near-surface water in the landscape. This water can either be static (e.g. pans) or slowly moving through the landscape. The source of the water can include surface flow, interflow (water flowing through the soil profile), groundwater (including deep and/or perched groundwater), direct rainfall, or any combination of these. Whatever the source, the water must be present for long enough to influence both the soil properties and the vegetation. In practice, the wetland boundary is defined as the position in the landscape where hydric indicators occur in the soil within 0.5 m of the surface (DWAF, 2005). Where these hydric indicators are deeper than 0.5 m, they generally do not support wetland adapted plants. Thus, the 0.5 m measurement traditionally forms the boundary between terrestrial and wetland adapted plant species (DWAF, 2008b). The formal prescribed approach for delineating wetland extents in the field is described in DWAF (2005).

This report focuses on the wetlands within the Mvoti to Umzimkulu WMA in KwaZulu-Natal. Within this WMA, available desktop maps indicate hundreds (Nel et al., 2011) to thousands (SANBI, unpublished data) of wetlands are present in the WMA. There are too many wetlands to evaluate on an individual basis and a desktop level quaternary-scale catchment assessment of the wetlands across the entire study area was undertaken. This approach allows for the average PES and EIS categories of wetlands within each quaternary catchment to be estimated using available desktop data and has been used in several previous DWA studies. The resultant PES and EIS scores per quaternary catchments provide the estimated average score of all wetlands within the quaternary catchment, with scores reported in the standard Ecological Categories (Table 7.1) and Importance

and Sensitivity Categories (Table 6.1) for PES and EIS respectively. These outputs provide an overview of the current state and importance of the wetlands within the Mvoti WMA, facilitating some basic information and catchment context of wetlands for planning, Water User Licence Application (WULA) assessments and associated desktop RDM processes relating to wetlands.

Table 6.1 Description of the DWAF Ecological Importance and Sensitivity scores (after Kleynhans, 1999)

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

6.2 APPROACH

The status quo assessment of the wetlands focussed primarily on two aspects:

- *Determination of the EIS of the wetlands at the quaternary catchment scale; and*
- *Determination of the PES of the wetlands at the quaternary catchment scale.*

The desktop assessment results were then correlated with field assessment data of some of the key priority wetlands in the study area.

High priority wetlands that are dependent on large (mapped at 1:500 000 scale) rivers and tributaries were also identified to enable hotspots within the study area to be identified.

6.2.1 Quaternary catchment-scale desktop EIS wetland assessment

The river EIS assessment tool (Kleynhans, 2000) has been adapted for use in determining the EIS of wetlands at the quaternary catchment scale. This tool has been applied in wetland assessments of the Upper Vaal, Inkomati and parts of the Gouritz WMAs, and was applied to this WMA. Assessment of site-specific criteria and/or those that require field-data such as direct human benefits (e.g. grazing, subsistence agriculture, etc.) and the potential hydrological functional importance of wetlands (such as flood attenuation) are precluded from the desktop assessment because these cannot be reliably assessed at the quaternary catchment scale.

Available desktop data, including the South African National Biodiversity Institute (SANBI) wetland probability map (SANBI, unpublished data), the NFEPA wetlands layers, vegetation types and conservation status (Mucina and Rutherford, 2006), location of Important Birding Areas (IBAs) and Google Earth™ imagery, were used to assess wetland density, types, sizes, NFEPA status, conservation status of vegetation and IBA information at the quaternary catchment level. These data were used to assess the criteria which influence the EIS of wetlands (Table 6.2) and are scored from low (score of 1) to very high (score of 4).

Table 6.2 The list of criteria used to derive the quaternary scale EIS scores for wetlands

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

Based on these scored criteria, an average weighted score for each quaternary catchment is calculated and EIS categories assigned (Table 7.1). Quaternary catchments with low or marginal wetland EIS indicate catchments with very low densities and/or small wetlands. These are low priority wetland areas which have a few small, isolated wetlands. Due to low wetland density and often cryptic nature of the small wetlands, they cannot be reliably assessed at the desktop level and therefore no PES assessments were undertaken in these catchments.

6.2.2 Quaternary catchment-scale desktop PES wetland assessment

Low confidence desktop estimates of the wetland PES were undertaken for the quaternary catchments of the study area with a moderate or higher EIS. The catchments with low/marginal EIS were excluded since these are low priority wetland areas with few small wetlands which cannot be reliably assessed at the desktop level.

The desktop PES assessment for wetlands uses an approach based on the desktop quaternary scale PES assessments of rivers and tributaries (Kleynhans, 2000).

The impact criteria from the Wetland Index of Habitat Integrity PES assessment tool (DWAF, 2007a) were divided into those that needed to be considered at the catchment scale and those that needed to be assessed at the individual wetland unit (i.e. within-wetland) scale (Table 5.3). Each criterion is rated on a scale of 0 (no impact evident) to 5 (the maximum possible extent or intensity of impact possible) for each quaternary catchment. Google Earth™ imagery, maps and landuse information of the catchment are used to score these criteria. An average weighted score for each quaternary catchment is then calculated and PES categories (Table 7.1) assigned. These results yield an estimated average PES category of the wetlands within the relevant quaternary catchment.

Table 6.3 Criteria (potential impacts) assessed for the desktop wetland PES assessment

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

6.3 RESULTS

A wide variety of wetland types are found within the WMA. Typically the larger wetlands are valley bottom wetland types - floodplains (Figure 6.1), channelled, and unchannelled valley bottom wetlands. Numerous smaller seepage wetlands are also present in the WMA, and a few isolated pans (e.g. Figure 6.2) were also identified in the study area.

Figure 6.1 A meandering floodplain wetland with oxbows (cut off meanders) in quaternary catchment T52E

Figure 6.2 An isolated pan wetland within quaternary catchment U10D

6.3.1 Wetlands Ecological Importance and Sensitivity

The EIS assessment indicated that High and Very High EIS wetland areas tend to be concentrated in the middle and upper catchment areas, with Moderate and Low EIS areas dominating the lower reaches and coastal zone (Figure 6.3). A Ramsar site, the Ntsikeni wetland, is located in the Very High EIS T51H quaternary catchment. Other large wetlands located in the upper catchments account for the similarly Very High categories of U40A (e.g. Mvoti Vlei), U20A (e.g. Mgeni Sponge) and U10A quaternaries.

The coastal zone and lower reaches of the catchments within the WMA tend to have lower wetland sizes and densities than the middle and upper reaches. Rivers are usually more deeply incised and confined, the topography more undulating and thus there is less opportunity for large wetlands to form in these lower incised coastal zones. The low density of usually small wetlands largely accounts for the low EIS scores along the coast. This pattern does not take into account the presence of large estuaries. The assessment and consideration of estuaries is discussed separately in this report. The scores and comments for each quaternary catchment are provided in the CD that includes raw data and supporting documentation for the project. A summary of the EIS results for the moderate and higher EIS scoring quaternary catchments are provided in Table 6.4. The grey lines indicate quaternary catchments with a high or very high EIS.

Table 6.4 Moderate and higher EIS scoring quaternary catchments

Quat	EIS	High scoring metrics
T4 - Mtamvuna		
T40A	*Moderate*	*Diversity of wetland types.*
T40B	*Moderate*	*Diversity of wetland types.*
T40C	*Moderate*	*Diversity of wetland types.*
T40E	*Moderate*	*Diversity of wetland types (IBA (Mtamvuna Nature Reserve), NFEPA wetland/cluster).*
		Unique wetlands.
T5 - Umzimkulu		
T51A	*High*	*Diversity and density of wetland types.*
		Importance of conservation and natural areas (IBA/Drakensberg Nature Reserve, NFEPA wetlands).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
T51B	*High*	*Diversity and density of wetland types.*

Quat	EIS	High scoring metrics
		Unique wetlands (Extensive connected seeps and valley bottom wetlands; several large NFEPA wetlands).
		Importance of conservation and natural areas (IBA/Drakensberg Nature Reserve, NFEPA wetlands).
T51C	*High*	*Diversity and density of wetland types.*
		Unique wetlands (a few large NFEPA wetlands).
T51D	*High*	*Diversity and density of wetland types.*
		Unique wetlands (Extensive connected seeps and valley bottom wetlands; several large NFEPA wetlands).
		Importance of conservation and natural areas (IBA/Drakensberg Nature Reserve, NFEPA wetlands).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
T51E	*High*	*Diversity and density of wetland types.*
		Unique wetlands (large NFEPA wetlands).
		Sensitivity to upstream flow changes (wide valley bottom wetlands are particularly sensitive to water decreases).
T51F	*High*	*Diversity and density of wetland types.*
		Unique wetlands (Extensive connected seeps and valley bottom wetlands; several large NFEPA wetlands).
		Importance of conservation and natural areas (IBA/Drakensberg Nature Reserve, NFEPA wetlands).
		Rare/endangered/unique populations (IBAs indicate spp. importance)
T51G	*High*	*Diversity and density of wetland types.*
		Importance of conservation and natural areas (IBA/Drakensberg Nature Reserve, NFEPA wetlands).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
T51H	*Very high*	*Unique wetlands (several NFEPA wetlands).*
		Importance of conservation and natural areas (Ntsikeni Conservation area (RAMSAR); Midlands Mistbelt Grassland (endangered)).
		Diversity and density of wetland types.
		Migration route/corridor (extensive network of wetlands (clusters) are important).
		Rare/endangered/unique populations (wattled crane).
		Dependence on Groundwater.
T51J	*High*	*Diversity and density of wetland types.*
		Unique wetlands (a few NFEPA wetlands).
		Sensitivity to upstream flow changes (valley bottom wetlands would be sensitive to reduced flows).
T52A	*High*	*Diversity and density of wetland types.*
		Unique wetlands (several large wetlands, a few NFEPA clusters).
		Importance of conservation and natural areas (four patches of IBAs).
		Migration route/corridor (extensive network of wetlands (clusters) are important).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
T52B	*High*	*Unique wetlands (some very small NFEPA patches).*
		Diversity and density of wetland types.
T52C	*Moderate*	*Diversity and density of wetland types.*
		Unique wetlands (some very small NFEPA patches).
		Species richness high – grasslands.
		Migration route/corridor (extensive network of wetlands (clusters) are important).
T52D	*Moderate*	*Diversity and density of wetland types.*
		Unique wetlands (NFEPA wetlands).
		Sensitivity to upstream flow changes (valley bottoms will be sensitive to flow reduction).
T52E	*High*	*Unique wetlands (some small NFEPA patches).*
		Diversity and density of wetland types.
		Species richness high – grasslands.
		Sensitivity to upstream flow changes (extensive wetlands would be sensitive to reduced flows).

Quat	EIS	High scoring metrics
T52F	Moderate	Diversity and density of wetland types
		Unique wetlands (large valley bottom complex)
		Importance of conservation and natural areas (NFEPA, endangered vegetation type)
T52H	High	Diversity and density of wetland types.
		Unique wetlands (some very small NFEPA patches).
		Species richness high – grasslands.
U1 - Mkomazi		
U10D	Very high	Density of wetlands (very high).
		Unique wetlands (numerous NFEPA systems).
		Rare/endangered/unique populations (IBAs indicate spp. importance - NB area for wattled crane).
U10E	High	Density of wetlands.
		Importance of conservation and natural areas (two IBAs - extensive Impendle Nature Reserve).
		Migration route/corridor (extensive network of wetlands (clusters) are important).
U10G	High	Density of wetlands.
		Importance of conservation and natural areas (three patches of IBAs; several small NFEPA wetlands).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
U10H	High	Density of wetlands.
		Importance of conservation and natural areas (four patches of IBAs).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
U10J	High	Diversity of wetland types.
		Unique wetlands Several NFEPAs/clusters).
		Species richness high – grasslands.
		Importance of conservation and natural areas (three patches of IBAs).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
U10K	High	Diversity of wetland types.
		Unique wetlands (several NFEPAs/clusters).
		Species richness high – grasslands.
		Importance of conservation and natural areas (four patches of IBAs).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
U2 - Mgeni		
U20A	Very high	Diversity and density of wetland types.
		Unique wetlands (large NFEPA systems).
		Importance of conservation and natural areas (Mgeni Vlei Ramsar site; IBA/Nature Reserve.)
		Rare/endangered/unique populations (IBAs indicate spp. importance - NB wattled crane breeding area).
U20B	High	Density of wetlands.
		Unique wetlands (several NFEPA wetlands in the quat).
		Species richness high - Misbelt grasslands.
U20C	High	Diversity and density of wetland types.
		Unique wetlands (several NFEPA wetlands in the quat).
U20D	High	Unique wetlands (several NFEPA wetlands in the quat).
		Diversity and density of wetland types.
U20E	Moderate	Unique wetlands (several NFEPA wetlands in the quat).
		Diversity and density of wetland types.
		Species richness high - Mistbelt grasslands.
U20F	High	Unique wetlands (several NFEPA wetlands in the quat).
		Diversity of wetland types.
		Species richness high - Mistbelt grasslands.
U20H	Moderate	Diversity and density of wetland types
		Importance of conservation and natural areas (small isolated NFEPA wetlands and a many NFEPA wetland clusters).

Quat	EIS	High scoring metrics
U20J	Moderate	Diversity and density of wetland types.
		Unique wetlands (all small patches, some NFEPA clusters).
U3 - Mdloti		
U30B	Moderate	Rare/endangered/unique populations (large barn swallow population at Mt Moreland IBA).
		Sensitivity to upstream flow changes (unchannelled valley bottom very sensitive).
		Sensitivity to water quality changes (the un/channelled valley bottom may be moderately sensitive).
U4 - Mvoti		
U40A	Very high	Diversity of wetland types.
		Unique wetlands (Mvoti vlei is very large).
		Importance of conservation and natural areas (several IBAs and conservation areas; Midlands Mistbelt Grassland (endangered)).
		Rare/endangered/unique populations (IBAs indicate spp. importance).
U40B	Moderate	Importance of conservation and natural areas (Endangered veg types. NFEPA wetlands).
		Diversity and density of wetland types.
U40C	Moderate	Importance of conservation and natural areas (Endangered veg types. NFEPA wetlands).
		Diversity and density of wetland types.
U40F	Moderate	Importance of conservation and natural areas (Endangered veg types. NFEPA wetlands).
		Diversity and density of wetland types.
U40J	High	Importance of conservation and natural areas (IBA at the Mvoti mouth, endangered veg type).
		Unique wetlands (Some small and extensive reaches of the Mvoti).
		Species richness high - coastal forest/grassland.
U5 - Nonoti		
U50A	High	Diversity of wetland types.
		Unique wetlands (Some small NFEPAs, plus upstream of estuaries).
U6 - Mlazi		
U60A	Moderate	Diversity and density of wetland types.
		Importance of conservation and natural areas (IBAs, Small isolated NFEPA wetlands and a few clusters).
U60B	Moderate	Importance of conservation and natural areas (IBAs, Small isolated NFEPA wetlands and a few clusters).
		Rare/endangered/unique populations (IBAs with central wetland suggest spp importance).
		Diversity and density of wetland types.
U60C	Moderate	Density of wetlands.
		Importance of conservation and natural areas (small NFEPA wetlands, No IBAs).
U60E	Moderate	Species richness high - coastal forest/grassland
U7 - Lovu		
U70A	Moderate	Importance of conservation and natural areas (small NFEPA wetlands, small IBA).
		Density of wetlands.
U70B	Moderate	Density of wetlands.
		Importance of conservation and natural areas (small NFEPA wetlands, no IBAs).
U80E	Moderate	Unique wetlands (NFEPA wetland complex high in the catchment).
		Migration route/corridor.

6.3.2 Wetlands Present Ecological State

The wetland PES of quaternary catchments with a moderate or higher EIS was assessed. The average PES of the wetlands in WMA 11 is estimated at a low C. Although some catchments are characterised by high PES (B and B/C) wetlands, most of the quaternary catchments are characterised by C or C/D wetlands (Figure 5.4). Lower reaches are, in general, in worse condition than the upper reaches. There is a weak trend of high EIS areas correlating with higher PES scores (Figure 6.5).

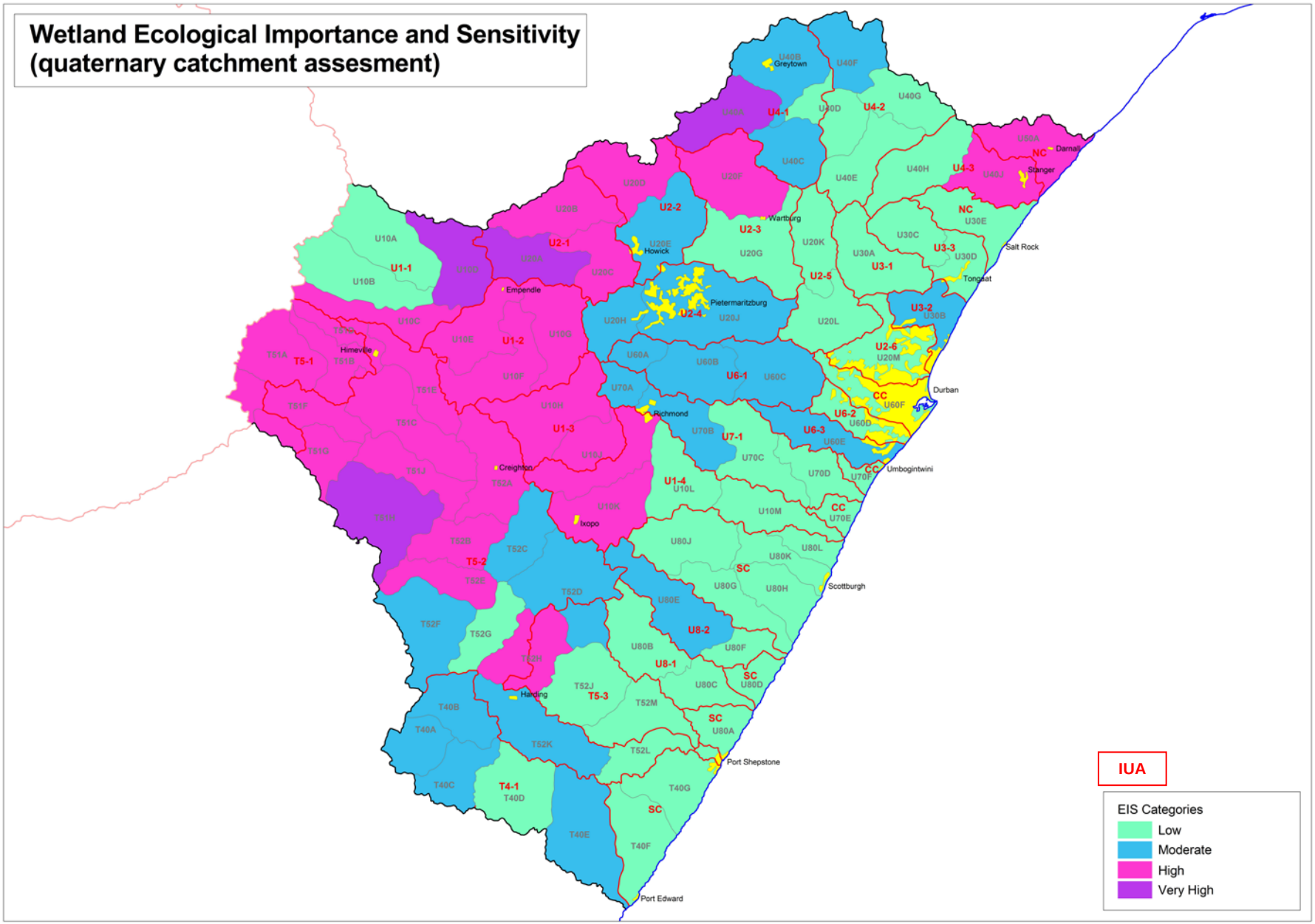


Figure 6.3 Wetland EIS categories of the quaternary catchments in WMA 11

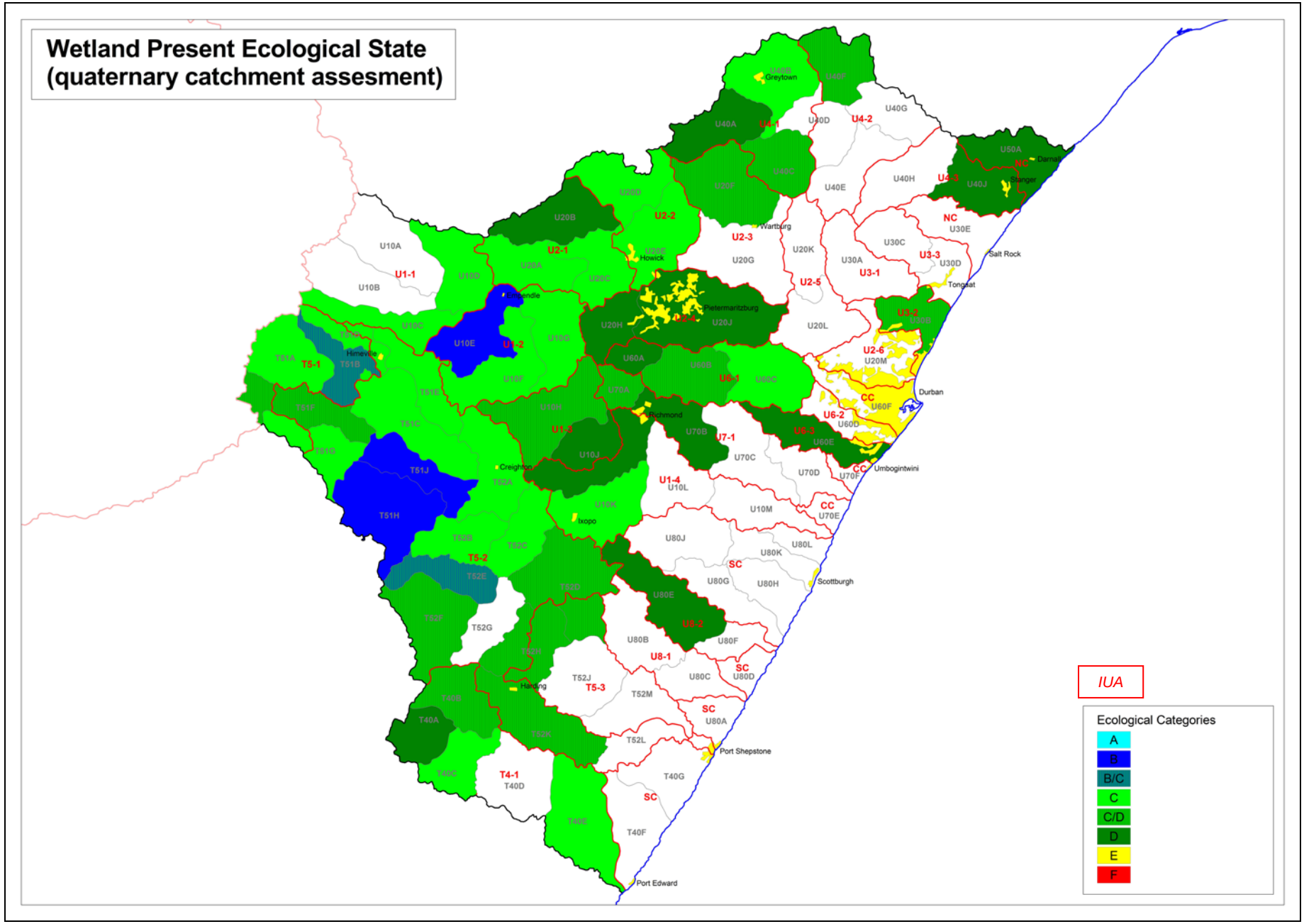


Figure 6.4 The average PES of wetlands in the quaternary catchments of WMA 11

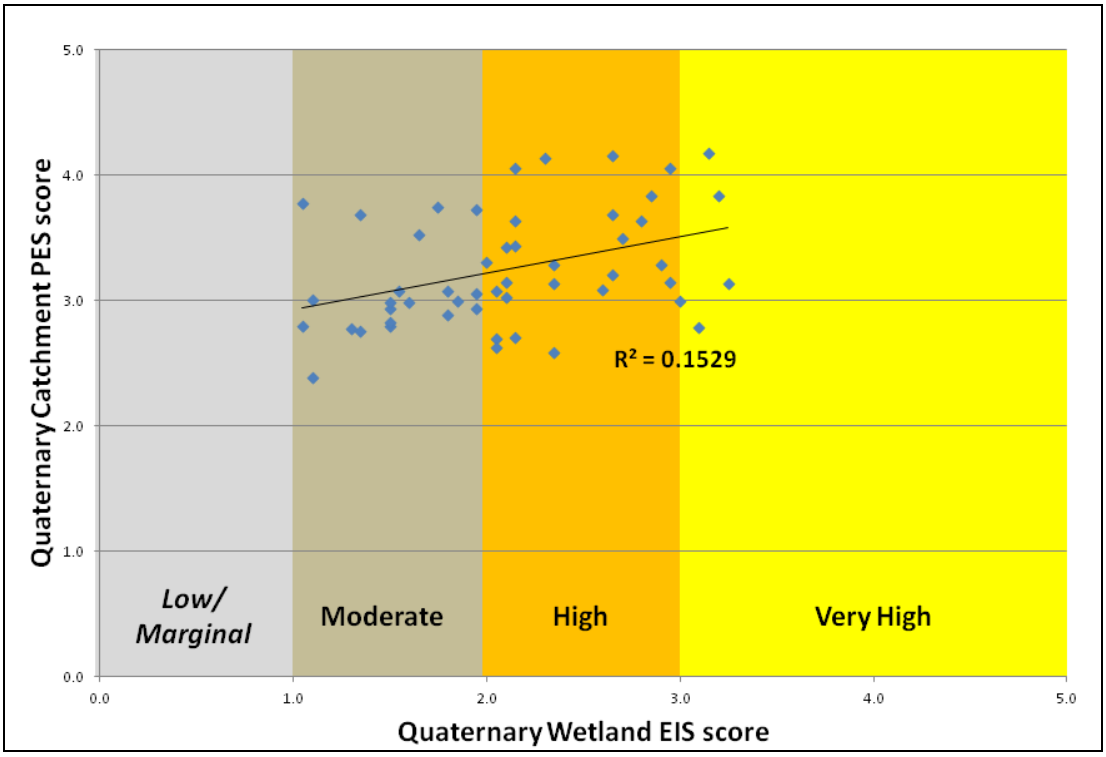


Figure 6.5 The weak correlation between PES and EIS, indicating a slight trend for higher EIS areas correlating to higher PES scores

The widespread landuse conversion and encroachment of landuse within wetlands is attributed to the current PES. At the catchment scale, dams, irrigated agriculture and afforestation have reduced inflows to wetlands. Urban and industrial areas, and to a lesser extent agriculture, have negatively affected water quality entering wetlands.

Within the wetlands themselves, encroachment of agriculture, forestry and sugar cane in to the wetland areas has caused degradation of wetlands across much of the catchment. Drainage of wetlands associated with these landuse changes, as well as erosion by dongas, has reduced wetted areas and durations within wetlands, causing further degradation.

Encroachment from forestry and agriculture are the main impacts in central and upper catchments; with impacts from sugar cane and urban areas becoming increasingly dominant in lower and coastal areas. Good buffers from forestry and agriculture however sometimes play a significant amelioration role.

The scores and comments for each quaternary catchment are provided on the CD including all raw data and supporting documentation for this project. A summary of the key impacts for quaternary catchments selected for PES assessment is provided in Table 6.5.

Table 6.5 Key impacts for quaternary catchments selected for wetland PES assessments

Quat	PES	Key Catchment scale impacts	Key within wetlands impacts
T4 - Mtamvuna			
T40A	**D**	*Non-Flow: Agriculture.*	*Non-Flow[1]: Canalisation and erosion.*
T40B	**C/D**	*Non-Flow: Forestry with poor buffer zones.*	*Non-Flow: Canalisation and erosion.*
T40C	**C**	*Non-Flow: Agriculture.*	*Non-Flow: Erosion.*
T40E	**C**	*Flow: Dams, irrigation and other flow reduction*	*Non-Flow: Sugar cane farming.*

Quat	PES	Key Catchment scale impacts	Key within wetlands impacts
		activities. Non-Flow: Urbanization.	
T5 - Umzimkulu			
T51A	C	Flow: Farm dams.	Non-Flow: Erosion and grazing. Some cropping in wetlands.
T51B	B/C	Flow: Numerous farm dams; some irrigated agriculture.	Non-Flow: Some canalisation.
T51C	C	Non-Flow: Large afforested sections, invasive trees along watercourses. Flow: Some irrigated agriculture, farm dams.	Non-Flow: Some widespread dongas/eroding drains.
T51D	C	Flow: Several large farm dams.	Flow[2]: Several large farm dams are within the wetland areas.
T51E	C	Flow: Several small dams, some irrigation, cropping, forestry.	Non-Flow: Canalisation, erosion, invasive plants, cropping.
T51F	C/D	Flow: Farm dams, irrigated agriculture.	Non-Flow: Agricultural encroachment. Flow: Farm dams, some drains present.
T51G	C	Non-Flow: Afforestation. Flow: Irrigation dams.	Non-Flow: Canalisation, erosion, invasive plants, cropping.
T51H	B/C	Non-Flow: Some afforestation, low density residential areas.	Non-Flow: Limited erosion and invasive plants.
T51J	B	Non-Flow: Lower catchment is peri-urban.	Non-Flow: Erosion dongas (incised channels) are present.
T52A	C	Non-Flow: Some afforestation.	Non-Flow: Some Invasive Alien Plants (IAPs) evident, forestry encroachment. Flow: Few canals.
T52B	C	Non-Flow: Afforestation.	Non-Flow: Erosion.
T52C	C	Non-Flow: Afforestation.	Non-Flow: Erosion.
T52D	C/D	Non-Flow: Afforestation, small urban and peri-urban areas, some agriculture. Flow: Some farm dams, irrigated agriculture.	Non-Flow: Erosion, forestry encroachment, invasive plants.
T52E	B/C	Non-Flow: Afforestation, some small urban and peri-urban areas.	Non-Flow: Forestry encroachment, invasive plants.
T52F	C/D	Non-Flow: Upper catchment afforested, widespread peri-urban areas, numerous settlements.	Non-Flow: Erosion. Flow: Many canals/drains
T52H	C/D	Non-Flow: Numerous settlements.	Non-Flow: Erosion. Flow: Drains in wetlands
T52K	C/D	Non-Flow: Large afforested sections.	Non-Flow: Some forestry and agriculture. Erosion and invasive plants.
U11 - Mkomazi			
U10C	C	Flow: Many farm dams, irrigated agriculture.	Non-Flow: Agricultural encroachment.
U10D	C	Non-Flow: Limited agriculture.	Non-Flow: Erosion. Flow: Drains, dams in some wetlands.
U10E	B	Non-Flow: Forestry in some areas, but generally wide buffers.	Non-Flow: Erosion and forestry encroachment. Flow: Some drains.
U10F	C	Non-Flow: Forestry in some areas, but generally wide buffers.	Non-Flow: Some forestry encroachment (low). Some dams.
U10G	C	Flow: Widespread irrigation/agriculture in high density wetland areas.	Non-Flow: Agricultural encroachment. Flow: Dams, possibly dykes.
U10H	C/D	Non-Flow: Widespread forestry in high density wetland areas, agriculture, settlements.	Flow: Dams, roads, drains. Non-Flow: Agricultural encroachment, erosion.
U10J	D	Non-Flow: Widespread irrigated and dryland (often within wetland) agriculture. Widespread settlements.	Flow: Dams, roads, drains. Non-Flow: Severe encroachment by agriculture.
U10K	C	Non-Flow: Widespread (often within wetland) agriculture. Forestry in upper catchment.	Non-Flow: Severe encroachment by agriculture.
U2 - Mgeni			
U20A	C	Non-Flow: Some afforestation in the lower catchment, IAPs in some sections. Flow: Several small dams.	Flow: Extensive drains, some dams. Non-Flow: Some cropping encroachment. Incision in some wetlands.
U20B	D	Flow: Several dams, irrigated agriculture.	Non-Flow: Extensive cropping encroachment. Flow:

Quat	PES	Key Catchment scale impacts	Key within wetlands impacts
			Many dams, some drains.
U20C	**C**	*Non-Flow: Agriculture. Flow: A few small dams, irrigated agriculture.*	*Non-Flow: Extensive cropping encroachment.*
U20D	**D**	*Flow: A few small dams, irrigated agriculture. Non-Flow: Agriculture.*	*Non-Flow: Forestry and agricultural encroachment.*
U20E	**C**	*Non-Flow: Agriculture and settlements. Flow: A few small dams, irrigated agriculture, large dam upstream.*	*Non-Flow: Forestry and agriculture. Encroachment in some places.*
U20F	**C/D**	*Non-Flow: Widespread forestry in high density wetland areas.*	*Non-Flow: Erosion. Forestry and agriculture. Encroachment in some places. Flow: Some dams in wetlands.*
U20H	**D**	*Non-Flow: Widespread urban areas/settlements.*	*Non-Flow: Erosion.*
U20J	**D**	*Non-Flow: Pietermaritzburg - widespread urban areas/settlements.*	*Non-Flow: Erosion.*
U3 - Mdloti			
U30B	**C/D**	*Non-Flow: Widespread urban areas/settlements. Flow: Dams, widespread sugar cane.*	*Non-Flow: Erosion.*
U4 - Mvoti			
U40A	**D**	*Non-Flow: Extensive afforestation. Flow: Afforestation, irrigated agriculture.*	*Non-Flow: Extensive forestry, although sometimes wide buffers are in place along watercourses, invasive plants.*
U40B	**C**	*Non-Flow: Widespread forestry in high density wetland areas.*	*Non-Flow: Invasive plants.*
U40C	**C/D**	*Non-Flow: Dams, irrigated agriculture.*	*Non-Flow: Agricultural encroachment.*
U40F	**C/D**	*Flow: Dams and irrigated agriculture.*	*Non-Flow: Extensive agricultural encroachment.*
U40J	**D**	*Flow: Widespread sugar cane farming. Non-Flow: Stanger in lower reach.*	*Non-Flow: Extensive agricultural encroachment.*
U5 - Nonoti			
U50A	**D**	*Flow: Widespread sugar cane farming.*	*Non-Flow: Extensive agricultural encroachment. Infestation of IAPs in many wetlands.*
U6 - Mlazi			
U60A	**D**	*Non-Flow: Widespread forestry.*	*Non-Flow: Roads, encroachment from forestry. Widespread erosion.*
U60B	**C/D**	*Non-Flow: Intensive agriculture.*	*Non-Flow: Agricultural encroachment.*
U60C	**C**	*Flow: Several farm dams, agriculture.*	*Non-Flow: Heavy grazing on largest wetland.*
U60E	**D**	*Non-Flow: Widespread urban areas.*	*Non-Flow: Urban and industrial encroachment. Erosion. Flow: High peak flows, wetlands isolated from rivers/other wetlands.*
U7 - Lovu			
U70A	**C/D**	*Non-Flow: Extensive forestry, narrow buffers.*	*Non-Flow: Forestry encroachment.*
U70B	**D**	*Non-Flow: Dams and agriculture.*	*Non-Flow: Forestry and agricultural encroachment. Flow: Numerous dams in wetlands.*
U80E	**D**	*Non-Flow: Dams and agriculture. Forestry.*	*Non-Flow: Forestry and agricultural encroachment. Flow: Numerous dams in wetlands.*

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

6.3.3 Verification of desktop results

Limited field-verified wetland assessment data exist. Four wetlands that are monitored by Ezemvelo KZN wildlife are located within WMA 11. The results of the 2012 wetland surveys (MacFarlane et al., 2012) were used to verify desktop PES assessment results.

Although the sample size is small, the desktop assessment results correlate well with field data (Figure 6.6) and the Ecological Categories are the same for most wetlands (Table 6.6).

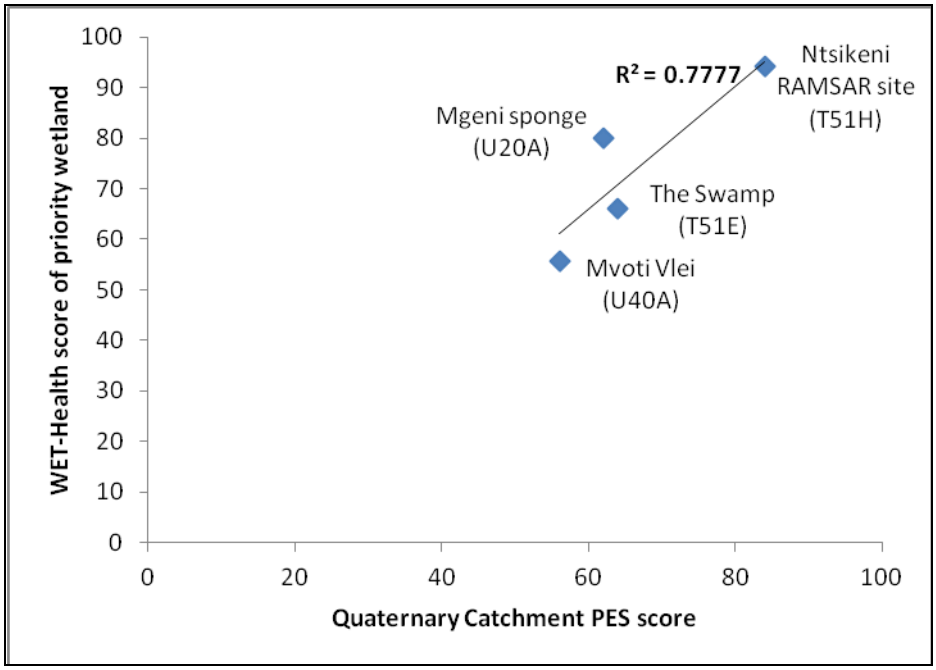


Figure 6.6 Correlation between the desktop quaternary PES scores (this study) and available field assessments of key wetlands (MacFarlane *et al*., 2012)

Table 6.6 Comparison of the rapid desktop and more detailed field wetland assessments undertaken for key wetlands in WMA 11

Desktop Assessment (this study)			Field Assessment (MacFarlane *et al.*, 2012)		
Quat	**Quat EIS**	**Quat PES**	**Key wetland assessed**	**Size of wetland (ha)**	**Wet-Health PES score**
U40A	*Very High*	*D*	*Mvoti vlei*	*2768*	*D*
U20A	*Very High*	*C*	*Mgeni "sponge"*	*2066*	*C*
T51H	*Very High*	*B**	*Ntsikeni (Ramsar Site)*	*1491*	*A*
T51E	*High*	*C*	*The Swamp*	*1079*	*C*

**The average PES for T51H is indicated as a B. Although the Ntsikeni wetland is cited as an A category wetland, the B condition is likely to more accurately represent the average condition of all wetlands in the catchment as not all of them are as pristine as the Ramsar site.*

7 STATUS QUO ASSESSMENT: ECOLOGICAL RIVER STATE

7.1 INTRODUCTION

Determination of the Present Ecological State (PES), which in essence represents the ecological status quo of the rivers, is undertaken as part of the EcoClassification process (Kleynhans and Louw, 2007). The EcoClassification process consists of 4 levels which refer increasing complexity and intensity of work from the Level I (Desktop) to Level IV. An additional level, also Desktop, was developed by Dr Kleynhans (Kotze et al., 2012) with the specific purpose of building up a country wide database of PES and Ecological Importance (EI) - Ecological Sensitivity (ES). This project is referred to as the PESEIS project and is currently being finalised. The spreadsheets undertaken for the U tertiary catchment and T4 and T5 secondary catchments has been finalised (Ref). This data was used as the baseline for the status quo assessment.

7.2 APPROACH

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

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

Table 7.1 Ecological Categories (ECs) and descriptions

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

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

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

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

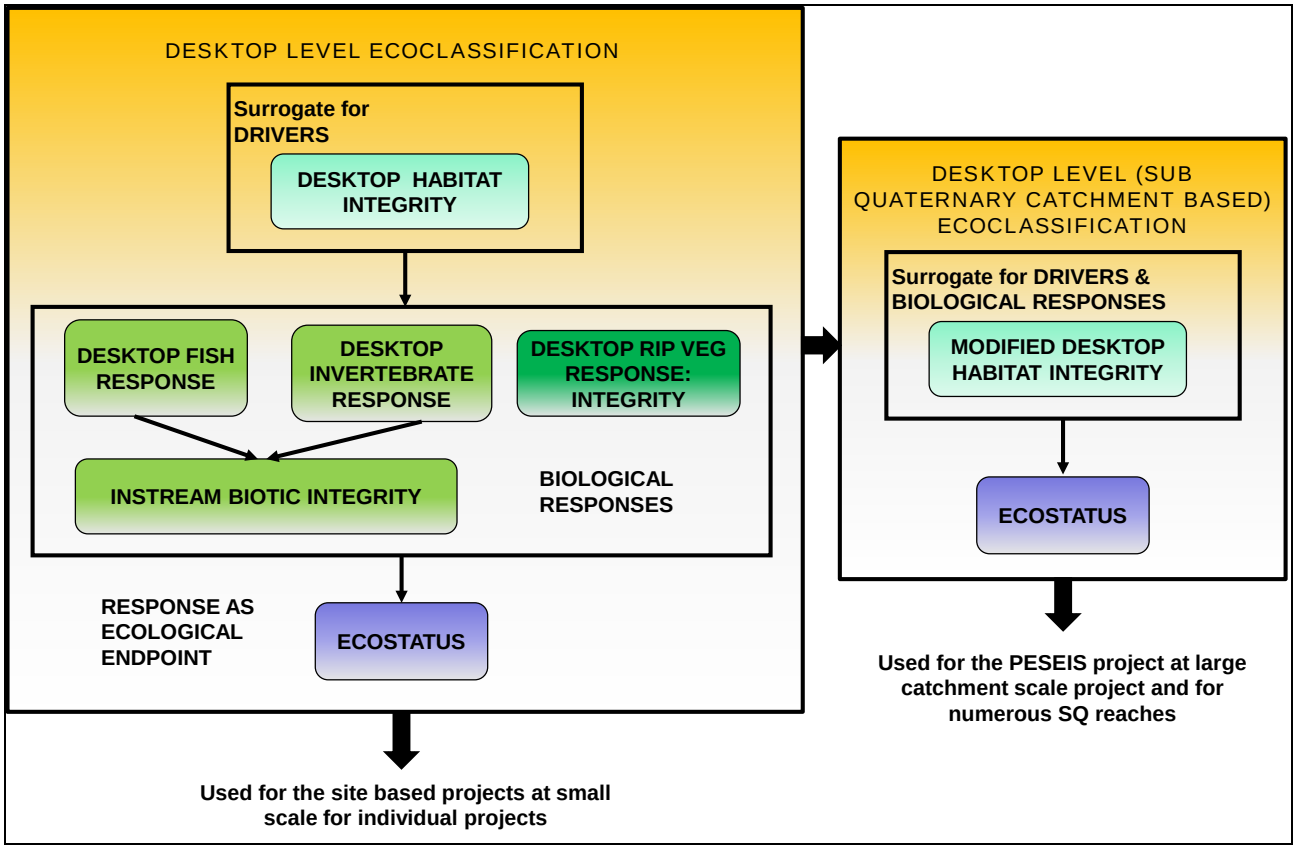


Figure 7.2 Relationship between the Desktop Level EcoClassification and the PESEIS approach to determine the PES

The PES is assessed according to six metrics that represents a very broad qualitative assessment of both the instream and riparian components of a river. The metrics used in the PES model and an explanation of what they refer to is explained in Table 7.2 (DWA, 2013). Each metric is scored from zero to five.

Table 7.2 PES metrics and explanations (DWA, 2013)

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

7.2.2 PES supporting information

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

7.2.3 Database for PES information in an Excel spreadsheet

The WMA 11 consists of 288 SQ reaches. The final modelled information in the front end model for each secondary is available from Dr Kleynhans, Directorate: Resource Quality Services (D:RQS), DWA. Information was extracted in a 'master spreadsheet' that incorporates all the PESEIS results, modifications to the PES results, as well as the additional information required for this project. Each secondary is provided as a separate spreadsheet. The spreadsheets will be available on the final data CD for this project and the columns of the PES sheet (called PES) is described below. Note the PES_raw sheet is a copy of the data as provided from the PESEIS project without any adjustments.

Colour coding used in the spreadsheet relevant to the SQ rows is as follows:

- *Blue: SQ that ends in an estuary and where the estuary PES and future assessments will be used to represent the SQs.*
- *Green: SQ that ends in an estuary and where a river point is selected additional to the estuary to represent the river. Usually these SQs will be generally longer than the ones coloured in blue.*

PES sheet column descriptions in the in the master spreadsheet:

- *Column A: SQ number: Individual code provided for each SQ by DWA and based on the codes used in the NFEPA assessment.*
- *Column B: River: River name where available.*
- *Column C: Length km: River length of SQ.*
- *Column D - O: A 0 - 5 rating for impacts for metrics as provided from the PESEIS study (DWA, 2013)*
- *Column P - V: PES metrics with completed ratings (0 - 5) from the PESEIS study (DWA, 2013). The values in yellow indicate values that were refined during this study.*
- *Column W: Comments: Comments copied from the front end model providing a valuable summary of activities in the SQ.*
- *Column X to AE: Statistics based on the ratings completed for the PES metrics.*
- *Column AF: PES median of all metrics: PES value generated using the metrics as provided in Column P - V.*
- *Column AG: PES category based on median of PES metrics: PES as an EC.*
- *Column AH: Water quality hotspots (PS): An evaluation by Dr Patsy Scherman to identify problem (ecology and user) water quality areas. Only hotspots which represent a 3, 4 or 5 rating have been completed.*
- *Column AI: Water quality hotspot comments: Provides an indication of what the reasons are for the water quality hotspots.*
- *Column AJ: Flow: The word 'flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a flow impacts.*
- *Column AK: WQ: The word 'WQ' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a WQ impact.*
- *Column AL: Non-flow: The word 'non-flow' is included in the cell whenever there is a value of a 3, 4 or 5 in any of the previous columns that relate to a non-flow impact.*
- *Column AM: Summary: Concatenates the information in columns AJ, AK and AL.*
- *Column AN: A blank column separating all the previous columns which provide basic information from the columns which will be used and are relevant in this project.*
- *Column AO: Primary PES driver: An indication is provided whether the key PES driver that is mostly responsible for the changes from natural reference condition is flow, non-flow or water quality dominated, or a combination of both.*
- *Column AP: River PES (value) (2012): PES value copied from the PESEIS front end model.*
- *Column AQ: River PES (EC) (2012): PES as an EC copied from the PESEIS front end model.*
- *Column AR: PES (revised) (2013): PES revised during this study. PES value as a median.*
- *Column AS: PES (revised) EC (2013): PES as an EC relating to column AR.*
- *Column AT: Wetland PES (value): PES value generated for the selected wetlands only (see Chapter 7).*

- *Column AU: Wetland PES (EC): PES as an EC generated for the selected wetlands only (refer to Chapter 7).*
- *Column AV: Max River/Wetland PES: The river or wetland PES that represents the best condition is selected and the value provided.*
- *Column AW: Final PES: This provides the PES as an EC which is the best condition for either wetlands or river.*
- *Column AX: Final Final PES. The evaluation provides a finer resolution than the A to F scale and includes the half-category evaluation.*

7.3 STATUS QUO ASSESSMENT

The status quo assessment is provided per secondary and consists of a table and short summary for each secondary. No key PES drivers are provided for rivers in a B or higher PES as the changes from natural are minor. The secondaries are discussed as they occur from south (Mtamvuna, T4) to north (Nonoti, U5). Maps are provided of the IUAs which also include the PES results (Chapter 9, Figure 9.2 to 9.5).

7.3.1 T4: Mtamvuna

Table 7.3 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
T40A-05450	Mafadobo	B	n/a
T40A-05487	Goxe	B/C	Non-flow[1]: Sediment, overgrazing.
T40B-05337	Weza	C	Flow[2]: Forestry. Non-Flow: Forestry, vegetation clearing.
T40C-05510	Mtamvuna	B/C	Non-flow: Sedimentation, alien veg., agricultural practices.
T40C-05520	Mtamvuna	B/C	Flow: Abstraction. Non-flow: Sedimentation, alien veg., agricultural practices.
T40C-05530	Mtamvuna	B	n/a
T40C-05566	Ludeke	B	n/a
T40C-05589	KuNtlamvukazi	B	n/a
T40C-05600	Ludeke	B	n/a
T40D-05537	Mtamvuna	B	n/a
T40D-05584	Mtamvuna	B	n/a
T40D-05615	Tungwana	B	n/a
T40D-05643	Gwala	B	n/a
T40D-05683	Ntelekweni	B/C	Non-flow: Forestry, water quality.
T40D-05707	Mtamvuna	C	Non-flow: Water quality, sedimentation, veg removal.
T40D-05719	Londobezi	B	n/a
T40E-05601	Mtamvuna	B/C	Non-flow: Sedimentation, dryland sugar cane, overgrazing.
T40E-05767	Hlolweni	B/C	Non-flow: Informal agriculture, sedimentation.
T40F-05666	Mbizana	B	n/a
T40G-05616	Vungu	B/C	Non-flow: All impacts from Uvongo, US section in slightly better condition - also non-flow.

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

The PES of the SQ reaches varies between B (21 reaches) and C (15 reaches) PES. Quaternary catchment T40A (Mafadobo and Goxe rivers) ranges between B and C PES and is subjected to small areas of forestry and low density rural settlements with the primary impacts being non-flow related (sedimentation). T40B falls in a C PES with flow and non-flow related impacts, consisting of extensive forestry occurring in the upper reaches, with a timber mill and rural settlements in the lower reaches. The reaches in T40C ranges between B and C PES, with the primary land use

activities being subsistence farming, grazing and low density rural settlements. Impacts are therefore predominantly non-flow related, although some flow related (abstraction) impacts are evident in T40C-5520 (Mtamvuna). Within quaternary catchment T40D, the main Mtamvuna River and its Tungwana (T40D-5643), Gwala (T40D-5643) and Londobezi (T40D-5719) tributaries are currently in a good condition with a B PES while the remaining rivers fall in a C PES. The good state of the B PES is often the result of protection provided by gorges. The primary impacts are non-flow related activities including small scale subsistence farming, rural settlements and limited forestry in the most upper reaches. The main Mtamvuna River and its tributary (Hlolweni: T40E-5767) within quaternary catchment T40E falls in a C PES with impacts being primarily non-flow related (rural settlements, subsistence farming, sedimentation and grazing).

The lower density of human settlements in the Mbizana River has placed this SQ in a B PES, while the higher density of rural settlements, sugar cane farming, an in-stream dam, waste water treatment works and quarries close to the river, places the Vungu River in a C PES.

7.3.2 T5: Umzimkulu

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

SQ number	River	River PES (EC)	Key PES Driver
T51A-04431	Umzimkulu	B	n/a
T51A-04522	Mzimude	B	n/a
T51A-04608		B	n/a
T51A-04551	Mzimude	B/C	Non-flow[1]: Agriculture; Flow[2]: Centre-pivot.
T51B-04421	Umzimkulu	B	n/a
T51C-04606		C	Non-flow: Agriculture and barrier/dam; Flow: Centre-pivot.
T51C-04582	Umzimkulu	C	Non-flow: Water quality issues, vegetation removal, alien veg.
T51C-04760	Umzimkulu	C	Non-flow: Vegetation removal, agriculture and forestry.
T51D-04404	Pholela	B	n/a
T51D-04460	Pholelana	D/E	Flow, non-flow due to presence of many dams. Inundation and barrier effect high.
T51E-04536		C	Non-flow: Barrier effect, alien veg. Flow: Irrigation.
T51E-04478	Pholela	C	Non-flow: Vegetation removal, alien veg. Flow: Irrigation.
T51E-04604	Pholela	B/C	Non-flow: Vegetation removal (forestry, alien veg).
T51F-04566	Boesmans	A	n/a
T51F-04611	Ngwangwane	A	n/a
T51F-04674		C	Flow and Non-flow: Agriculture, presence of dams, riparian zone impacts.
T51F-04605	Ngwangwane	B/C	Non-Flow: Sedimentation, vegetation removal.
T51F-04621	Ngwangwane	B/C	Flow: Dams and extensive irrigation. Non-flow: Agriculture and riparian zone impacts.
T51G-04669	Ndawana	B	n/a
T51G-04751		B	n/a
T51G-04722	Ndawana	C	Flow: Dams and extensive irrigation. Non-flow: Agriculture and riparian zone impacts.
T51H-04828	Gungununu	A/B	n/a
T51H-04846	Lubhukwini	A	n/a
T51H-04913	Nonginqa	B/C	Non-flow: Forestry and subsistence farming.
T51H-04923	Malenge	B/C	Non-Flow: Informal agriculture (removal of vegetation).
T51H-04808	Gungununu	B	n/a
T51H-04884	Gungununu	B/C	Non-flow: Subsistence farming, grazing, erosion.

SQ number	River	River PES (EC)	Key PES Driver
T51H-04908	Gungununu	B/C	Non-flow: Subsistence farming, grazing, erosion.
T51J-04747	Ngwangwane	C	Non-flow: Subsistence farming, grazing, erosion.
T51J-04844	Ngwangwane	C	Water quality issue, agriculture.
T52A-04690	Umzimkulu	C	Non-flow: Irrigation, forestry, grazing.
T52B-04947	Cabane	B	n/a
T52C-04880		C	Flow: Forestry, irrigation. Non-flow: Forestry, roads.
T52C-04960	Umzimkulu	B	n/a
T52D-05024	Ncalu	B/C	Non-flow: Forestry and subsistence farming.
T52D-05061	Mgodi	B/C	Non-flow: Subsistence farming, irrigation.
T52D-04948	Umzimkulu	C	Non-flow: Subsistence farming.
T52D-05137	Umzimkulu	B	n/a
T52D-05155	Umzimkulu	B	n/a
T52E-05053	Upper Bisi	B/C	Non-flow: Vegetation removal (forestry, farming).
T52F-05104	Little Bisi	C	Non-flow: Vegetation removal (forestry, farming).
T52F-05190	Mbumba	B/C	Non-flow: Vegetation removal over grazing, farming.
T52F-05139	Little Bisi	B	Non-flow: Vegetation removal over grazing, farming.
T52G-05226	uMbumbane	B/C	n/a
T52G-05171	Bisi	B	Non-flow: Vegetation removal over grazing, farming.
T52H-05244	Mahobe	B/C	n/a
T52H-05295	Magogo	B	n/a
T52H-05121	Bisi	B/C	n/a
T52H-05178	Bisi	B	n/a
T52H-05189	Bisi	B	n/a
T52J-05276	Umzimkulu	B	n/a
T52K-05353	Mzimkhulwana	C	Flow: Dam, irrigation. Non-flow: Agriculture.
T52K-05475	Nkondwana	B/C	Non flow: Agriculture, irrigation (sugar cane), subsistence farming.
T52K-05467	Mzimkhulwana	B/C	Some abstraction and various other non-flow activities.

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

Upper Umzimkulu Mountain Zone: *A mountainous zone which contains several headwater streams (T51A - all SQs, T51D-4404, T51B-4421, T51F-4566, T51F4611, T51G-4669, and T51G-4751). Most SQs are untransformed and classified as A or B PES, with a single C (T51A-04551). Most SQs start in uKhahlamba Basalt Grassland (least threatened), traverse Southern Drakensberg Highland Grassland (least threatened) and Drakensberg Foothill Moist Grassland (least threatened). Low severity impacts that exist are created by small patches of afforestation and other alien vegetation, small dams, tourism, irrigation and rural community use in the form of subsistence farming (grazing and trampling, agricultural lands). A large percentage of the area is protected in various Wilderness areas and the Cobban Nature Reserve (T51D-04404).*

Middle Umzimkulu and Mzimkhulwana tributary: *Apart from three tributaries in the Ngwangwane sub-catchment, all the other 9 SQs are evaluated in a PES C. Extensive rural development and associated settlements are the main cause for the C PES, however forestry, irrigation, trampling and erosion, dams and alien invasive plants add to the problems. The three sites with high integrity (in T51H) originate in the Ntsikeni Wildlife Reserve and due to the intactness of the streams, the PES categories include two A and one B PES. The Lubhukwini River (T51H-04846) is noted for high priority wetlands (extensive seeps) which are KZN priority monitoring sites and is also a Ramsar site. Wetland rehabilitation is evident.*

Similarly, the upper Umzimkulu catchment consists of rivers with a C PES. All of these SQs flow through areas which are densely populated by rural communities, an impact condition aggravated by extensive forestry, in-stream dams and extensive irrigation and large-scale erosion. The one SQ that is in an E category is drowned by dams. The middle Umzimkulu catchment has one B category SQ, T52B (less populated with some forestry, irrigation), the rest of the sub-catchment are grouped in a C PES. This lower integrity score is owed to dense human settlement and large townships. Additional impacts due to the high human presence include extensive forestry, irrigation, subsistence farming, cattle and fallow lands. The topography of the Bisi catchment creates deeper valleys which prevents the utilization of certain reaches, which results in some B category rivers (T52F-05139, T52G-05171) in the middle of the sub-catchment. The rest of the catchment is in a PES category of a C due to extensive forestry and high density settlement with the associated impacts: subsistence farming, frequent burning, cattle trampling, erosion and sedimentation.

The Mzimkhulwana sub-catchment originates in an area near the town of Harding in plantation forestry, the system further downstream are impacted by rural development that includes informal agriculture and townships. The lower part of the Mzimkhulwana River comprised of deeply incised river valleys which limits land-use and is therefore limited to open terrain/natural vegetation. The Umzimkulu at T52D-04948 is noted for narrow channelled valley bottom wetlands, mostly on short tributaries. Most wetlands are utilised for grazing.

Lower Umzimkulu: *This reach includes the main Umzimkulu, as well as the lower Bisi and Magogo tributaries and is all in a B PES. The good state of especially the main Umzimkulu in is attributed to the protection provided by a large gorge section. Impacts in this area is primarily non-flow related, related to small scale subsistence farming, grazing, limited forestry, erosion and sedimentation of instream habitats. A lime stone mining plant is also present in the lower Umzimkulu River reach but does not impact notably on the present status of this zone.*

7.3.3 U8: Mzumbe and Mtwalume

Table 7.5 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U80B-05145	*Mzumbe*	**B**	*n/a*
U80B-05161	*Mhlabatshane*	**B**	*n/a*
U80C-05231	*Mzumbe*	**B**	*n/a*
U80C-05329	*Kwa-Malukaka*	**B**	*n/a*
U80E-05028	*Mtwalume*	**C**	*Non-flow[1]: Subsistence farming, grazing. Flow[2]: Forestry, small farm dams, irrigation. Water quality: Rural settlements, sugar cane.*
U80E-05212	*Quha*	**B**	*n/a*
U80F-05258	*Mtwalume*	**B/C**	*Flow: Irrigation. Water quality: Sugar cane. Non-flow: Subsistence farming, grazing.*
U80F-05301	*Mgeni*	**B/C**	*Non-flow: Forestry, subsistence agriculture, sugar cane.*
U80G-05097	*Fafa*	**B/C**	*Flow: Irrigation (sugar cane). Non-flow: Subsistence farming.*
U80H-05109	*Mzinto*	**C/D**	*Flow: Irrigation. Water quality: Sugar cane. Non-flow: Subsistence farming, grazing, erosion.*
U80J-04979	*Mpambanyoni*	**B**	*n/a*
U80J-05043	*Ndonyane*	**B/C**	*Flow: Irrigation. Water quality: Sugar cane. Non-flow: Subsistence farming, grazing, erosion.*
U80K-04952	*Mpambanyoni*	**C**	*Water quality: Settlements. Non-flow: High density rural settlements, erosion, sedimentation.*

U80L-05020	aMahlongwa	B/C	Water quality: Settlements. Non-flow: High density rural settlements, erosion, sedimentation.

1: Non-flow refers to Non-Flow related activities. 2: Flow refers to Flow related activities.

The Mzumbe traverses Ngongoni Veld (vulnerable) and Kwazulu-Natal Coastal Belt (endangered), while the Mtwalume traverses both these vegetation types as well as Kwazulu-Natal Sandstone Sourveld (endangered) and Midlands Mistbelt Grassland (endangered) (Mucina and Rutherford, 2006). All the SQs that comprise the Mzumbe system have B PES, while the SQs of the Mtwalume have predominantly B and C PES. Impacts in the Mzumbe comprise mainly forestry (U80B-05145), rural settlements and subsistence farming, small dams in the tributaries, and associated non-flow related impacts such as grazing, but all with low severity or extent. Both flow and non-flow related impacts dominate the Mtwalume and its tributaries. Notable are instream dams, forestry, subsistence agriculture and encroaching sugar cane fields. No importance has been noted for wetlands.

The coastal rivers consist of inland streams and their estuaries. There are numerous short rivers along the coast that will be evaluated mainly on the state of the estuaries and are not dealt with in this chapter. The Mpambanyoni system (U80J and U80K) have SQs with either a B or a C PES. Forestry impacts on the upper catchments, while rural developments and associated cultivation, as well as in-stream weirs cause the lowering in integrity. The Fafa River system (U80G) is also a C PES mainly due to rural developments, plantations and an in-stream weir.

7.3.4 U1: Mkomazi

Table 7.6 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U10A-04115	Lotheni	A/B	n/a
U10A-04202	Nhlathimbe	B	n/a
U10A-04301	Lotheni	B	n/a
U10B-04239	Mkomazi	B	n/a
U10B-04251	Mkomazi	A	n/a
U10B-04274	Nhlangeni	A	n/a
U10B-04337	Mkomazi	B	n/a
U10B-04343	Mqatsheni	B	n/a
U10C-04347	Mkhomazana	B	n/a
U10D-04199	Nzinga	A	n/a
U10D-04222	Rooidraai	B	n/a
U10D-04298	Nzinga	B/C	Non-flow[1]: Sedimentation, riparian zone, erosion.
U10D-04349	Mkomazi	B/C	Non-flow: Sedimentation, riparian zone, erosion.
U10D-04434	Mkomazi	B/C	Non-flow: Sedimentation, riparian zone, erosion.
U10E-04380	Mkomazi	C	Non-flow: Sedimentation, overgrazing, erosion.
U10F-04528	Mkomazi	B/C	Non-flow: Sedimentation, riparian zone, erosion.
U10F-04560	Luhane	B/C	Non-flow: Sedimentation, riparian zone, erosion.
U10G-04388	Elands	C	Non-flow: Alien vegetation, riparian zone, water quality.
U10G-04405		C	Non-flow: Forestry, irrigation, roads.
U10G-04473	Elands	C	Non-flow: Alien vegetation, riparian zone, water quality.
U10H-04576	Tholeni	B	n/a
U10H-04638	Mkomazi	B	n/a
U10H-04666	Ngudwini	B/C	Non-flow and Flow[2]: Dam, forestry.

SQ number	River	River PES (EC)	Key PES Driver
U10H-04675	Mkomazi	B	
U10H-04708	Ngudwini	B	n/a
U10H-04729	Mzalanyoni	C	Non-flow and Flow: Dam, forestry.
U10J-04679	Mkomazi	B	n/a
U10J-04713	Mkobeni	C	Non-flow: Forestry, subsistence farming, agricultural lands.
U10J-04721	Pateni	B	n/a
U10J-04799	Mkomazi	C	Non-flow: Agriculture, erosion.
U10J-04807	Mkomazi	B	n/a
U10J-04820	Lufafa	B/C	Non-flow: Agriculture, erosion.
U10J-04833	Mkomazi	B/C	Non-flow: Agriculture, erosion.
U10J-04837		A/B	n/a
U10K-04838	Mkomazi	B/C	Flow: Irrigation. Non-flow: Agriculture.
U10K-04842	Nhlavini	B	n/a
U10K-04899	Xobho	C/D	Flow: Large dams. Irrigation.
U10K-04946	Nhlavini	B/C	Non-flow: Forestry.
U10M-04746	Mkomazi	B/C	Flow: Cumulative impact of all upstream abstractions. Non-flow: Subsistence farming.

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

Mkomazi Mountain Zone: *The upper SQs are untransformed and are classified as A or B PES. The few impacts that exist are created by small patches of afforestation and other alien vegetation, small dams and trout farms, tourism, and rural community use in the form of subsistence farming (cattle trampling, erosion, roads, agricultural lands). A large percentage of the area is protected in nature reserves (Lotheni, Vergelegen, and Mkhomazi). The lower SQs of the Mkomazi and Nzinga, are all categorized as a C PES. The lower integrity of these river are due to an increase in subsistence farming which leads to an increase in abandoned lands, roads, trampling and erosion.*

Middle Mkomazi: *This zone includes the U10E, F and G quaternary catchments. All SQs within this zone have a C PES, and all occur within the grassland biome (Mucina and Rutherford, 2006). Rivers that comprise this zone are the Mkomazi (U10E-04380 and U10F-04528), Luhane (U10F-04560) and Elands (U10G-04388, U10G-04405 and U10G-04473) Rivers. The Mkomazi and Luhane rivers are dominated by non-flow related impacts (mainly forestry and rural settlements with informal agriculture), while the Elands and its tributaries is dominated by both flow (mainly small dams and some irrigation) and non-flow related (mainly forestry and rural settlements with informal agriculture) impacts. The proposed Smithfield Dam will be located at the end of the U10F catchment.*

Mkomazi Gorge Zone: *This zone includes mostly the rivers falling within quaternary catchments U10H and U10J (ending with U10J-4807). This zone is dominated by a PES of B with only two reaches falling in a C. The two C reaches falling in a C include the Ngudwini (U10H-4666) and Mzalanyoni (U10H-4729). These reaches are impacted by both flow and non-flow related activities, consisting primarily of forestry, subsistence farming and sugar cane agriculture, resulting in instream sedimentation, riparian zone modification and flow alterations. The main stem of the Mkomazi River flowing into quaternary catchment U10H improves from an upstream PES of a C to a B primarily as a result of the protection provided by a continuous gorge section. The Mkomazi remains in a B throughout U10H and U10J to the end of U10J-4807, with the primary land use being limited agriculture taking place. EWR (IFR) site 2 is also situated in this reach of the Mkomazi (U10J-4679). The Tholeni River (U10H-4576), a tributary flowing into the Mkomazi in this*

reach is impacted by forestry in the upper reaches, but still remains in a B PES. The same scenario is true for the Pateni River (U10J-4721) with extensive forestry activities but remaining a status of a B PES.

Lower Mkomazi: *This zone includes the U10K, L and M quaternary catchments. Quaternary catchment U10K contains the Xobho (U10K-04899) and Nhlavini (U10K-04946 and U10K-04842) Rivers which join the Mkomazi River (U10M-04746) in quaternary U10L, and which flows through U10M to its mouth at Umkomaas. Floristically diverse, U10K occurs in both Grassland and Savanna biomes, U10L in the Savanna biome, and U10M contains both Savanna and Indian Ocean Coastal Belt biomes (Mucina and Rutherford, 2006). Similarly, the PES for the zone is varied, although predominantly a C. The Xobho River is a D (main impacts being dams, forestry and agriculture), while the Nhlavini River ranges from a C (upper portion) to a B (main impacts being small dams and agriculture). The Mkomazi River in U10L and M is a category C river with the predominant impacts being overgrazing. Wetlands have been noted for very high and high importance in the Xobho (large valley bottom wetlands in headwater area) and Mkomazi (extensive narrow valley bottom wetlands) rivers respectively, while the Nhlavini River was noted for wetlands, but with a low importance.*

7.3.5 U7: Lovu

Table 7.7 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U70A-04599	*Serpentine*	**C**	*Non-flow[1]: Small town. Flow[2]: Forestry.*
U70A-04609	*Lovu*	**B/C**	*Non-flow: Forestry. Flow: Forestry.*
U70A-04618		**C**	*Non-flow: Forestry. Flow: Forestry.*
U70A-04685	*Lovu*	**C**	*Non-flow: Forestry. Flow: Forestry.*
U70B-04655	*Lovu*	**C/D**	*Flow: Forestry, large dam, irrigation-sugar cane, water quality (WWTW, Richmond town, fertilisers, and pesticides). Non-flow: Forestry, township, formal and informal agriculture (sugar cane, subsistence farming, grazing).*
U70C-04710	*Mgwahumbe*	**C**	*Flow: Forestry, small dams, irrigation (formal agriculture (sugar cane)), water quality (agricultural runoff). Non-flow: Afforestation, agriculture, rural settlements, subsistence farming.*
U70C-04724		**C**	*Non-flow: Forestry. Flow: Forestry.*
U70C-04732		**C**	*Non-flow: Forestry. Flow: Forestry.*
U70C-04859	*Lovu*	**B/C**	*Non-flow: Rural settlements, subsistence agriculture, grazing.*
U70D-04800	*Nungwane*	**B/C**	*Non-flow: Barrier of large dams.*
U70E-04942	*Umsimbazi*	**C**	*Flow: Irrigation, water quality (agricultural runoff, township). Non-flow: Agriculture, rural settlements, high density township, grazing.*
U70E-04974	*uMgababa*	**C**	*Flow: Dam. Non-flow: Rural settlements, grazing.*
U70F-04845	*Manzimtoti*	**C**	*Water quality: Urban runoff). Non-flow: Urban and rural settlements, subsistence farming.*
U70F-04893	*Little Manzimtoti River*	**C**	*Water quality: Urban runoff. Non-flow: Urban and rural settlements.*

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

The uppermost tributaries of the Lovu catchment (U70A) are situated in areas mainly covered with plantation forestry, thus the C PES. Further downstream, the main stem of the river and its major tributary, the Mgwahumbe, also have large areas of forestry. Furthermore, the sugar cane, rural

development (towns/townships), and dams, have increased impacts on these rivers, especially the water quality. Therefore the Lovu reach are rated a D PES, and the Mgwahumbe a C PES.

As the river flows through the lower parts of the catchment, it enters very hilly landscapes, and although there is still a high density of rural communities, the deeper valleys of the Lovu and Nungwane prevent the people from impacting too much on the rivers. However, poor water quality from upstream and deforestation in areas, renders the PES of these systems still a C.

All the coastal rivers in the Lovu catchment is in a C PES, and the impacts are very similar for all these rivers; Rural settlement with extensive high density townships, with associated activities (informal agriculture and some sugar cane).

7.3.6 U6: Mlazi

Table 7.8 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U60A-04533	*Mlazi*	**C**	*Non flow[1]: Forestry, water quality, agriculture lands. Flow[2]: Instream dams – irrigation.*
U60B-04614	*Mkuzane*	**C/D**	*Non-flow: Barriers, forestry, agricultural lands, alien vegetation. Flow: Irrigation.*
U60C-04555	*Mlazi*	**C/D**	*Non-flow: Water quality, barrier, vegetation removal from agriculture. Flow: Large dam, abstraction.*
U60C-04556	*Sterkspruit*	**D**	*Water quality issues associated with townships.*
U60C-04613	*Wekeweke*	**C**	*Non-flow: Key - alien vegetation. Vegetation removal (sugar). Barrier*
U60C-04697	*Mlazi*	**C/D**	*Water quality. Non-Flow: Vegetation removal from wood harvesting.*
U60D-04661	*Mbokodweni*	**B**	*n/a*
U60E-04714	*Mbokodweni*	**C**	*Non-Flow: Water quality; also vegetation removal from wood harvesting.*
U60E-04795	*Bivane*	**B/C**	*Non-flow: Trampling, sedimentation, vegetation removal.*
U60F-04597	*Sipingo*	**D/E**	*Non-flow: Trampling, sedimentation, vegetation removal.*
U60F-04632	*Umbilo*	**D**	*Non-flow: Trampling, sedimentation, vegetation removal.*

1: Non-flow refers to Non-Flow related activities. 2: Flow refers to Flow related activities.

Upper Mlazi: *The main river is the Mlazi, but also includes the Mkuzane, Sterkspruit and Wekeweke Rivers. Most SQs are D PES, while U60A-04533 and U60C-04613 are C PES. SQs from U60A, B and C all culminate in the Shongweni Dam. Upstream of the dam predominant impacts are both flow (instream dams and irrigation) and non-flow related (forestry, agricultural activities, alien invasive vegetation, and water quality especially in U60C-04556). The Mlazi (U60D-04661) downstream of the Shongweni Dam, is in a D PES and the main impacts are degraded water quality and riparian vegetation removal (wood harvesting and grazing).*

Mbokodweni: *This zone includes only 3 SQs which comprise the Mbokodweni and Bivane Rivers. The upper Mbokodweni (U60E-04714) is a B PES and the remainder of the zone is a C PES. The main reasons for the PES on the Mbokodweni are non-flow related impacts including water quality, vegetation removal (wood harvesting) and sugar cane plantations (in the upper reach). Similarly, the main impacts on the Bivane River is also non-flow related (trampling, sedimentation, vegetation removal).*

Mhlatuzana and Umbilo: *These Rivers are upstream of Durban harbour. This zone is highly developed with many residential, rural and industrial areas. Main impacts are non-flow related with poor water quality, trampling, sedimentation, alien vegetation and vegetation removal causing a PES of D and E for the Umbilo and Mhlatuzana respectively.*

7.3.7 U2: Mgeni

Table 7.9 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U20A-04253	Mgeni	B/C	Non-flow[1]: Agriculture, grazing. Flow[2]: Dams, forestry, agriculture. Water quality: Agricultural runoff, livestock farming.
U20B-04074	Ndiza	B/C	Flow: Forestry, small dams.
U20B-04144	Mpofana	C	Flow: Interbasin Transfer (IBT), irrigation, water quality (irrigation return flows, town runoff. Non-flow: Agriculture.
U20B-04173	Lions	C	Flow: Dams, forestry, irrigation. Water quality (agricultural runoff, urban runoff, livestock farming). Non-flow: Agriculture, forestry, livestock farming.
U20B-04185	Lions	B/C	Flow: IBT, forestry. Non-flow: Forestry, commercial farming.
U20C-04190	Lions	B/C	Flow: Forestry, IBT. Non-flow: Forestry, dryland agriculture.
U20C-04275	Mgeni	C	Flow: IBT, irrigation. Non-flow: Agriculture.
U20C-04332	Gqishi	B/C	Flow: Forestry, irrigation. Non-flow: Forestry, agriculture.
U20C-04340	Nguklu	C	Flow: Forestry, water quality (township runoff, organic and bacterial pollution). Non-flow: Forestry and urban areas.
U20D-04029	Yarrow	B/C	Flow: Forestry, irrigation. Non-flow: Forestry, agriculture.
U20D-04032	Karkloof	C	Flow: Forestry, irrigation. Non-flow: Forestry, agriculture.
U20D-04098	Kusane	D	Flow: Dams, irrigation, forestry. Non-flow: Agriculture.
U20D-04151	Karkloof	B/C	Non-flow: Agriculture.
U20E-04136	Nculwane	C	Flow: Forestry. Non-flow: Forestry.
U20E-04170	Karkloof	B/C	Flow: Irrigation, forestry. Non-flow: Forestry, agriculture.
U20E-04221	Mgeni	B/C	Flow: Midmar dam, irrigation. Non-flow: Agriculture.
U20E-04243	Mgeni	C	Flow: Midmar Dam water quality (Howick town).
U20E-04271	Doring Spruit	B/C	Non-flow: Agriculture, forestry.
U20F-04011	Sterkspruit	C/D	Flow: Forestry, dams, agriculture. Non-flow: Forestry, agriculture.
U20F-04095	Mpolweni	C/D	Flow: Forestry, dams, irrigation. Non-flow: Forestry, agriculture.
U20F-04131	Mhlalane	C/D	Flow: Agriculture, sugar cane. Non-flow: Irrigation return flows, urban runoff.
U20F-04204	Sterkspruit	B/C	Flow: Agriculture/sugar cane/irrigation. Non-flow: Agriculture: sugar cane.
U20F-04224	Mpolweni	B/C	Water quality (nutrients). Non-flow:township.
U20G-04194	Mkabela	C/D	Flow: Dams, forestry, irrigation. Non-flow: Forestry, agriculture.
U20G-04215	Cramond Stream	B/C	Water quality (township runoff, agricultural runoff). Non-flow: Township and agriculture.
U20G-04240	Mgeni	B/C	Flow modification: Albert Falls Dam, irrigation. Water quality (agricultural and livestock farming).
U20G-04259	Mgeni	B/C	Flow: Albert Falls Dam, irrigation. Non-flow: Agriculture.
U20G-04385	Mgeni	E	Flow: Nagel dam. Water quality (nutrient load, urban runoff). Non-flow: Rural village.
U20H-04410	Nqabeni	C	Non flow: Agriculture and townships, water quality.
U20H-04449	Msunduzi	C	Non flow: Sedimentation, overgrazing, alien.
U20J-04364	Msunduzi	D/E	Non flow: Water quality, canalisation, inundation, barriers. Urbanisation.
U20J-04391	Msunduzi	C	Non Flow: Water quality from upstream, agriculture, some flow impacts.

SQ number	River	River PES (EC)	Key PES Driver
U20J-04401	Msunduzi	D	Non-flow: Urban development, clearing of riparian vegetation, water quality.
U20J-04452	Mpushini	B/C	Non-flow: Urbanisation, Ashburton, vegetation removal.
U20J-04459	Msunduzi	C	Non flow: Water quality, informal settlements with agriculture, sand mining.
U20J-04461	Slang Spruit	C/D	Non flow: Water quality, urbanisation.
U20J-04488	Mshwati	B/C	Non flow: Vegetation removal from informal agriculture, wood collection. Water quality.
U20K-04181	Mqeku	C	Flow: Forestry, irrigation, small dams. Non-flow: Forestry, formal agriculture (sugar cane), rural areas, grazing.
U20K-04296	Tholeni	C	Flow: Agriculture. Non-flow: Agriculture, grazing.
U20K-04411	Mqeku	B/C	Non-flow: Rural villages, grazing.
U20L-04435	Mgeni	B/C	Flow: Nagel dam, water quality (Msinduzi).
U20M-04396	Mgeni (upstream of Inanda dam)	C	Water quality (nutrients). Non-flow: Rural area, grazing.
U20M-04642	Palmiet	D	Water quality (urban and industrial). Non-flow: Urban/industrial.
U20M-04649	Mbongokazi	C	Non-flow: Residential.
U20M-04653	Palmiet	C/D	Water quality (nutrients). Non-flow: Urban.
U20M-04659	Palmiet	C	Water quality: Urban area.
U20M-04682		C/D	Non-flow: Residential.

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

Mgeni upstream of Midmar Dam: *The upper catchment of the Mgeni River is heavily developed, mainly formal agriculture and forestry. The tributaries upstream of the Midmar Dam (U20A, B and C) are all in a C PES. Forestry is not restricted to the higher altitudes, patches occur throughout the area. In-between these patches commercial farms comprise irrigation and dry land agriculture. Flow impacts stem from damming and water transfers (Mpofana River), while water quality impacts are associated with irrigation return flows, urban runoff and effluent from different sources (towns, farming, trout dams). A large section of the main stem is also inundated by the Midmar Dam.*

Mgeni Midmar Dam to Albert Falls Dam: *The Mgeni River and its tributaries between the Midmar Dam and Albert Falls Dam are in a C PES, except the Kusane River which is a D PES due to a combination of forestry, dams and irrigation impacts. The main stem of the Mgeni River becomes very regulated as 0.9 m^3/s is released constantly from Midmar Dam with occasional spills, which is to the detriment of the river (C PES). Inundation by the large dams also impact on the integrity of the rivers. All the tributaries between the two dams are also heavily impacted due to plantation forestry, irrigation and dry land agriculture (formal), weirs and dams, and removal of riparian vegetation.*

Mgeni Downstream of Albert Falls Dam to Inanda Dam: *This zone mostly includes reaches in a D PES (Upper Sterkspruit, Mpolweni and Mhlalane) and two in a C PES (lower Sterkspruit and Mpolweni). Impacts in this zone are primarily flow and non-flow related with extensive forestry and formal agriculture (sugar cane) present in this area. Some rural areas and townships with associated non-flow (grazing, subsistence farming) and water quality (runoff) related impacts are also present.*

The reaches of the middle Mgeni mostly flow into deeply incised river valleys. The human component present in these areas, mainly consist of moderate density rural settlements, mostly on the higher plateaus, and on the river banks where slope is gentler. Their impacts on the river spring from deforestation and informal agriculture that leads to erosion and sedimentation. The

more serious impacts that are the main cause for deteriorating these main stem SQs into categories C and a E PES, are flow regulation by the large upstream dams (a continuous base flow from the Albert Falls Dam, no seasonality), the impact of the Nagle Dam in the main stem (inundation and no releases), and poor water quality deriving from the upper catchments (Pietermaritzburg and Howick areas).

The tributaries are influenced by forestry, dams and agriculture, with a C and D PES.

Msunduze: *This zone contains all SQs within the U20H and U20J quaternary catchments. The main river is the Msunduze and tributaries include the Nqubeni, Slang Spruit and Mpushini Rivers. This zone contains Henley Dam, Pietermaritzburg and numerous other informal settlements. Upstream of Henley Dam the PES is a C, with non-flow related impacts causing the majority of deviation from reference state. Predominant impacts are poor water quality, rural settlements, sedimentation, overgrazing, agriculture and alien vegetation. Downstream of Henley Dam through Pietermaritzburg the PES ranges from C to an E (U20J-04364). The Msunduze (U20J-04364), flowing through Pietermaritzburg, is mainly impacted by poor water quality, canalisation, inundation, instream barriers and high intensity urbanisation. The Msunduze from Pietermaritzburg to its confluence with the Mgeni River is mainly impacted by poor water quality, rural settlements, informal agriculture, clearing of vegetation, overgrazing and some erosion.*

Downstream of Inanda Dam to Estuary:
This zone includes the Mgeni River downstream of Inanda Dam, as well as the Palmiet River system (entire U20M quaternary catchment). Most of the rivers in this reach are largely to seriously modified. The lower Mgeni River is especially in a poor state (PES of an E) due to the flow regulation by Inanda dam, coupled with extensive urban and industrial areas (primary impacts are flow and water quality related). The Palmiet River reaches range between a C PES and D PES and the alterations are primarily non-flow and water quality related due to the extensively developed catchment (urban/residential and industrial areas).

7.3.8 U3: Mdloti

Table 7.10 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U30A-04228	*Mdloti*	**B/C**	*Non-flow[1]: Subsistence farming, limited sugar cane, grazing.*
U30A-04360	*Mdloti*	**D**	*Flow[2]: Dam, irrigation, water quality (nutrients). Non-flow: Rural settlements, grazing, informal agriculture.*
U30A-04363	*Mwangala*	**B/C**	*Non-flow: Subsistence farming, grazing.*
U30B-04465	*Black Mhlashini*	**B/C**	*Water quality (nutrients). Non-flow: Agriculture: sugar cane; informal settlements/rural area, grazing, informal agriculture.*
U30C-04227	*Tongati*	**B/C**	*Non-flow: Rural settlements, informal farming, grazing.*
U30C-04272	*Mona*	**B/C**	*Non-flow: Dryland agriculture, rural settlements, informal farming, grazing.*
U30E-04207	*Mhlali*	**C**	*Non-flow: Agriculture: sugar cane; settlements.*
U30A-04228	*Mdloti*	**B/C**	*Non-flow: Subsistence farming, limited sugar cane, grazing.*
U30A-04360	*Mdloti*	**D**	*Flow: Dam, irrigation, water quality (nutrients). Non-flow: Rural settlements, grazing, informal agriculture.*
U30A-04363	*Mwangala*	**B/C**	*Non-flow: Subsistence farming, grazing.*
U30B-04465	*Black Mhlashini*	**B/C**	*Water quality (nutrients). Non-flow: Agriculture: sugar cane, informal settlements/rural area, grazing, informal agriculture.*

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

This zone includes all the rivers falling within quaternary catchments U30A (upper Mdloti), U30B (lower Mdloti), U30C (upper Tongati and Mona Rivers) and U30D (lower Tongati). These rivers fall mostly in a B/C and D PES and are primarily subjected to non-flow related activities. The primary land-use activities in this zone include informal settlements with related subsistence agriculture and grazing.

The dominant activity in the Mhlali (lower) is dry land formal agriculture (sugar cane). The impacts are therefore flow related (agriculture), non-flow related (agriculture and settlements) as well as water quality related (agricultural and township runoff, WWTW effluents).

7.3.9 U4: Mvoti

Table 7.11 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U40A-03869	*Mvoti*	**B/C**	*Non-flow[1]: Forestry, Agriculture (vegetation removal). Flow: Centre pivot, dams in tributaries.*
U40B-03708	*Intinda*	**C**	*Non-flow: Forestry, Agriculture (vegetation removal). Barriers.*
U40B-03740	*Mvozana*	**C**	*Non-flow: Forestry, Agriculture (vegetation removal), barrier, inundation.*
U40B-03770	*Heinespruit*	**C**	*Non-flow: Forestry, Agriculture (vegetation removal). Barrier.*
U40B-03832	*Mvozana*	**C/D**	*Non flow: Agriculture. Barriers, vegetation removal. Water quality. Flow[2]: Abstraction for irrigation.*
U40B-03896	*Mvoti*	**C**	*Non flow: Aquatic alien macrophytes, agriculture (vegetation removal) encroachment.*
U40C-03982	*Khamanzi*	**B/C**	*Non-flow: Forestry, agriculture, and overgrazing.*
U40D-03867	*Mvoti*	**B/C**	*Non-flow: Overgrazing, erosion.*
U40D-03908	*Mtize*	**B**	*n/a*
U40D-03957	*Mvoti*	**B**	*n/a*
U40E-03967	*Mvoti*	**B/C**	*Non-flow: Overgrazing, informal agriculture.*
U40E-03985	*Mvoti*	**B/C**	*Non-flow: Overgrazing, sedimentation.*
U40E-04079	*Faye*	**B**	*n/a*
U40E-04082	*Sikoto*	**B**	*n/a*
U40E-04137	*Sikoto*	**B**	*n/a*
U40F-03690	*Potspruit*	**C**	*Non-Flow: Forestry, agriculture, inundation, barrier.*
U40F-03694	*Hlimbitwa*	**C**	*Non-Flow: Vegetation removal (agriculture and forestry), canalisation.*
U40F-03730	*Cubhu*	**C**	*Non-Flow: Forestry, agriculture, overgrazing, barrier impacts.*
U40F-03769	*Hlimbitwa*	**C**	*Flow: Large dam in SQ and upstream. Non-flow: Forestry and agriculture.*
U40F-03790	*Nseleni*	**B/C**	*Non-flow: Forestry and agriculture.*
U40F-03806	*Hlimbitwa*	**B**	*n/a*
U40G-03843	*Hlimbitwa*	**B**	*n/a*
U40H-04064	*Mvoti*	**B/C**	*Non-Flow: Sedimentation, overgrazing, trampling.*
U40H-04091	*Pambela*	**B/C**	*Non-Flow: Sedimentation, overgrazing, trampling.*

SQ number	River	River PES (EC)	Key PES Driver
U40H-04117	Nsuze	B/C	Non-Flow: Sedimentation, overgrazing, trampling.
U40H-04133	Nsuze	B/C	Non-Flow: Sedimentation, overgrazing.
U40J-03998	Mvoti	C	Non-Flow: Sedimentation, overgrazing. Flow: Cumulative dams in tributaries, small abstractions.

1: Non-flow refers to Non-Flow related activities. *2: Flow refers to Flow related activities.*

Mvoti Upper Reaches: *This zone includes SQs within U40A, U40B, U40C and a single SQ in U40D (U40D-03867). The main river is the Mvoti and the Heinespruit, Intinda, Mvozana and Khamanzi Rivers form its tributaries. Most SQs are in a C PES, with only the Mvozana (U40B-03832) a D PES. Impacts are predominantly non-flow related such as forestry, agriculture (vegetation and wetland removal), overgrazing, erosion, aquatic alien macrophytes (U40B-03896) and dams. The Heinespruit passes close to Greytown which influences the water quality. Some irrigation and centre pivots are also prevalent.*

Mvoti Middle Reaches*: This zone includes the Mvoti River from U40D-03957 down to U40E-03985 and includes the Mtize, Faye, Sikoto and Hlimbitwa (including its headwater tributaries) Rivers. The confluence of the Mvoti and Hlimbitwa Rivers is the site of the proposed Isithundu Dam. All the SQs within the zone are either B or C PES. Much of the Mvoti in this zone flows through a gorge and is highly confined. Predominant impacts are non-flow related: Mostly overgrazing, informal agriculture and some erosion. The Hlimbitwa at U40G-03843 is similar, but upstream of this there are several first and second order stream with a predominant category of C PES and the main impacts being forestry, overgrazing and instream dams.*

Mvoti Lower Reaches: *This zone includes the Mvoti from U40H-04064 to the coast and includes the Nsuze and Pambela tributaries. All the SQs in this zone are C PES with the main impacts being non-flow related, especially sedimentation, overgrazing, trampling and vegetation removal. The last section of the Mvoti (U40J-03998) consists mainly of subsistence farming, dryland sugar cane, road crossings, sand mining and residential in the lower reach until the estuary.*

7.3.10 U5: Nonoti

Table 7.12 River PES and key drivers resulting in modification from natural

SQ number	River	River PES (EC)	Key PES Driver
U50A-04018	Zinkwazi	B/C	Non-flow[1]: Formal agriculture: sugar. Flow[2]: Dryland agriculture, small dam. Water quality (agricultural runoff).
U50A-04021	Nonoti	B/C	Flow: Dryland agriculture. Water quality (agricultural runoff, WWTW effluent). Non flow: Agriculture, settlements.
U50A-04141	Mdlotane	B/C	Flow: Dryland agriculture. Water quality (agricultural runoff). Non-flow: Formal agriculture: sugar.

All the rivers in this ecological zone fall in a PES of a C. The three rivers (Zinkwazi, Nonoti and Mdlotane) are all subjected to similar land use activities of which the dominant activity is dry land formal agriculture (sugar cane). The impacts are therefore flow related (agriculture), non-flow related (agriculture and settlements) as well as water quality related (agricultural and township runoff, WWTW effluents).

ECOLOGICAL ZONES

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

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

This results in zones that are homogenous in terms of PES and impacts and can be managed as an entity. In this situation, the ecological zones are very similar to the final IUAs and therefore no further discussion or representation of the zones will be provided in this chapter. The IUAs are described in Chapter 9.

8 STATUS QUO ASSESSMENT: ESTUARIES

8.1 INTRODUCTION

For the purposes of this report a summary of existing information on existing pressures on the 64 estuaries within the study area was provided and included:

- *Degree of flow modification.*
- *Level of development in the estuary functional zone (i.e. below the 5 m contour).*
- *Fishing effort, and*
- *Pollution levels.*

The levels of assessment required at the estuary nodes will only be determined after May 2013 during which a desktop assessment for all estuaries including PES, RECs, general Ecological Specification and prioritised monitoring requirements for the 64 estuaries in the catchment will be undertaken.

8.2 APPROACH

The Mvoti to Umzimkulu area includes a vast number of estuaries - 64 in total. Ten estuary EWR studies have been completed in this study area at various levels of confidence, namely:

Name	Level	Year	PES
eZotha	*Rapid*	*2011*	*Yes*
Umzimkulu	*Intermediate*	*2011*	*Yes*
Little Manzimtoti	*Rapid*	*2011*	*Yes*
Mbokodweni	*Rapid*	*2011*	*Yes*
Mgeni	*Rapid*	*2011*	*Yes*
Mhlanga	*Rapid*	*2003*	*Yes*
Mdloti	*Intermediate*	*2007*	*Yes*
	Rapid	*2003*	*Yes*
Tongati	*Intermediate*	*2007*	*Yes*
	Rapid	*2006*	*Yes*
Mvoti	*Historical Ecological Flow Requirement Study*	*1996*	*No*
Mkomazi	*Historical Ecological Flow Requirement Study*	*1998*	*No*

This Status quo assessment will incorporate the findings of the historical EFR and EWR studies and the National Biodiversity Assessment (NBA) 2011 (van Niekerk and Turpie, 2012). The findings of the Estuaries of Durban report (Forbes and Demetriades, 2008) which was an assessment of the Ecological Status of sixteen estuaries occurring in the Durban area, is also included in the NBA 2011 assessment and will therefore be considered.

8.3 STATUS QUO ASSESSMENT

As part of the National Biodiversity Assessment 2011 a desktop national health assessment was concluded for nearly 300 estuaries in South Africa. The health assessment was based on the Estuarine Health Index developed for South African ecological water requirement studies that has been applied systematically to over 30 estuaries at various levels of data richness and confidence (DWAF, 2008c). National experts, all familiar with the index, were used to evaluate the systems in their region. The findings of historical EWR studies (up to 2009) were incorporated and reviewed as part of this assessment.

Table 8.1 provides a summary of the 2009 desktop health assessment updated with the more recent findings of the Umzimkulu, Mgeni and eZothsa EWR studies. The provisional PES provided here should be seen in the context of the limited hydrology, physical and water quality information available at the time of the 2009 study. The refinement of the desktop PES based on improved pressured data will be focus of this EWR study.

Table 8.1 Desktop National Health Assessment 2009 indicating key pressures and low confidence Present Ecological Status

Pressure levels are indicated as very high (VH), high (H), medium (M) or low (L). A Blank indicates the absence of a pressure (Van Niekerk and Turpie, 2012). The colours in the first two columns group the secondaries together.

SQ	Estuary	Change in flow	Pollution	Habitat loss	Mining	Artificial Breaching	Fishing Effort	Fishing (Catches in tons)	Bait collection	Ecological Category*
T40E-05869	Mtamvuna	L	L	L		?	L	0.1	Y	B
T40F-05666	Mbizana	L	M	M	Y	?	L	0.2	Y	B
T40F-05770	Mpenjati	L	M	M	Y	Y	L	0.3	Y	B
T40F-05820	Kaba	L	M	M			L	0.6	Y	B
T40F-05839	Umhlangankulu	L	M	M		Y	L	0.2	Y	C
T40F-05879	Tongazi	L	M	M				0.2	Y	B
T40F-05884	Kandandhlovu	L	M	M			L	0.3	Y	B
T40F-05923	Sandlundlu	L	M	M	Y	Y	L	0.2	Y	C
T40F-05928	Ku-Boboyi	L	M	M			L	0	Y	B
T40F-05953	Zolwane	L	L	M		Y	L	0.2	Y	B
T40G-05573	Boboyi	L	H	M			L	0.1	Y	C
T40G-05577	Zotsha	L	M	M	Y	Y	L	0.2	Y	B
T40G-05611	Mbango	M	H	H			L	4	Y	E
T40G-05616	Vungu	L	M	L				0.2		B
T40G-05644	Mhlangeni	L	M	M		Y	L	0.7	Y	C
T40G-05722	Bilanhlolo	L	M	M		Y	L	0.2	Y	C
T40G-05739	Kongweni	L	M	H		Y	L	0	Y	C
T40G-05768	Umvazana	L	M	M		Y	L	0.2	Y	C
T40G-05773	Mvutshini	L	M	M		Y	L	0.2	Y	B
T52M-05547	Umzimkulu	M	M	M	Y	Y	H	0.2	Y	B
U80A-05456	Intshambili	L	L	M			L	0.3	Y	B
U80A-05461	Damba	L	M	M		Y	L	0.2	Y	C
U80A-05470	Mtentweni	L	M	M			L	0.2	Y	C
U80A-05496	Koshwana	L	M	M			L	0.2	Y	C
U80A-05527	Mhlangamkulu	L	M	M			L	0.2	Y	C
U80C-05448	Mzumbe	L	M	H	Y		L	0.2	Y	D
U80D-05327	Mnamfu	L	M	M			L	0.2	Y	C
U80D-05345	Kwa-Makosi	L	M	M			L	0.2	Y	B
U80D-05361	Mhlungwa	L	M	M			L	0.5	Y	C
U80D-05374	Mfazazana	L	M	H			L	0.4	Y	C
U80D-05375	Mhlabatshane	L	L	M			L	0.8	Y	B
U80F-05270	Mtwalume	L	M	M	Y		L	0.2	Y	D
U80G-05097	Fafa	L	M	M	Y	Y	L	0.1	Y	D
U80G-05302	Mvuzi	L	M	M			L	0.8	Y	C

SQ	Estuary	Change in flow	Pollution	Habitat loss	Mining	Artificial Breaching	Fishing Effort	Fishing (Catches in tons)	Bait collection	Ecological Category*
U80H-05109	Mzinto	L	M	M		?	L	0	Y	C
U80H-05120	Mzimayi	L	M	M			L	0.1	Y	C
U80H-05186	Mkumbane	L	M	M			L	0.6	Y	C
U80H-05202	Sezela	L	H	M		Y		0.2		D
U80H-05229	Mdesingane	L	M	H			L	0	Y	C
U80K-04952	Mpambanyoni	L	M	M	Y	?	L	7.6	Y	C
U80L-05020	Mahlongwa	L	M	M	Y	Y	M	0.4	Y	C
U80L-05056	Mahlongwane	L	M	M		?	L	7		B
U10M-04746	Mkomazi	L	M	M	Y	Y	H	1.9	Y	C
U70D-04905	Lovu	M	M	M	Y	Y		0		C
U70E-04942	Msimbazi	L	L	L				0		B
U70E-04974	Umgababa	L	L	M		Y		0		B
U70E-05010	Ngane	L	L	M		?	L	0	Y	B
U70F-04845	Manzimtoti	L	H	H	Y	Y		0		D
U70F-04893	Little Manzimtoti	M	H	H		Y		0		D
U60E-04792	Mbokodweni	M	H	H	Y	Y		0		E
U60E-04827	Sipingo	H	H	H				53		F
U60F-04684	Durban Bay	M	H	H			H	3.7	Y	E
U20M-04543	Mgeni	M	H	H	Y	Y	L	0.1	Y	E
U30B-04475	Mdloti	L	H	H	Y	Y	L	0.6	Y	D
U30B-04498	Mhlanga	M	H	M		Y	L	1	Y	D
U30D-04315	Tongati	L	H	H	Y	Y	L	0.6	Y	E
U30E-04207	Mhlali	M	H	M	Y	Y	L	0	Y	C
U30E-04256	Seteni	M	M	M			L	1	Y	C
U40J-03998	Mvoti	M	H	M	Y	Y	L	0.2	Y	D
U50A-04018	Zinkwazi	L	M	H	Y	Y	L	17	Y	C
U50A-04021	Nonoti	L	M	M	Y	Y	L	3	Y	B
U50A-04141	Mdlotane	L	L	M			L	0.6	Y	B

** Ecological Category was determined by an EWR study, otherwise determined by desktop study.*

8.3.1 Degree of flow modification

The NBA 2011 pressure assessment indicated that while only one estuary, the Isipingo Estuary, was under very high flow modification pressure, nearly 20% were subjected to a moderate degree of flow modification (Table 8.2). Many of these flow modifications were linked to elevated base flows as a result of WWTW discharges.

Table 8.2 A desktop assessment the degree to which river inflow has been modified from reference conditions

Level of flow modification	Number of estuaries (64)	% of estuaries
High	1	1.6
Medium	12	18.8
Low	51	79.7

8.3.2 Level of development in the estuary functional zone (i.e. below the 5 m contour)

Approximately 23% of the estuaries in WMA 11 have significant development pressures in the estuary functional zone (under the 5 m mean sea level contour), while more than 70% show

moderate levels of development pressure (see Table 8.3). Activities linked to development pressures in WMA 11 include infilling of the floodplain for sugar cane faming, residential development, parking lots and golf courses.

Table 8.3 A desktop assessment the degree development encroachment into the estuarine functional zone (i.e. below the 5 m M.S.L. contour).

Level of flow modification	Number of estuaries (64)	% of estuaries
High	*15*	*23.44*
Medium	*46*	*71.88*
Low	*3*	*4.688*

8.3.3 Fishing effort

About 5% of the estuaries in WMA 11 are under significant fishing pressure, while about 50% have moderate fishing pressures on them (Table 8.4). Nearly 20% of the systems in WMA 11 have no fishing pressure on them.

Table 8.4 A desktop assessment the fishing pressure on the estuaries

Level of flow modification	Number of estuaries (64)	% of estuaries
High	*3*	*4.7*
Medium	*49*	*76.6*
Low	*1*	*1.6*
None	*11*	*17.2*

8.3.4 Pollution levels

Approximately 23% of the estuaries in WMA 11 are under significant pollution pressure; while more than 72% show moderate levels of pollution pressure (see Table 8.5). Activities linked to pollution pressure in WMA 11 include discharges from WWTW, agricultural return flow, stormwater runoff and discharges from industry.

Table 8.5 A desktop assessment the pollution pressures on the estuaries

Level of flow modification	Number of estuaries (64)	% of estuaries
High	*15*	*23.4*
Medium	*46*	*71.9*
Low	*3*	*4.7*

8.4 PES RESULTS

A desktop health assessment (augmented with recent EWR findings) of the PES of the estuaries of WMA 11 indicate that only about a third of the systems in the region was still in a good state, i.e. B PES (see Table 8.6). An additional 58% of the estuaries in WMA 11 were in a fair state (33% in a C PES and 14% in a D PES), while about 9% (6 estuaries) were judged to be in a very poor condition.

Table 8.6 A desktop assessment the PES of the estuaries

Level of flow modification	Number of estuaries (64)	% of estuaries
A	*0*	*0*
B	*21*	*32.8*
C	*28*	*43.8*
D	*9*	*14.1*
E	*5*	*7.8*
F	*1*	*1.6*

9 PRELIMINARY IUAS

9.1 PROCESS TO DETERMINE IUAS

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

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

The process of IUA delineation is summarised in a flow diagram, Figure 9.1. Once the IUAs are delineated, biophysical nodes must be identified for different levels of EWR assessment.

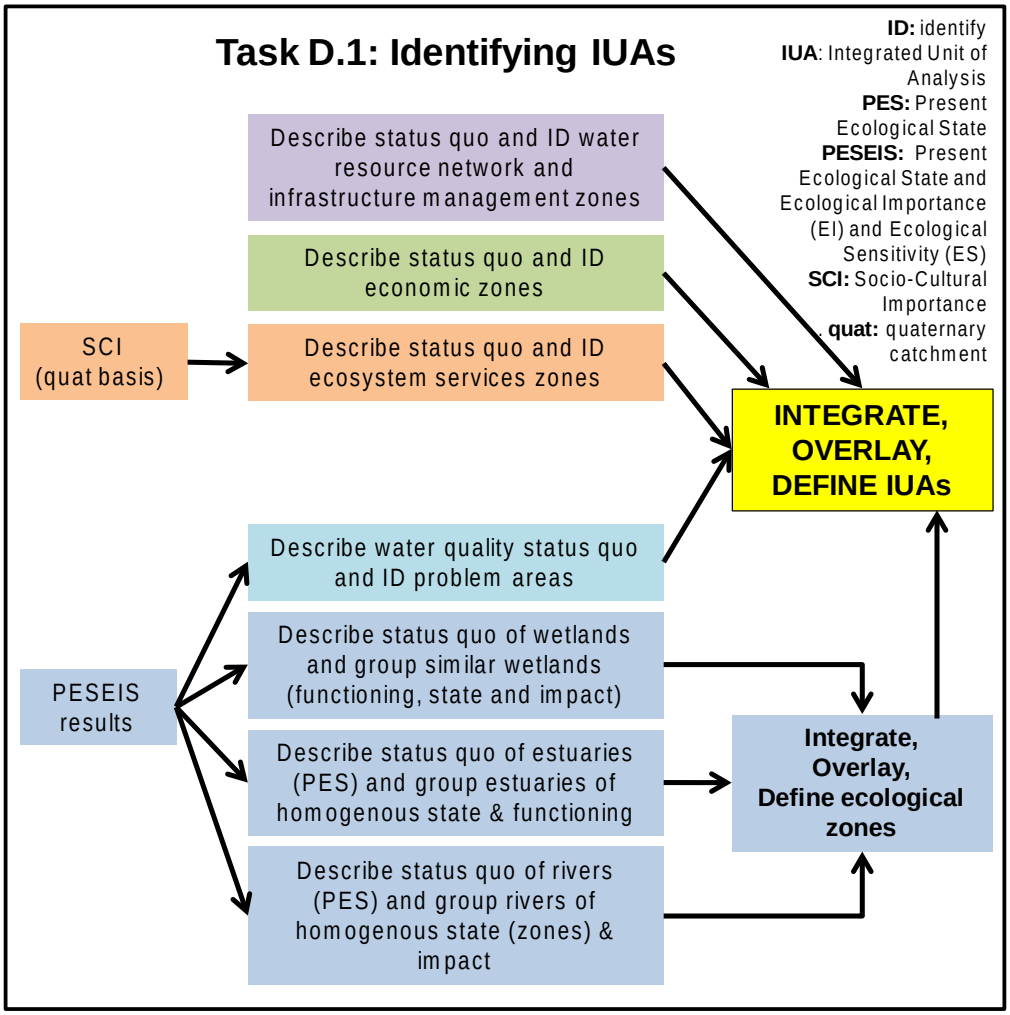


Figure 9.1 Summary of process to identify IUAs

9.2 DESCRIPTION OF STATUS QUO PER IUA

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

9.2.1 IUA T4: Mtamvuna

Water resources: *The storage regulation in this IUA is low with no noticeable dams located in the area. There is no surface water developments planned in the IUA. The land use activities include extensive forestry in the upper reaches and some cultivation in the lower reaches. The IUA is predominantly rural with a large number of scattered rural and informal settlements supplied from regional water abstractions.*

According to a desktop investigation conducted as part of this study, insignificant volumes of groundwater are utilised in the water resources IUA and there is a potential for some groundwater development in the upper reaches underlain by Karoo sediments. The lower reaches are underlain by low yielding Dwyka tillites. The locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

Economy: *Mtamvuna River forms the boundary with the Eastern Cape Province. It is a very popular holiday area with some sub-tropical fruit, mostly banana and sugar cane production.*

EGSA: *The upper portion of the IUA consists of plantation and formal commercial farming with the utilisation of EGSA limited to ad hoc consumption by farm workers and recreational usage - not significant. The remainder of the catchment is under communal tenure and made up of former homeland areas (Transkei). Utilisation of EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Some parts of the IUA are characterised by high population densities and development is more typically that associated with the closer settlement that was developed as "betterment planning". Here the resource base is under considerable stress and as such the production of EGSA is constrained. The lower part of the Mtamvuna Gorge is a popular area with aesthetic appeal.*

Ecology (rivers and wetlands): *Dominated by B and B/C PES. Quaternary catchment T40A (Mafadobo and Goxe rivers) is subjected to small areas of forestry and low density rural settlements with the primary impacts being non-flow related (sedimentation). T40B has flow and non-flow related impacts, consisting of extensive forestry occurring in the upper reaches, with a timber mill and rural settlements. Subsistence farming, grazing and low density rural settlements occur in T40C. T40D is mostly in a good state which is often due to the protection provided by gorges. Impacts are non-flow related as well as for the rivers further downstream with impacts being primarily non-flow related (rural settlements, subsistence farming, sedimentation and grazing).*

IUA rationale: *The storage regulation in this IUA is low with no noticeable dams located in the area. There is no surface water developments planned in the IUA. Landuse is mostly forestry (upper areas) and rural. Ecological impacts are similar and in relatively good state. The Mtamvuna catchment therefore forms a logical unit.*

9.2.2 IUA T5-1: Upper Umzimkulu Mountain Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and instream dams. There is no surface water developments planned in the IUA.*

The upper reach of the IUA is mainly a mountainous area below which the IUA is mainly characterised by agricultural activities including extensive forestry, extensive irrigation, cultivation, dairy, cattle and sheep farming. Some parts of the IUA are rural with some community water use from the scattered rural villages. Subsistence farming is practised in these areas. The towns Underberg and Himeville are also located in the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised in the water resources IUA for rural supply and livestock watering purpose and there is some potential for further groundwater development as the Karoo sediments underlying the region are moderately yielding. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Economy: *Umzimkulu catchment starts in the Drakensberg area of Underberg, a mixed farming area with large areas under animal pasture production supporting the dairy industry in the area, followed by commercial forestry and large tracts of communal land.*

EGSA: *This is largely the Drakensberg and adjacent foothills. For the most part the population density is very low. There are some patches of commercial farming entities but the bulk of the IUA is given over to conservation. Recreational aspects of EGSA are important.*

Ecology (rivers and wetlands): *A mountainous zone which contains several headwater streams. Most SQs are an A or B PES, with a single C PES. Low severity impacts that exist are created by small patches of afforestation and other alien vegetation, small dams, tourism, irrigation and rural community use in the form of subsistence farming (grazing and trampling, agricultural lands). A large percentage of the area is protected in various Wilderness areas and the Cobban Nature Reserve (T51D-04404).*

The Pholela (T51D-04404) has been noted for low wetland importance (large valley bottom wetlands). Several wetland clusters also occur in the zone, mostly not associated with a SQ.

IUA rationale: *Mountainous zone with most of the rivers in a good PES and impacts similar. Low storage capacity and not prospects for future development. Population density is low with some recreation. Outside of this IUA, the uses and level of impacts change due to the different topography, therefore providing the rationale for this IUA.*

9.2.3 IUA T5-2: Middle Umzimkulu and Mzimkulwana Tributary

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. A surface water development planned for the area is the Ncwabeni off-channel dam with abstraction from a new weir on the Umzimkulu River for regional water supply, which will have some effect on the flows.*

The land use activities in the IUA include extensive forestry concentrated in the upper higher rainfall areas, irrigation in the upper reaches, cultivation, cattle farming and subsistence farming.

There are a number of scattered rural villages supplied by regional water supply schemes. The towns Creighton and Umzimkulu are also located in the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised by rural villages in the water resources IUA, with a potential for further groundwater development, however, the lower reaches are underlain by low yielding Dwyka tillites. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** Commercial forestry is the main economic activity surrounded by large areas of tribal land. Saw mills operate at Harding and Weza.*

***EGSA:** The upper portion of the IUA consists of plantation and formal commercial farming and EGSA is limited to ad hoc consumption by farm workers and some recreational usage (not significant). The rest of the IUA is under communal tenure and made up of former homeland areas. Utilisation of goods and services (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Some parts of the IUA are characterised by high population densities and development is more typically that associated with the closer settlement that was developed as "betterment planning". Here the resource base is under considerable stress and the production of EGSA is constrained. Oribi Gorge in the catchment is a popular area with aesthetic appeal.*

***Ecology (rivers and wetlands):** Most of the rivers are in a B/C and C PES. Extensive rural development and associated settlements are the main impacts. Forestry, irrigation, trampling and erosion, dams and alien invasive plants occur. Further downstream, dense human settlements and large townships occur. SQs with a high PES originate in the Ntsikeni Wildlife Reserve and in other areas, are protected by being within steep valleys. The one SQ that is in an E PES is drowned by dams.*

The Lubhukwini River (T51H-04846) is noted for high priority wetlands (extensive seeps) which are KZN priority monitoring sites and is also a Ramsar site. Wetland rehabilitation is evident. Very high priority channelled valley bottom wetlands with meandering grasslands have been noted in the Pholelana (T51D-04460) and Pholela (T51E-04478) Rivers. Meandering floodplains in the Pholela are KZN priority monitoring sites. Some wetlands are inundated and grazing and formal agriculture has affected wetland PES.

***IUA rationale:** Most of the rivers in a similar state due to similar land use and impacts. The upper border of this IUA is due to the change in topography and landuse. It is split from the T5-3 due to the rivers being all in a better state than this SQ, probably due to the protection of steep valleys. Land use also changes.*

9.2.4 IUA T5-3: Umzimkulu

***Water resources:** The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The upstream development of the Cwabeni off-channel dam with abstraction from a new weir on Umzimkulu for regional water supply will have some effect on the flows.*

The land use activities include extensive forestry and sugar cane, Oribi Gorge Nature Reserve, natural areas with grazing, and run of river abstraction or regional water supply to rural villages.

The town Harding is also located in the IUA. Industrial activities include limestone mining and the Illovo Umzimkulu sugar mill in the lower reach, which abstracts water directly from the Umzimkulu River just upstream of the estuary.

According to a desktop investigation conducted as part of this study, some groundwater is utilised by rural villages in the water resources IUA, with a potential for further groundwater development in areas underlain by Natal Metamorphic Province and Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** Commercial forestry is the main economic activity surrounded by large areas of tribal land.*

***EGSA:** In the upper part the population densities are relatively low as the topography militates against development. Most of this portion of the IUA is under communal tenure and made up of former homeland areas. Although utilisation is low given population density and problems of accessibility the EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) are of high importance to those who do consume them. The bottom part of the IUA is made up of the town of Port Shepstone. Recreational use of the river in this area is of potentially high importance.*

***Ecology (rivers and wetlands):** The SQs are all in a B PES. The good state of especially the main Umzimkulu in this area is attributed to the protection provided by a large gorge section. Impacts in this area is primarily non-flow related, related to small scale subsistence farming, grazing, limited forestry, erosion and sedimentation of instream habitats. A lime stone mining plant is also present in the lower Umzimkulu River reach but does not impact notably on the present status of this zone.*

The Bisi (T52H-05178) has been noted for low importance wetlands (isolated pockets of valley bottom wetlands).

***Ecology (estuary):** The Umzimkulu Estuary is a B PES. This status has been confirmed through a detailed EWR study recently conducted on the system. Currently it is under moderate flow modification, pollution, habitat loss and medium-high fishing pressure. Artificial mouth-breaching is practised in the system. It is of moderate importance from a biodiversity perspective. The estuary also forms part of the national priority set identified under the National Estuaries Biodiversity Plan, which affirms the REC as a B Category (Turpie et al., 2012). This catchment plays an important role in providing nutrients and sediments to the near-shore marine environment.*

***IUA rationale:** The River is mostly protected by gorge section which results in a better state than the upper reaches. It culminates in an estuary which is also in a good state.*

9.2.5 IUA U8-1: Mzumbe

***Water resources:** The storage regulation in this IUA is low with no significant dams present and there is no future surface water developments planned in the IUA.*

The IUA is predominantly rural with scattered rural villages located throughout. There is some forestry and cultivation located in the upper reach of the IUA.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for limited groundwater development in the area, since it is underlain by low yielding Natal Metamorphic Province rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** It is has a large rural population in the inland area with some mixed farming and commercial forestry and sugar cane production.*

***EGSA:** The very top end of IUA is given over to forestry (low EGSA utilisation). The rest has pockets of forest, is under communal tenure and made up of former homeland areas. EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Some parts of the IUA are characterised by high population densities, particularly the ridges, and development is more typically that associated with the closer settlement.*

***Ecology (rivers and wetlands):** All the SQs that comprise the Mzumbe system have B PES. Impacts in the Mzumbe comprise mainly forestry (U80B-05145), rural settlements and subsistence farming, small dams in the tributaries, and associated non-flow related impacts such as grazing, but all with low severity or extent.*

***Ecology (estuary):** The Mzumbe estuary is a D PES. Currently it is under low flow modification pressure, but moderate pollution and habitat loss pressures. It is of average importance from a biodiversity perspective. The estuary is highly sensitive to modification in base flow as it influences the mouth state.*

***IUA rationale:** There is no reason to break the Mzumbe River catchment in different IUAs as the ecological state is similar, the landuse is predominantly rural and there are no planned developments.*

9.2.6 IUA U8-2: Mtwalume

***Water resources:** The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few instream dams. There is no future surface water developments planned in the IUA.*

Land use activities in the water resources IUAs generally include cultivation and some forestry in the middle and upper reaches. Rural villages are also scattered throughout the IUA with semi-urban and urban areas located along the coast.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a limited potential for further groundwater development in the area since it is largely underlain by low yielding Natal Metamorphic Province rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** It is has a high rural population in some areas with some mixed farming and commercial forestry and sugar cane production.*

***EGSA:** The very top end of IUA is given over to forestry and formal commercial agriculture. There are pockets of scattered forestry development in other parts of the IUA (EGSA utilisation is low).*

The bulk of the remainder is under communal tenure and made up of former homeland areas. EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Some parts of the IUA are characterised by high population densities, particularly the ridges, and development is more typically that associated with the closer settlement. Population densities increase closer to the coastal areas.

Ecology (rivers and wetlands): *Rivers are mostly in a B, C, B/C and D PES. Both flow and non-flow related impacts dominate the Mtwalume and its tributaries. Notable are instream dams, forestry, subsistence agriculture and encroaching sugar cane fields. No importance has been noted for wetlands.*

Ecology (estuary): *The Mtwalume Estuary is a D PES. Currently it is under low flow modification pressure, but moderate pollution and habitat loss pressures. It is of average importance from a biodiversity perspective. The estuary is highly sensitive to modification in base flow as it influences the mouth state.*

IUA rationale: *There is no reason to break the Mtwalume River catchment in different IUAs as the ecological state is very varied, with varied landuse and there are no planned developments.*

9.2.7 IUA SC: Southern Coastal

Water resources: *These include the coastal strips and immediate hinterland associated with Port Edward, Leisure Crest, Palm Beach, Southbroom, Ramsgate, Margate, Shelly Beach Oslo Beach, South Port, Pumula, Hibberdene, Bazeley Beach, Pennington, Park Rynie, and Palmcliffe. The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. There is no surface water developments planned in the IUA.*

Landuse activities in the water resources IUAs generally include cultivation (mostly sugar cane with some orchards) and some forestry plantations slightly inland. Rural settlements are usually located more inland with semi-urban and urban areas towards the coast. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

According to a desktop investigation conducted as part of this study, groundwater is utilised for rural supply in the water resources IUA and there is a limited potential for further groundwater development in the area since it is largely underlain by low permeability Dwyka tillites and Natal Metamorphic Province rocks. An exception may be the karstic rocks of the Mzimkulu Formation of the Natal Metamorphic Province in the vicinity of Umzimkulu. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for SC are shown below.*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U80H-5109	*Mzinto*	*Serious (4)*	*Elevated nutrients; possible impact of WWTW.*
U80H-5120	*Mzimayi*	*Large (3)*	*Possible impact of WWTW in Umzinto; low confidence.*
U80L-5056	*Mahlongwana*	*Large (3)*	*Elevated nutrients.*

Economy: *Port Shepstone is the largest coastal town on the South Coast with a sugar cane mill, forestry production and a beverage producing facility. The surrounding coastal area is also a very popular holiday area with a number of holiday resorts.*

EGSA: *The coastal stretch is heavily developed and other than recreational utilisation of the river (swimming and fishing) above the estuary there is little in the way of utilisation of the EGSA. Also included in this section are scattered pockets of commercial farming enterprises (low EGSA). The coastal and hinterland areas associated with the old KwaZulu homeland are densely populated and EGSA utilisation is high. Densities mean that resources are under pressure. Nevertheless the utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance.*

Ecology (rivers and wetlands): *The Mzinto River is in a D PES. Extensive sugar cane farming, in addition to other developments in the catchment is present. The Mpambanyoni system (U80J and U80K) is in a B, B/C and C PES. Impacts are forestry on the upper catchments, with rural developments and associated cultivation, as well as in-stream weirs downstream. The Fafa River system (U80G) is in a C PES mainly due to rural developments, plantations and an in-stream weir. Low priority wetlands have been noted on the Fafa (U80G-05097), Mzinto (U80H-05109) and Mpambanyoni (U80K-04952) Rivers. These consist of small to narrow patches of both channelled and unchannelled valley bottom wetlands.*

The lower density in human settlement in the Mbizana (T4) River has resulted in a B PES. The higher density of rural settlements, sugar cane farming, an in-stream dam, WWTW and quarries close to the river, places the Vungu (T4) River in a B/C PES. No wetlands of any importance were noted.

Ecology (estuary): *Thirty seven estuaries form this cluster of which the majority is in a B, and C PES with one system in a D PES and one in an E PES. The majority of the systems are subject to low flow modification pressure but under moderate to high pollution and habitat loss pressures. Artificial mouth breaching is also practised in some of the systems. All temporarily open/closed estuaries are highly sensitive to modification in baseflow as it influences their mouth state.*

IUA rationale: *This IUA consists of a range of short coastal rivers. The impacts on especially the estuaries are very similar and these estuaries and rivers form a logical grouping in an IUA.*

9.2.8 IUA U1-1: Mkomazi Mountain Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The proposed Smithfield Dam site is located at the lower end of the IUA and is likely to be developed in the future. The DWA is currently in the process of conducting a feasibility study for the Mkomazi River Development Project (Smithfield Dam) and the purpose of the project is to augment the Mgeni River supply area. The construction of Smithfield Dam will have a noticeable effect on the river flows downstream of the dam.*

The middle to upper reach of the IUA is mainly a mountainous area, where nature reserves (Lotheni, Vergelegen, Kamberg, Highmore Nature Reserves, and Mkomazi National Park) and the Sani Pass Tourism area are located. There is some agriculture and community water use. The main activities in the middle to lower end of the IUA underlain by the Middelveld Karoo groundwater region include forestry, cultivation, irrigation, grazing, and community water use from

low density rural settlements. Bulwer Town is located in the lower end of the IUA. In general there are few impacts on the river systems and the water quality can be regarded as good.

According to a desktop investigation conducted as part of this study, some groundwater is utilised in the water resources IUA and there is some potential for further groundwater development in the area. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** Some commercial cattle farming occurs at the top end of the river, followed by a mixture of commercial plantations and rural tribal land.*

***EGSA:** There is a belt of commercial farming entities but the bulk of the upper part of the IUA is given over to conservation in the Drakensberg. Recreational aspects of EGSA are important. In the DS section, EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Population densities in this part of IUA are high and the regions of Sitofela and Moyeni are particularly dense.*

***Ecology (rivers and wetlands):** The Rivers are mostly in an A, A/B and B PES category. The few impacts that exist are created by small patches of afforestation and other alien vegetation, small dams and trout farms, tourism, and rural community use in the form of subsistence farming (cattle trampling, erosion, roads, and agricultural lands). A large percentage of the area is protected in nature reserves (Lotheni, Vergelegen, and Mkomazi). The two B/C PES SQs are due to an increase in subsistence farming which leads to an increase in abandoned lands, roads, trampling and erosion.*

The Nzinga River (U10D-04199) is noted for low priority wetlands, mainly small pockets of channelled valley bottom wetlands, and several wetland clusters (predominantly seep wetlands and channelled valley bottom wetlands) (Nel et al., 2011).

***IUA rationale:** Mountainous zone with most of the rivers in a good PES and impacts similar. The proposed Smithfield Dam is the logical break for the IUA.*

9.2.9 IUA U1-2 Middle Mkomazi

***Water resources:** The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The land use activities in the IUA include forestry, cultivation, irrigation, some sugar cane, cattle farming, and community water use from low density rural settlements. The small town Ixopo is also located in the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised for rural supply in the water resources IUA and there is some potential for further groundwater development in the area since it is underlain largely by moderately yielding sediments of the Ecca Group. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Economy: *Commercial plantations, some irrigation activities and cattle farming are the main economic activities.*

EGSA: *The eastern part has well-developed commercial agriculture and forestry (use of EGSA is limited to ad hoc consumption by farm workers and some recreational usage). The remainder of the catchment is under communal tenure and made up of former homeland areas of KwaZulu. Some parts, particularly around Machabasini, Impendle and Nkumba, are densely populated. Densities mean that resources are under pressure. Nevertheless the utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance.*

Ecology (rivers and wetlands): *All SQs are in a C PES. The Mkomazi and Luhane rivers are dominated by non-flow related impacts (mainly forestry and rural settlements with informal agriculture), while the Elands and its tributaries is dominated by both flow (mainly small dams and some irrigation) and non-flow related (mainly forestry and rural settlements with informal agriculture) impacts.*

The zone also contains several NFEPA wetland clusters, which are not necessarily associated with the river directly.

***IUA rationale*:** *The upper border of the IUA is delineated by Smithfield Dam. The lower border is due to the change in topography of the Mkomazi gorge. Ecological impacts all similar due to similar range of land use.*

9.2.10 IUA U1-3: Mkomazi Gorge Zone

Water resources: *The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The land use activities are predominantly community water use from low density rural settlements.

According to a desktop investigation conducted as part of this study, minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for further groundwater development in the area. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Economy: *Very little economic activities occur with some tourist facilities present.*

EGSA: *The upper and western part has well-developed commercial agriculture and forestry (use of EGSA is limited to ad hoc consumption by farm workers and some recreational usage). The gorge itself is of aesthetic importance with recreation (rowing) taking place. There are pockets of former homeland areas of KwaZulu including KwaSandanezwe. The utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance but constrained by problematic access.*

Ecology (rivers and wetlands): *The IUA is dominated by a B PES with one C and one B/C PES SQ. These reaches are impacted by both flow and non-flow related activities, consisting primarily of forestry, subsistence farming and sugar cane agriculture, resulting in instream sedimentation, riparian zone modification and flow alterations.*

The Tholeni and Pateni Rivers are impacted by forestry in the upper reaches. The Mkomazi (U10H-04638, U10H-04675, and U10J-04807), Mkobeni (U10J-04713), Pateni (U10J-04721) and Lufafa (U10J-04820) rivers are all noted for low importance wetlands (mostly small or narrow valley bottom wetlands).

***IUA rationale:** The topography, i.e. the gorge, resulted in this IUA. This zone is largely inaccessible and dominated by a good PES.*

9.2.11 IUA U1-4: Lower Mkomazi

***Water resources:** The storage regulation in this IUA is low with no dams located in the IUA. The development of the upstream Mkomazi River Development Project (Smithfield Dam) will have a significant impact on the Mkomazi River in the water resource IUA.*

The landuse activities are predominantly community water use from low density rural settlements and there is also an abstraction for Sappi Saiccor in the lower end of the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised for rural supply in the water resources IUA and there is limited potential for further groundwater development in the area, since it is underlain by low permeability Dwyka tillites and Natal Metamorphic Province rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Economy:** The large Sappi cellulose producing facility, SAICCOR, operates close to the coast. Some holiday facilities also operate in the area.*

***EGSA:** Part of this IUA has well-developed commercial agriculture and forestry including the regionally important centre of Ixopo. The bulk of the main portion of the IUA is former homeland areas of KwaZulu. Some parts, particularly around Mgandleni, KwaNkukhu, KwaMagidigidi, and Kadeda are densely populated. Densities mean that resources are under pressure. Nevertheless the utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. The bottom part of the IUA includes Craigieburn, and the associated Sappi Saiccor development as well as parts of the town of Umkomaas. This part is heavily developed and other than recreational utilisation of the river (swimming and fishing) above the estuary there is little in the way of utilisation of the EGSA.*

***Ecology (rivers and wetlands):** The dominant PES is C and B/C. The Xobho River is a D PES (main impacts being dams, forestry and agriculture). The Mkomazi River in U10L and M is a B/C PES with the predominant impacts being overgrazing.*

Wetlands have been noted for very high and high importance in the Xobho (large valley bottom wetlands in headwater area) and Mkomazi (extensive narrow valley bottom wetlands) rivers respectively, while the Nhlavini River was noted for wetlands, but with a low importance.

***Ecology (estuary):** The Mkomazi Estuary is a C PES. It is under low flow modification, moderate pollution and habitat loss pressure and under high fishing pressure. It is of moderate importance from a biodiversity perspective. Artificial mouth-breaching is practised in the system. The estuary also forms part of the national priority set identified by the National Estuaries Biodiversity plan (Turpie et al., 2012). The plan also recommends that Mkomazi Estuary be improved to a B PES.*

This catchment plays an important role in providing nutrients and sediments to the near-shore marine environment.

IUA rationale**:** *This IUA represents the remainder of the Mkomazi catchment. There are no reasons for a finer delineation.*

9.2.12 IUA U7 Lovu

Water resources: *The storage regulation in this IUA is low and the only dams include a number of small farm and instream dams. There is no future surface water developments planned in the IUA.*

There are extensive forestry and sugar cane plantations located in the middle to upper reach of the IUA with Richmond town and adjacent township also located in the upper reach. The middle to lower reach of the IUA is occupied by scattered rural villages. Discharges from the Richmond and township area enter the river systems affecting both the flow and especially the water quality of the river.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply and livestock watering in the water resources IUA and there is a potential for further groundwater development in the area, especially in the lower reaches underlain by faulted Natal Metamorphic Provice and Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality**:** *Water quality hotspots for U7-1 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U70B-4655	Lovu	Serious (4) - around Richmond	WWTW, urban centre; fertilizers and pesticides.
U70D-4905	Lovu	Large (3)	Oil and diesel pollution; sugar mill; elevated nutrients.

Economy: *It hosts timber and sugar cane plantations feeding the saw and sugar mills and well as leisure tourism on the coastal area.*

EGSA: *The upper half of the Lovu catchment is home to well-developed commercial agriculture and forestry including the regionally important centre of Richmond. Utilisation of EGSA is limited to ad hoc consumption by farm workers and some recreational usage (not significant). The remainder of the catchment is under communal tenure and made up of former homeland areas. The population density given the proximity to the metropolitan areas of Durban is high. Densities mean that resources are under pressure. The utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance. The formal town of Illovo Beach is at the bottom of the IUA. Recreational utilisation of the river above the estuary, mostly swimming and fishing, is an important part of EGSA.*

Ecology (rivers and wetlands): *The upper Lovu catchment (U70A) is situated in areas mainly covered with plantation forestry (C and B/C PES). Further downstream there are large areas of forestry. Sugar cane, rural development (towns/townships), and dams, have increased impacts on these rivers, especially the water quality (C/D PES). The deeper valleys of the Lovu and Nungwane prevent the people from impacting too much on the rivers but water quality impacts prevail.*

The Lovu at U70C-04859 has been noted for low priority, isolated, small and narrow channelled valley bottom wetland patches associated with the main channel.

Ecology (estuary): *The Lovu Estuary PES is a C PES. Currently it is under moderate flow modification, pollution and habitat loss pressure. Artificial mouth-breaching is practised in the system. While the estuary is of average importance from a biodiversity perspective, it does form part of the national priority set identified by the National Estuaries Biodiversity Plan (Turpie et al., 2012). The estuary is highly sensitive to modification in baseflow as it influences the mouth state.*

IUA rationale: *There is no reason to break the Lovu River catchment in different IUAs as the ecological state and land use is similar and there are no planned developments. Water quality problems are an issue.*

9.2.13 IUA U6-1: Upper Mlazi

Water resources: *The IUA is regulated by the Shongweni Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. There is no future surface water developments planned in the IUA.*

The main landuse activities include cultivation (dryland sugar cane, maize), irrigation and forestry located in the upper half of the IUA. There are some low density settlements as well as semi-urban and urban areas with industries located in the lower half of the IUA. Discharges from the Hopewell and Hammersdale (industrial area) WWTWs into the rivers affect both the flow and especially the water quality of the river.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply and livestock watering in the water resources IUA and there is a potential for further groundwater development in the area, especially in the lower reaches underlain by faulted Natal Group sandstones. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U6-1 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U60C-4555	Mlazi	Large (3)	Urban and industrial effluents, so high nutrient and salt load.
U60C-4556	Sterkspruit	Serious (4)	Elevated salts, nutrients, and toxicants. Identified by eThekwini MM as a hotspot.
U60C-4613	Wekeweke	Large (3)	Elevated nutrients and fertilizers.
U60C-4697	Sterkspruit	Large (3)	Urban and industrial effluents.

Economy: *It hosts some timber and sugar cane plantations feeding the saw and sugar mills.*

EGSA: *The upper half has well-developed commercial agriculture and forestry including the Baynesfield farming area (limited EGSA use). The lower part of the IUA has peri- urban and urban settlement, including Mpumalanga. The population density given the proximity to the metropolitan areas of Durban is high. Densities mean that resources are under pressure. Utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance. Parts of the riverine system are difficult to access and this further inhibits utilisation.*

Ecology (rivers and wetlands): *The IUA is dominated by C/D and D PES rivers. Upstream of the Shongweni Dam predominant impacts are both flow (instream dams and irrigation) and non-flow*

related (forestry, agricultural activities, alien invasive vegetation, and water quality especially in U60C-04556). The Mlazi at SQs U60A-04533 and U60C-04555 is noted for wetlands of moderate and low importance respectively. Most wetlands consist of isolated patches of valley bottom wetlands that have a C or D PES. Many of the wetlands are inundated or reduced in extent by forestry and agricultural activities. The Sterkspruit (U60C-04556) is noted for wetlands of moderate importance.

Overall wetland PES is low (D or worse mainly due to agricultural encroachment and overgrazing).

***IUA rationale:** The land use in the IUA result in both flow (instream dams and irrigation) and non-flow related (forestry, agricultural activities, alien invasive vegetation, and water quality especially in U60C-04556) ecological impacts. The proposed Shongweni Dam is located at the end of the IUA which is a logical break for the IUA.*

9.2.14 IUA U6-2: Lower Mlazi

***Water resources:** The IUA is regulated by the upstream Shongweni Dam and there is no future surface water developments planned in the IUA.*

The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban and urban areas. Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river. There is also a hazardous landfill site in the upper reaches of the tributaries which also affect the water quality of the Mlazi River, which is regarded as very poor. The lower end of the Mlazi River has been canalised and hence there is no estuary.

According to a desktop investigation conducted as part of this study there are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for U6-2 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U60D-4661	*Mlazi*	*Critical (5)*	*Elevated salts, nutrients, toxicants; Identified by eThekwini MM as a hotspot.*

***Economy:** It is surrounded by the eThekwini expanding urban areas and the farming area is shrinking.*

***EGSA:** This includes the informal and formal urban developments of Mlazi township that forms part of the Durban metropolis. This part is heavily developed and other than recreational utilisation of some of the rivers (swimming and fishing) above the estuary there is little in the way of utilisation of the EGSA.*

***Ecology (rivers and wetlands):** The River is in a D PES and impacts are degraded water quality and riparian vegetation removal (wood harvesting and grazing).*

Ecology (estuary): *The Mlazi Estuary has been canalised and is not considered a functional estuary any more (Van Niekerk and Turpie, 2012).*

IUA rationale**:** *The upper border of the IUA is delineated by Shongweni Dam. The ecological impacts are all similar due to the similar range of land use and water quality problems are an issue in the IUA.*

9.2.15 IUA U6-3: Mbokodweni

Water resources: *The storage regulation in this IUA is low and there are no major dams present. There is no future surface water developments planned in the IUA.*

There is some sugar cane (dryland) located in the upper reaches of the IUA. The middle to upper reach of the IUA is occupied by scattered rural villages and the middle to lower reach by semi-urban areas, urban areas (Umlazi, Isipingo) as well as industrial areas close to the coast (Prospecton Industrial area). Discharges from numerous WWTWs enter the river system affecting both flow and especially the water quality of the river.

According to a desktop investigation conducted as part of this study there are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U6-3 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U60E-4792	*Mbokodweni*	*Serious (4) – especially Isipingo River*	*High organic and nutrient load. Isipingo River identified by eThekwini MM as a hotspot.*

Economy: *It is surrounded by the eThekwini expanding urban areas and the farming area is shrinking with sugar cane in the interior.*

EGSA: *This includes the informal and formal urban developments associated with the outskirts of the Durban metropolis. The upper part consists of informal semi-rural closer settlements. Although it is rural the population density given the proximity to the metropolitan areas of Durban is high. Densities mean that resources are under pressure. The lower part is heavily developed and includes Adams Mission, Folweni and parts of the extended Mlazi Township. Other than recreational utilisation of some of the rivers (swimming and fishing) above the estuary there is little in the way of utilisation of the EGSA.*

Ecology (rivers and wetlands): *The upper Mbokodweni (U60E-04714) is a B PES and the remainder of the IUA a C PES. Impacts are non-flow related including water quality, vegetation removal (wood harvesting) and sugar cane plantations (in the upper reach). Similarly, the main impacts on the Bivane River is also non-flow related (trampling, sedimentation, vegetation removal).*

Ecology (estuary): *The Mbokodweni and Isipingo estuaries are in an E and F PES respectively. The Mbokodweni PES status has been confirmed through an EWR study. The Mbokodweni is under moderate flow modification, and high pollution and habitat loss pressures. Artificial mouth*

breaching is also practised in the system. The Isipingo Estuary is under high flow modification (most of its catchment has been diverted), pollution and habitat loss pressure. Both systems are of average importance from a biodiversity perspective. The Mbokodweni Estuary is highly sensitive to modification in baseflow as it influences the mouth state.

***IUA rationale:** There was no reason for delineation of the Mbokodweni River catchment into separate IUAs as the ecological state and land use is similar.*

9.2.16 IUA CC: Coastal Cluster

***Water resources:** The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams. There is no surface water developments planned in the IUA.*

The area is predominantly urban with some semi-urban and rural settlements. Return flows from a number of WWTW enter river systems affecting both the flow and quality of the river system.

According to a desktop investigation conducted as part of this study, small volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for CC are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U60F-4597	Mhlatuzana	Critical (5)	Urban and industrial effluents, so high nutrient and salt load.
U60F-4632	Umbilo	Critical (5)	Urban and industrial effluents, so high nutrient and salt load.

***Economy:** eThekwini metropolitan covers most of the area with holiday accommodation along the coast. On the southern areas sugar cane plantations and commercial forestry is also present.*

***EGSA:** This includes the informal and formal urban developments of Umgababa, Winkelspuit, Kingsborough, Amanzimtoti, and the greater Durban metropolis. This part is heavily developed and other than recreational utilisation of some of the rivers (swimming and fishing) above the estuary there is little in the way of utilisation of the EGSA. There may be some grazing of riverine grasses but overall, given the state of the rivers, would be marginal.*

***Ecology (Rivers and Wetlands):** Four coastal rivers in the U7 (Lovu) were evaluated and are in a C PES. The impacts are rural settlement with extensive high density townships, with associated activities (informal agriculture and some sugar cane).*

The Mhlatuzana and Umbilo Rivers in U60F upstream of Durban harbour are highly developed with many residential, rural and industrial areas. Main impacts are non-flow related with poor water quality, trampling, sedimentation, alien vegetation and vegetation removal resulting in a PES of D and D/E for the Umbilo and Mhlatuzana respectively.

***Ecology (estuary):** Six estuaries form the Central Coastal cluster of which 3 are in a B PES (Msimbazi, Mgababa and Ngane), 1 in a D PES (Manzimtoti), and 2 in an E PES (Durban Bay and Little Manzimtoti). The majority of the systems are subject to low to moderate flow, pollution and*

habitat loss pressure, with the exception of the Manzimtoti and Little Manzimtoti which are under high pollution pressure. Artificial mouth breaching is also practised in some of the systems.

***IUA rationale:** This IUA consists of a range of short coastal rivers originating within the coastal quaternary with similar land use (predominantly urban and semi-urban). The impacts on especially the estuaries are very similar and these estuaries and rivers form a logical grouping in an IUA.*

9.2.17 IUA U2-1: Mgeni: Upstream of Midmar Dam

***Water resources:** The IUA is regulated by the Midmar Dam located at the lower end of the IUA and there are also a number of small farm and instream dams. The interbasin Mooi-Mgeni Transfer Scheme transfers water from the Mooi River System (Mearns Weir) to the Midmar Dam catchment (Mpofana River, a tributary of the Lions River that flows into Midmar Dam). This has resulted in increased flows in the effected rivers. The second phase of the MMTS is in the process of being constructed i.e. Spring Grove Dam in the Mooi River catchment, which will transfer additional volumes of water into the Midmar Dam catchment. Water is abstracted from Midmar Dam to supply Msunduze (Pietermaritzburg) and surrounding areas.*

The main land use activities in the IUA include forestry, cultivation and irrigation. The Mpophomeni semi-urban is located in the IUA, almost adjacent to the Midmar Dam.

According to a desktop investigation conducted as part of this study, minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for groundwater development in the area since it is underlain by moderately yielding argillaceous rocks of the Adelaide Sub group and Volksrust Formations. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for U2-1 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U20C-04340	*Nguklu*	*Large (3)*	*Elevated nutrient loads.*

***Economy:** It is mostly commercial mixed farming area with some commercial forestry plantations and a number of rural tribal areas.*

***EGSA:** The upper half of this IUA is home to well-developed commercial agriculture and forestry including the regionally important centre of Nottingham Road. In this area the utilisation of EGSA is limited to ad hoc consumption by farm workers and some recreational usage. Potentially the most important use is probably that associated with fly-fishing.*

***Ecology (rivers and wetlands):** The IUA is mostly in a C and B/C PES. Forestry is not restricted to the higher altitudes, patches occur throughout the area. In between these patches are well-organised commercial farms comprising of irrigation and dry land agriculture. Flow impacts stem from damming and water transfers (Mpofana River), while water quality impacts are associated with irrigation return flows, urban runoff and effluent from different sources (towns, farming, trout dams). A large section of the main stem is also inundated by the Midmar Dam.*

This zone contains several wetlands clusters (Nel et al., 2011) and is noted for Mgeni vlei (a KZN priority monitoring site). The upper portion of the U20A quaternary has a high density of seep wetlands (mostly not associated with the main channel), and some channelled valley bottom

wetlands farther down. Impacts on the wetlands in U20A (C PES) comprise mainly of inundation, agricultural encroachment and grazing. The Kusane and Mgeni have moderate priority wetlands noted. Instream dams, forestry, road crossings, irrigation and cultivation result in wetlands ranging from D to E PES.

***IUA rationale:** The land use in IUA is can be characterised by agricultural actives and the Mooi-Mgeni Transfer Scheme which transfers water from the Mooi River System (Mearns Weir) into the Mpofana River (a tributary of the Lions River that flows into Midmar Dam) results in increased flows in the affected rivers. Midmar Dam is located at the end of the IUA which is a logical break for the IUA.*

9.2.18 IUA U2-2: Mgeni: Midmar Dam to Albert Falls Dam

***Water resources:** The IUA is regulated by the upstream Midmar Dam, Albert Falls Dam located at the lower end of the IUA and also a number of small farm and instream dams. The IUA is regarded as highly regulated. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. There is no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources.*

Howick town and industrial area are located in the IUA, just downstream of Midmar Dam. Return flows from the Howick WWTW enter the Mgeni River affecting both the flow and the water quality.

The main land use activities in the IUA include extensive forestry, cultivation (sugar cane and other cash crops) and irrigation.

According to a desktop investigation conducted as part of this study, minimal volumes of groundwater are utilised in the water resources IUA and there is some potential for groundwater development in the area since it is underlain by moderately yielding sediments of the Ecca Group. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for U2-2 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U20E-04243	*Mgeni*	*Large (3)*	*Elevated nutrient loads; urban run-off.*

***Economy:** The main town is Howick followed by the well-known Karkloof leisure and nature area. The farming activities are mixed with some dairy and vegetable production.*

***EGSA:** The upper half of the this IUA is home to well-developed commercial agriculture and forestry including the regionally important centre of the Karkloof In this area the utilisation of EGSA is limited to ad hoc consumption by farm workers and some recreational usage. The Karkloof Nature Reserve as well as a number of smaller private reserve areas means that recreational aspects are of high importance.*

***Ecology (rivers and wetlands):** The IUA SQs are in a C and B/C PES, except the Kusane River which is a D due to a combination of forestry, dams and irrigation impacts. The main stem of the Mgeni River becomes very regulated as 0.9 m^3/s is released constantly from Midmar Dam. All the*

tributaries between the two dams are also heavily impacted due to forestry, irrigation and dry land agriculture (formal), weirs and dams, and removal of riparian vegetation.

***IUA rationale*: The upper border of the IUA is delineated by Midmar Dam and Albert Falls Dam is located at the end of the IUA which is a logical break for the IUA.**

9.2.19 IUA U2-3: Mgeni Downstream of Albert Falls Dam to Msunduze Confluence

***Water resources:** The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams as well as Nagle Dam located at the lower end of the IUA from where water is abstracted for the eThekwini supply area. Nagle Dam is supported from the upstream dam and the IUA is regarded as highly regulated. There are also a number of small farm and instream dams located in the IUA. There is no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact of the water resources.*

Small towns such as New Hannover and Wartburg as well as other scattered rural and informal settlements are located in the IUA. The main land use activities in the IUA include extensive forestry and dry land sugar cane.

According to a desktop investigation conducted as part of this study, some volumes of groundwater are utilised in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group sandstones. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for U2-3 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U20F-04224	Mpolweni	Large (3)	High nutrient load.
U20G-04194	Mkabela	Large (3)	High nutrient load; toxics may be present.
U20G-04215	Cramond Stream	Large (3)	High nutrient load; toxics may be present.
U20G-04240	Mgeni	Large (3)	High nutrient load.
U20G-04385	Mgeni	Large (3)	High nutrient load; urban impacts.

***Economy:** Some commercial cattle farms occur in the area, but the area is mostly rural tribal land.*

***EGSA:** The upper half, which includes Wartburg, has well-developed commercial agriculture and forestry. The utilisation of EGSA is limited to ad hoc consumption by farm workers and some recreational usage. The lower part has relatively high density rural closer settlements. Densities mean that resources are under pressure – particularly just upstream of Nagle Dam. Nevertheless the utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance.*

***Ecology (rivers and wetlands):** The northern tributaries of the Umgeni have a PES of C/D and three tributaries are in a B/C PES. Impacts are primarily flow (consistent high base flows from Albert Falls Dam) and non-flow related with extensive forestry and formal agriculture (sugar cane) present in this area. Some rural areas and townships with associated non-flow (grazing, subsistence farming) and water quality (runoff) related impacts are also present. The main Umgeni is in a B/C due to protection of steep river valleys. The main impacts are dense rural settlements on higher plateaus and on gentle river slopes as well as impacts due to deforestation, agriculture*

(erosion, sedimentation etc.). The reach in which Nagle Dam is, is in an E PES due to the presence of the dam and the flow related impacts DS of the dam. There are no releases from Nagle Dam.

Low priority wetlands have been noted in the Mpolweni River (U20F-04224) and are mostly valley bottom wetlands.

***IUA rationale*: The upper border of the IUA is delineated by Albert Falls Dam and the confluence of the Mgeni and Msunduze River, just downstream of Nagle Dam is located at the end of the IUA, which is a logical break for the IUA.**

9.2.20 IUA U2-4: Msunduze

***Water resources*: The storage regulation in this IUA is low. Henley Dam is located in the upper reaches of the IUA, which is a relatively small dam when compared to the dams located in the Mgeni System, and there are also a number of small farm and instream dams.**

A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and there are also a large number of semi-urban and rural settlements. Discharges from the Darvill WWTW (Pietermaritzburg area) enter the Msunduze River and affect the flow and especially the water quality of the river. Umgeni Water is currently investigating the potential of re-using effluent from the Darvill WWTW, which could have a future impact on the Msunduze River. The possibility of implementing such a project at this stage is uncertain.

The main land use activities in the IUA include extensive forestry and dry land sugar cane.

According to a desktop investigation conducted as part of this study, some volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area in the upper reaches underlain by Ecca Group sediments. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

***Water quality:** Water quality hotspots for U2-4 are shown below.*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U20J-04364	Msunduze	Serious (4)	Industrial discharges; elevated nutrients and salts.
U20J-04391	Msunduze	Critical (5)	WWTW; industrial discharges; elevated nutrients and salts.
U20J-04401	Msunduze	Critical (5)	Industrial discharges; elevated nutrients and salts.
U20J-04461	Slang Spruit	Critical (5)	Urban and industrial discharges.
U20J-04488	Mshwati	Large (3)	Urban impacts; nutrient elevations.

***Economy:** It hosts large timber and sugar cane plantations feeding the saw and sugar mills and includes the urban centre of Pietermaritzburg.*

***EGSA:** This IUA is associated with greater Pietermaritzburg. The upper two thirds are either formal urban or peri-urban, Other than recreational utilisation of some of the rivers (swimming and fishing) there is little in the way of utilisation of the EGSA. The bottom third of the IUA is less densely populated for the first part of the river course but then becomes very densely populated around the Mkhambathini area. The utilisation of fish, wood for fuel, building and handicrafts,*

medicinal plants, and riparian grazing is of high importance. The Duzi Canoe Marathon (from Pietermaritzburg downstream) also results in high importance for recreation.

Ecology (river and wetlands): *Upstream of Henley Dam the PES is a C, with non-flow related impacts (poor water quality, rural settlements, sedimentation, overgrazing, agriculture and alien vegetation). Downstream of Henley Dam through Pietermaritzburg the PES ranges from C to D to E. The E PES is due to poor water quality, canalisation, inundation, instream barriers and high intensity urbanisation. Downstream of the E, the river is impacted by poor water quality, rural settlements, informal agriculture, clearing of vegetation, overgrazing and some erosion.*

Valley bottom wetlands have been noted for the following SQs: U20H-04449, U20J-04364, U20J-04452 and U20J-04461. Several wetland clusters, not necessarily associated with the main stream are noted in this zone.

IUA rationale: *A large portion of the IUA is occupied by the greater Pietermaritzburg urban area and semi-urban and rural settlements with WWTW discharges. The ecological impacts are similar resulting in rivers being in relatively poor state. The confluence of the Mgeni and Msunduze River is located at the end of the IUA, which is a logical break for the IUA.*

9.2.21 IUA U2-5: Mgeni downstream of the Msunduze Confluence to Inanda Dam

Water resources: *The IUA is regulated by the upstream Midmar Dam and Albert Falls Dams, Nagle Dam as well as Inanda Dam located at the lower end of the IUA and is regarded as highly regulated. Abstractions are made from Inanda Dam for supplying water to the eThekwini area and the dam is supported by the upstream dams. The water quality of the Mgeni River reduces after the confluence with the Msunduze River. There are no surface water development options planned directly in the IUA but the implementation of MMTS Phase 2 will have an impact on the water resources as well as the potential implementation of the Darvill re-use project.*

A large portion of the IUA is rural, with scattered rural villages and subsistence farming activities. There are a large number of rural settlements located around the Inanda Dam area.

Areas in the upper reaches of the IUA are covered by extensive cultivation (dryland sugar cane) and forestry.

According to a desktop investigation conducted as part of this study, some volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for small scale further groundwater development in the area underlain by the Natal Metamorphic Province. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U2-5 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U20L-04435	*Mgeni*	*Large (3)*	*Urban impacts; nutrient elevations.*

Economy: *Mostly rural tribal land.*

EGSA: *The middle third of the IUA is less densely populated for the first and last parts of the river course in the IUA. Settlement is associated with the former KwaZulu homeland and is mostly*

communal. The utilisation of fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing is of high importance.

Ecology (rivers and wetlands): *The SQ reaches in the IUA are in a C and B/C PES. Impacts are flow related (no releases from Nagle Dam) and water quality from the Msunduze River. Tributaries are influenced by forestry, dams and agriculture.*

Several wetland clusters occur in this zone. Moderate and low priority valley bottom wetlands are noted in the Mqeku (U20k-04411) and Mgeni (U20M-04396) Rivers respectively.

IUA rationale: *The land use in the IUA is similar throughout the IUA. The upper border of the IUA is delineated by the confluence of the Mgeni and Msunduze River and Inanda Dam is located at the end of the IUA, which is a logical break for the IUA.*

9.2.22 IUA U2-6: Downstream of Inanda Dam to Estuary

Water resources: *The IUA is regulated by the upstream Midmar, Albert Falls Dams, Nagle and Inanda Dam and is regarded as highly regulated. Inanda Dam is supported by the upstream dams in the Mgeni River and compensation releases are also made from Inanda Dam for environmental purposes. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. The implementation of the upstream MMTS Phase 2 as well as the potential implementation of the Darvill re-use project will have an impact on the water resources in the IUA.*

A large portion of the IUA is semi urban area and urban in the lower reaches (eThekwini municipal area). There are a number of discharges form WWTW within the eThekwini municipal areas that enter the Mgeni River in the IUA that affect both the flow and the water quality of the river.

According to a desktop investigation conducted as part of this study there is no groundwater use in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Karoo and Natal Group sediments. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Economy: *On the high lying areas sugar cane production occurs, interspaced with the expanding urban areas of the eThekwini municipality.*

EGSA: *This part of the IUA is in the Durban metropolis. This first part is in the Mgeni Gorge and although surrounded by high density peri-urban settlement is relatively protected as it is very inaccessible. The last part is more accessible but given the nature of development (formal urban) the utilisation of EGSA is low. Some fishing in the upper part of the estuary takes place.*

Water quality: *Water quality hotspots for U2-6 are shown below.*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U20M-04396	*Mgeni*	*Serious (4)*	*Urban impacts; nutrient elevations; aquatic plants in upstream dam so low DO levels; treated effluent coming in from the Piesang in the north (below Inanda). Note the input of the Mhlangane River, which is a hotspot identified by eThekwini MM.*
U20M-04639	*Palmiet*	*Large (3)*	*Elevated nutrients.*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U20M-04642	Palmiet	Serious (4)	Elevated nutrients and industrial discharges.
U20M-04653	Palmiet	Large (3)	Elevated nutrients.

Ecology (rivers and wetlands): *This IUA includes the Mgeni River downstream of Inanda Dam, as well as the Palmiet River (U20M). The lower Mgeni River is especially in a poor state (E PES) due to the flow regulation by Inanda dam, coupled with extensive urban and industrial areas. The Palmiet River reaches a range between a PES of C and D and the alterations are primarily non-flow and water quality related due to the extensively developed catchment (urban/residential and industrial areas).*

Ecology (estuary): *The Mgeni Estuary is an E PES. This status has been confirmed through a rapid EWR study recently conducted on the system. Currently it is under moderate flow modification, high pollution, high habitat loss and low fishing pressure. Artificial mouth breaching is also practised in the system.*

IUA rationale: *This is the remaining portion of the Mgeni River catchment and the upper border of the IUA is delineated by the Inanda Dam. A large portion of the IUA is semi urban area and urban in the lower reaches (eThekwini municipal area) with WWTW discharges which culminates in an estuary which is in a poor state.*

9.2.23 IUA U3-1: Mdloti upstream of Hazelmere Dam

Water resources: *This zone includes all the rivers falling within quaternary catchments U30A (upper Mdloti), U30B (lower Mdloti), U30C (upper Tongati and Mona Rivers) and U30D (lower Tongati).*

The IUA is regulated by the Hazelmere Dam located at the lower end of the IUA. The raising of Hazelmere Dam has been approved, which will take place in the near future and will have a further impact on river flows downstream of the dam.

There is some dryland sugar cane located in the upper reaches of the IUA. There are a large amount of low density settlements and rural settlements spread throughout the IUA.

According to a desktop investigation conducted as part of this study, minimal volumes of groundwater are utilised for rural supply in the water resources IUA and there is a potential for further groundwater development in the area since is significantly faulted. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U3-1 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U30A-04360	Mdloti	Large (3)	Elevated nutrients, industrial discharges and high sediment loads.

Economy: *It is an important sugar producing area complimented by commercial forestry and mixed farming.*

EGSA: *Other than the very top of this IUA, the area consists of land under communal tenure. Population densities are moderate in the upper parts of the IUA but increase in the lower parts of the IUA particularly in the Oakford Priory/Ogunjini area. Utilisation of goods and services (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance.*

Ecology (rivers and wetlands): *The SQs in the IUA are in a B/C and D PES. The impacts are non-flow related activities (informal settlements with related subsistence agriculture and grazing).*

IUA rationale: *The land use is similar in the IUA resulting in similar ecological impacts. Hazelmere Dam is located at the end of the IUA which is a logical break for the IUA.*

9.2.24 IUA U3-2: Mdloti downstream of Hazelmere

Water resources: *The IUA is regulated by the upstream Hazelmere Dam. The raising of Hazelmere Dam has been approved, which will take place in the near future and will have a further impact on river flows in the IUA.*

A large portion of the IUA is occupied by urban areas (Verulam) and numerous WWTW discharges enter the Mvoti River from various WWTWs (Phoenix, Umhlanga, temporary WWTW from the King Shaka Airport) affecting both flow and water quality of the river. The eThekwini Municipality has conducted a feasibility study for the re-use of treated effluent in the eThekwini metropolitan area. The implementation of the investigated re-use schemes will have an impact on the WWTW return flows entering the river system in the future. A significant portion of the IUA is also covered by sugar cane (dryland and irrigated). There are also a large amount of low density rural settlements spread throughout the IUA.

According to a desktop investigation conducted as part of this study there is no groundwater use in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Karoo and Natal Group sediments. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U3-2 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U30B-04465	*Black Mhlashini*	*Large (3)*	*Elevated nutrients.*
U30B-04475	*Mdloti*	*Critical (5)*	*Elevated nutrients and blue-green algae; WWTW. Identified by eThekwini MM as a hotspot.*
U30B-04498	*Ohlanga*	*Critical (5)*	*Elevated nutrients; WWTW.*

Economy: *It is an important sugar producing area complimented by commercial forestry and mixed farming. Two sugar mills operate in the catchment. It is also an important tourism destination.*

EGSA: *This IUA is dominated by the formal urban development associated with Verulam and surrounds. There is a belt of commercial farming development downstream of Verulam but upstream of the coastal town on Umdloti. Other than recreational utilisation of some of the river, swimming and fishing in particular, above the estuaries there is little in the way of utilisation of the EGSA in this part of the IUA*

Ecology (rivers and wetlands): *The River downstream of Hazelmere Dam is in a D PES. The tributary is in a B/C PES. Non-flow related activities (informal settlements with related subsistence agriculture and grazing).*

High priority wetlands have been noted for both the Mdloti (U30B-04475) and Ohlanga (U30B-04498) Rivers. These are mainly floodplain and channelled valley bottom wetlands with coastal estuaries and are generally in a C PES (excludes estuaries). The Black Mhlashini (U30B-04465) has been noted for low priority wetlands.

Ecology (estuary): *Both the Mdloti and the Mhlanga estuaries are in a D PES. This status has been confirmed through more detailed EWR studies. The Mdloti is under low flow modification and high pollution and habitat loss pressure. The Mhlanga Estuary is under moderate flow modification, high pollution and moderate habitat loss pressure. Artificial mouth-breaching is practised in these systems.*

IUA rationale: *This is the remaining portion of the Mdloti River catchment. The land use is in the IUA is similar i.e. predominantly urban with WWTW discharges. The upper border of the IUA is delineated by the Hazelmere Dam. The IUA ends with the Mdloti and Mhlanga estuaries, which are both in a poor state.*

9.2.25 IUA U3-3: Tongati

Water resources**:** *The IUA is regulated by the Dudley Pringle Dam. There is no surface water resource developments planned in the IUA area.*

There are a large amount of low density settlements and rural settlements spread throughout the IUA. The Tongaat town and industries are located in the IUA area discharges from the Tongaat WWTW enter the Tongati River affecting both flow and water quality of the river. The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations.

According to a desktop investigation conducted as part of this study, minimal volumes of groundwater are utilised and there is some potential for groundwater development since it is largely underlain by faulted Natal Group sediments. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U3-3 are shown below.*

SQ reach	River name	Water quality impact (rating)	Water quality issues
U30D-04315	*Tongati*	*Large (3)*	*Elevated nutrients and fertilizers; industrial discharges.*

Economy: *The main economic activities consist of the production of the primary sector, which includes dryland sugar cane and forestry plantations.*

EGSA: *The bulk is given over to land under communal tenure. Population densities are moderate in the upper parts of the IUA but increase in the lower parts of the IUA particularly in the area around the town of Tongaat. The profile of the population in this small part of the IUA is such that utilisation of goods and services (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. The town of Tongaat and surrounds is in the lower third of*

the IUA. There is a belt of commercial farming between Tongaat and the coast. Recreational utilisation of some of the river (swimming and fishing) above the estuaries is of importance

Ecology (rivers and wetlands): *The SQ in the IUA is in a B/C PES. Only the two upper SQs were evaluated as the lower Tongaat is represented by the estuary (E PES). The impacts in the 2 SQs related to non-flow related activities (informal settlements with related subsistence agriculture and grazing).*

The Tongati (U30D-04315) SQ has been noted for low priority wetlands.

Ecology (estuary): *The Tongati Estuary is an E PES. This status has been confirmed through an Intermediate EWR study recently conducted on the system. It is under flow modification, high pollution and habitat loss pressure. Artificial mouth breaching is also practised in the system. It is of moderate importance from a biodiversity perspective. The Tongati Estuary is highly sensitive to modification in baseflow as it influences the mouth state.*

IUA rationale: *There was no reason for delineation of the Tongati River catchment into separate IUAs as the ecological state and land use is similar. Water quality problems are an issue in the IUA.*

9.2.26 IUA U4-1: Mvoti Upper Reaches

Water resources: *The main river is the Mvoti and the Heinespruit, Intinda, Mvozana and Khamanzi Rivers form its tributaries.*

The storage regulation in this IUA is low and the only dams in the area include a number of small farm and instream dams. The dams are of such nature that no releases are made for downstream users. The Greytown town is located in the upper reaches of the IUA and the discharges from the towns WWTW enter the river system, affecting both the flow and water quality of the river system. The Mvoti Poort Dam site is located at the lower end of the IUA. There is however a more favourable dam site lower down in the Mvoti River System (IsiThunda Dam Site), which is likely to be developed first.

The main land use activities in the IUA include extensive forestry and a significant amount sugar cane plantations and irrigation (sugar cane, maize etc.) also occur. There are also a few low density settlements and rural settlements located in the lower reaches.

According to a desktop investigation conducted as part of this study there are insignificant volumes of groundwater utilised in the water resources IUA and there is a potential for further groundwater development in the area in areas underlain by faulted Natal Group sandstones, and limited potential in the Pietermaritzburg shales. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U4-1 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U40B-03770	*Heinespruit*	*Serious (4)*	*Pesticides and nutrients; WWTW.*
U40B-03832	*Mvozana*	*Large (3)*	*Elevated nutrients and salts.*

Economy: *It is an important sugar producing area complimented by commercial forestry and mixed farming with the town Greytown in this area. Two sugar mills operate in the area and a wattle bark processing plant.*

EGSA: *This is almost exclusively forestry and commercial farming. The utilisation of EGSA is limited to ad hoc consumption by farm workers and some recreational usage. The town of Greytown is included.*

Ecology (rivers and wetlands): *Most SQs are in a C and B/C PES, with only the Mvozana a C/D PES. Impacts are predominantly non-flow related such as forestry, agriculture (vegetation and wetland removal), overgrazing, erosion, aquatic alien macrophytes and dams. The Heinespruit passes close to Greytown which influences the water quality. Some irrigation and centre pivots are also prevalent.*

The Mvoti River (U40A-03869) has high priority wetlands, notably the Mvoti Vlei (within the Mvoti Vlei Nature Reserve), but several other channelled valley bottom wetlands, seeps and meandering floodplains (with oxbows) occur. These wetlands are degraded by agriculture or floodplain manipulation (PES C). The Khamanzi (U40C-03982) is noted for low priority wetlands, mainly valley bottom wetlands in the tributaries which have an average PES of C.

IUA rationale: *A similar range of land use activities in the IUA result in similar ecological impacts. The lower border is due to the change in land use and in the topography.*

9.2.27 IUA U4-2: Mvoti Middle Reaches

Water resources: *This zone includes the Mvoti River from U40D-03957 down to U40E-03985 and includes the Mtize, Faye, Sikoto and Hlimbitwa (including its headwater tributaries) Rivers. The confluence of the Mvoti and Hlimbitwa Rivers is the site of the proposed IsiThunda Dam.*

The storage regulation in this IUA is low and the only dams in the area include a number of small farm dams in tributaries and a few Instream dams. The dams are of such nature that no releases are made for downstream users. The IsiThunda Dam site is located at the lower end of the IUA, which is the most favourable dam site for development in the Mvoti River catchment, with a high likelihood of is being developed in the short to medium term. The main land use in the IUA is extensive forestry and sugar cane (dryland and irrigated).

According to a desktop investigation conducted as part of this study, some groundwater is utilised by rural villages in the water resources IUA and there is a limited potential for further groundwater development in the area as it is underlain by faulted Natal Group Sandstones and Natal Metamorphic Province rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Economy: *Some sugar cane production with a number of rural tribal areas.*

EGSA: *Almost the entire IUA is given over to the former homeland. The EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Population densities in this part of IUA are generally lower and much of the area is sparse rural and steeply incised valleys making the river and its resources difficult to access*

Ecology (rivers and wetlands): *The SQ reaches are in a B or B/C PES. Much of the Mvoti flows through a gorge and is highly confined. Predominant impacts are non-flow related: Mostly overgrazing, informal agriculture and some erosion. The Hlimbitwa and tributaries upstream of U40G-03843 are mostly C PES with the main impacts being forestry, overgrazing and instream dams.*

No priority wetlands were noted in the zone, although many seeps occur in the U40F.

IUA rationale: *The change in land use and topography resulted in this IUA. The lower border of the IUA is delineated by the proposed IsiThunda Dam site. A similar range of land use activities in the IUA result in similar ecological impacts. The change in land use and topography, i.e. start of the gorge zone resulted in this IUA.*

9.2.28 IUA U4-3: Mvoti Lower Reaches

Water resources: *This zone includes the Mvoti from U40H-04064 to the coast and includes the Nsuze and Pambela tributaries.*

The storage regulation in this IUA is low but could however be impacted by future surface water resource developments planned upstream in the catchment i.e. the development of IsiThunda Dam. The town Kwadukuza (Stanger) is located in the lower end of the IUA and water is abstracted directly from the Mvoti River (run of river abstraction) for supplying the town, which affects the downstream river flow.

There is some dryland sugar cane and subsistence farming occurring in the area and there are a vast amount of low density and rural settlements located throughout the IUA.

According to a desktop investigation conducted as part of this study, some groundwater is utilised by rural villages in the water resources IUA and there is a potential for further groundwater development in the area, especially in the faulted sediments in the lower reaches. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for U4-3 are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U40H-04064	*Mvoti*	*Large (3)*	*Discharge from agriculture, urban and industrial areas.*
U40J-03998	*Mvoti*	*Large (3), esp. around KwaDukuzu*	*Sugar (Illovo) and paper mill effluents; WWTW so elevated nutrients; high turbidity levels; urban impacts (Stanger).*

Economy: *There is mostly sugar cane production with one sugar mill operating in the area which constitutes the main economic activity.*

EGSA: *The bulk of this IUA consists of the former KwaZulu homeland. Utilisation of EGSA (fish, wood for fuel, building and handicrafts, medicinal plants, and riparian grazing) is of high importance. Population densities in this part of IUA increase with proximity to the coast. There are pockets of very high density development in and around the town of Stanger and KwaDukuza. Commercial farming, mostly sugar cane is found in the coastal belts. The utilisation of EGSA here is limited to ad hoc consumption by farm workers and some recreational usage.*

Ecology (rivers and wetlands): *The SQs are in a B/C and C PES. Main impacts are non-flow related, especially sedimentation, overgrazing, trampling and vegetation removal. The last section of the Mvoti (U40J-03998) consists mainly of subsistence farming, dryland sugar cane, road crossings, sand mining and residential in the lower reach until the estuary.*

Several narrow channelled valley bottom wetlands were noted as very high priority.

Ecology (estuary): *The Mvoti Estuary is a B PES. Currently it is under moderate flow modification, high pollution and moderate habitat loss pressure. Artificial mouth-breaching is practised in the system. It is of average importance from a biodiversity perspective. The estuary also forms part of the national priority set identified under the National Estuaries Biodiversity Plan (Turpie et al., 2012). The estuary shows sensitivity to a reduction in baseflow. This catchment plays an important role in providing nutrients and sediments to the near-shore marine environment.*

IUA rationale: *The upper border of the proposed IsiThunda Dam site and the IUA represents the remainder of the Mvoti River catchment and there were no reasons for a finer delineation.*

9.2.29 IUA NCC: Northern Coastal Cluster

Water resources: *The storage regulation in this IUA is low and the only dams in the area include one or two small Instream dams.*

The area is predominantly a sugar cane farming area with most of the IUA covered with dry land sugar cane plantations. There are a few small coastal towns, some slightly inland and a few rural villages. Return flows from WWTW enter river systems in one or two cases.

According to a desktop investigation conducted as part of this study, some groundwater is utilised by a municipality and rural villages in the water resources IUA and there is a potential for further groundwater development in the faulted Karoo sediments. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed.

Water quality: *Water quality hotspots for NCC are shown below.*

SQ reach	River	Water quality impact (rating)	Water quality issues
U30E-04207	*Mhlali*	*Large (3)*	*Elevated nutrients; WWTW discharges.*

Economy: *On the coastal side there are large sugar production estates and well as forestry production and a number of holiday resorts.*

EGSA: *The southern part of this IUA is the Mhlali River. The very upper part of the IUA is given over to the former KwaZulu Homeland. The profile of the population in this small part of the IUA is such that utilisation of goods and services (fish, wood for fuel, building and handicrafts, medicinal plants) is of high importance.*

Ecology (rivers and wetlands): *This ecological zone includes all the coastal rivers falling in secondary catchment U5 (U50A, B/C PES) as well as sub-quaternary reach U30E-4207 (C PES). The three U5 rivers (Zinkwazi, Nonoti and Mdlotane) and the U3E (Mhlali) are all subjected to similar land use activities of which the dominant activity is dry land formal agriculture (sugar cane).*

The impacts are therefore flow related, non-flow related (agriculture and settlements) as well as water quality related (agricultural and township runoff, WWTW effluents).

Low priority wetlands (mainly unchannelled valley bottom wetlands) are noted in the Nonoti River but are reduced in extent by sugar cane fields (D PES).

***Ecology (estuary):** Six estuaries form this cluster, of which 2 are in a B and 4 in a C Category. The majority of the systems are under low to moderate flow, pollution and habitat loss pressure. Artificial mouth breaching is also practised in some of these systems.*

***IUA rationale:** This IUA consists of a range of short coastal rivers originating within the coastal quaternary with similar land use (predominantly sugar cane farming with small coastal towns and WWTW discharges in some cases). The impacts on especially the estuaries are very similar and these estuaries and rivers form a logical grouping in an IUA.*

Figure 9.2 IUAs in T4 (Mtamvuna) and T5 (Umzimkulu) secondary catchments

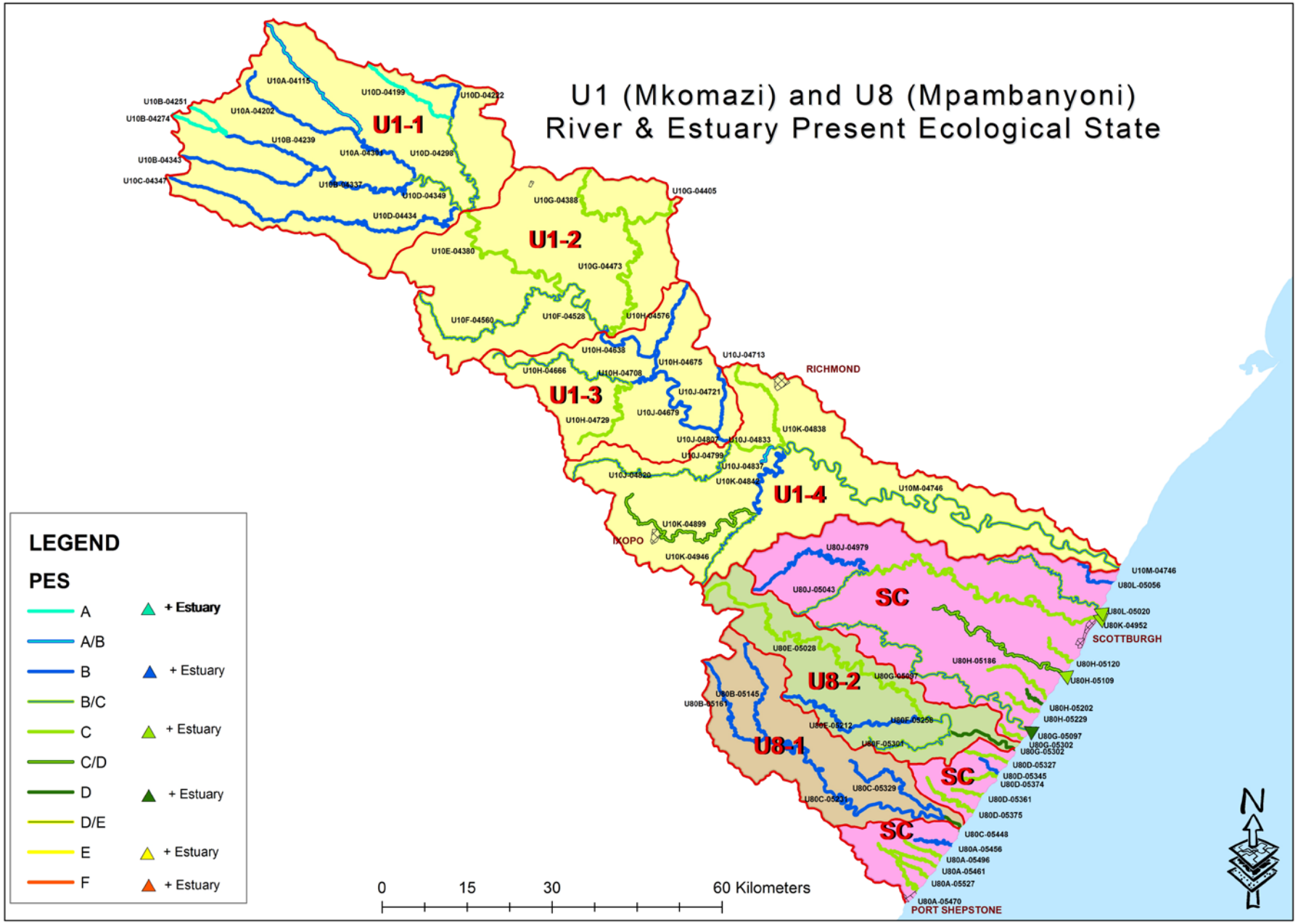


Figure 9.3 IUAs in U1 (Mkomazi) and U8 (Mpambanyoni) secondary catchments

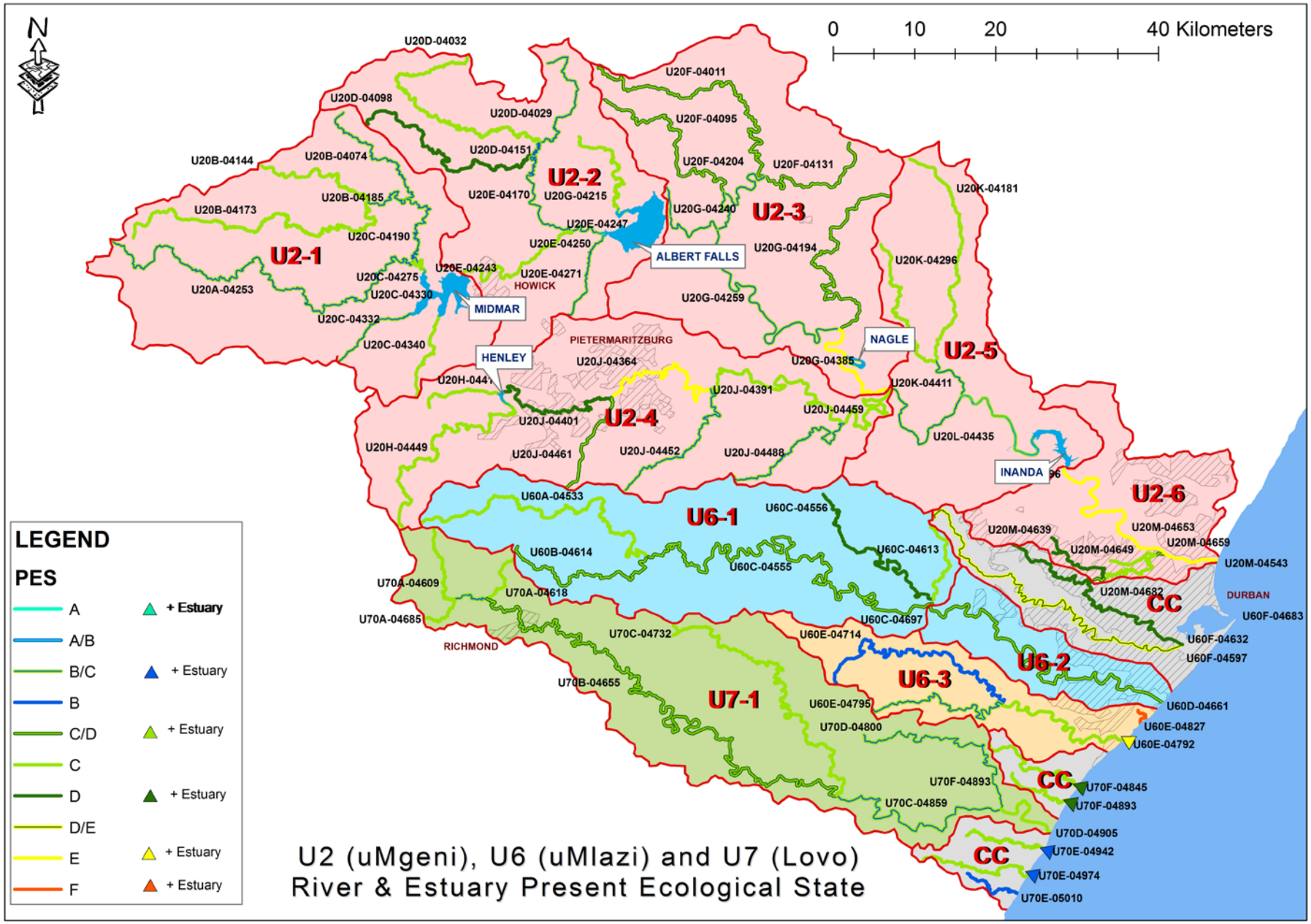


Figure 9.4 IUAs in U2 (Mgeni), U6 (Mlazi), and U7 (Lovu) secondary catchments

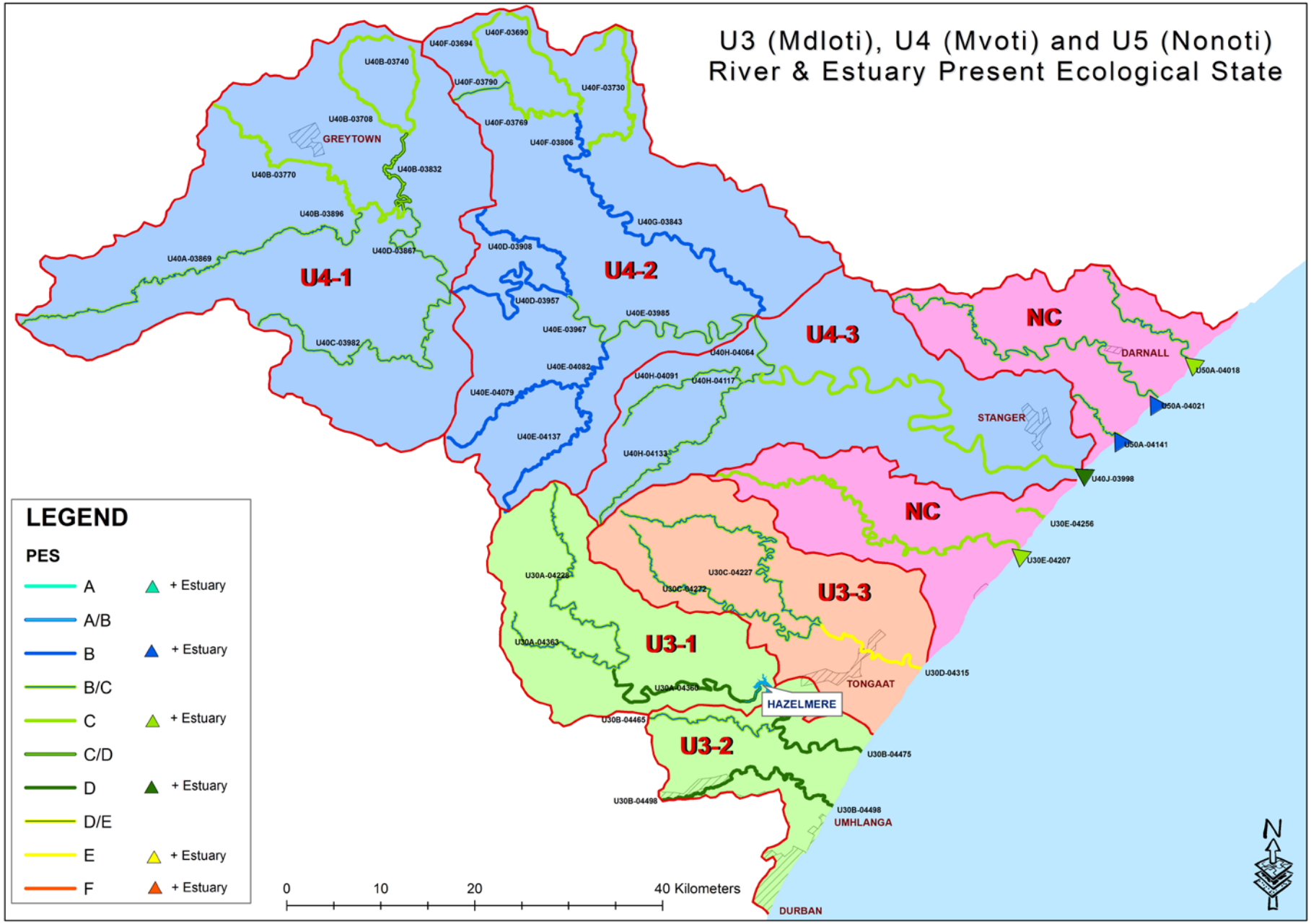


Figure 9.5 IUAs in U3 (Mdloti), U4 (Mvoti) and U5 (Nonoti) secondary catchments

10 METHOD TO IDENTIFY HOTSPOTS (RIVERS)

This chapter deals only with rivers. The estuary hotspots will be identified following a similar process and will form part of the updated desktop analysis to be undertaken during May 2013.

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

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

The purpose of the identification of hotspots for this study was the following:

- *To ensure that there were no hotspots that were not addressed by an existing EWR site.*
- *To select river reaches where new EWR sites should be selected*
- *To provide guidance to levels of Reserve that might be required for licensing purposes within the framework provided by the National Water Resource Classification System (NWRCS).*
- *To provide an indication where scenario development and testing would be important.*
- *To provide guidance to areas with a very low hotspot evaluation as flow requirements for these might be not be necessary.*

The process used is described in Figure 10.1 and relied on the results (with modifications during this study) of the PESEIS study. The total number of SQ reaches is 288 which therefore require 288 river biophysical nodes. Some of these biophysical nodes will be replaced by estuary nodes. It was proposed that all the nodes were considered in terms of ecological requirements, but that less desktop biophysical nodes should be selected for EWR estimation. Nodes that were excluded from the estimation process were those with:
its source in the Drakensberg mountains and conservation areas;
no water resource demands on them (often ephemeral drainage lines), and
EWRs covered by key biophysical sites (EWR sites).

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

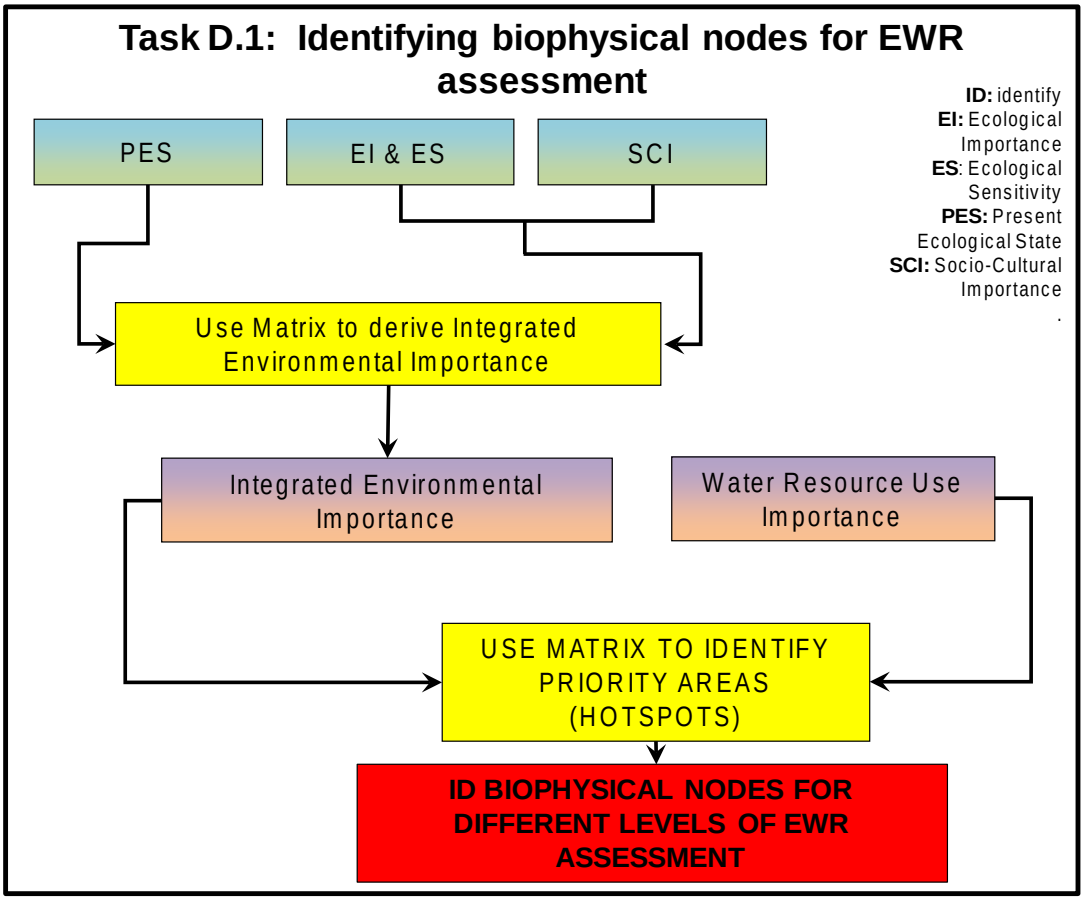


Figure 10.1 Summary of the process to identify biophysical nodes for EWR assessment

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

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

10.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

10.1.1 PES

The PES approach is described in Section 7.2.

10.1.2 Ecological Importance and Sensitivity

Rivers:

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

The importance evaluation for rivers used for this study were those generated as part of the PESEIS study (Kotze et al., 2012) from the front end models as provided by Dr Kleynhans, D:RQS, DWA. The Ecological Importance (EI) and Ecological Sensitivity (ES) of SQs were assessed to obtain an indication of its vulnerability to environmental modification within the context of the PES. This would relate to the ability of the SQ to endure, resist and able to recover from various forms of human use (DWA, 2013). Further explanations of the functions of the model must be referred to D: RQS.

River NFEPAs:

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

The current results of the PESEIS study (DWA, 2013) provided a higher confidence PES assessment as that on which the NFEPA study was based (which was largely Kleynhans (2000) data based as well as some localised and expert data). The PESEIS study (DWA, 2013) included a Google Earth™ assessment by various specialists with different backgrounds and extensive local knowledge and it has to supersede (Kleynhans, pers. comm.) the NFEPA baseline.

The current results of the PESEIS study (DWA, 2013) also provided information for fish species for every SQ based on survey results and expert knowledge on the expected species to occur. These results will also supersede the fish information used for the NFEPA assessment.

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

- *All FEPAs were identified from the shapefiles (Nel et al., 2011) as well as correlating it with the data provided in the front end PESEIS models (DWA, 2013).*
- *If the PES results from the PESEIS project indicated that the SQ was not a B or higher PES, it was not further considered as a FEPA.*
- *If the fish species on which the FEPA was based or partially based were indicated, the presence of these species in the SQ were verified using the information from the PESEIS study (DWA, 2013).*
- *If the FEPA was in a B or higher PES, but not fish information was provided to support this, a tick for yes with a ? was indicated.*

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

Wetlands:

The purpose of this prioritisation process was to identify priority wetland systems within the WMA 11 which are dependent on river systems. This was to aid in the identification of hotspots (high priority river, wetland and/or groundwater areas). This is not a conservation prioritisation process, but identification of high priority wetlands dependent on main stem river flow only.

The 288 SQs in the WMA 11 were assessed to determine if any individual wetlands and clusters of wetlands that have been identified as conservation priorities in the wetland FEPA assessment (Nel et al, 2011) were located within these sub-quaternary catchments. Sixty-nine SQs have FEPA wetlands or wetland clusters within them. Many have several hydrogeomorphic wetland types within them. However not all wetlands types are dependent on mainstem river flows. The FEPA wetland types were thus ranked by wetland type in decreasing order of likely linkage to the adjacent mainstem river system. Of the 69 FEPA wetland SQs:

- *6 SQs have at least floodplain wetlands (the most river-dependent wetland type).*
- *41 SQs have at least channelled valley bottom wetlands (these are at least linked to small streams and sometimes larger mainstem rivers); and*
- *4 SQs have at least unchannelled valley bottom wetlands, which when located in the lower reaches of the river in the KZN context, can indicate large lowland swamp wetlands.*

The remaining 18 SQs contain FEPA flat and seep wetlands. These wetland types are not dependent on mainstem watercourses and were not considered further in the analysis.

The remaining 51 wetland FEPA SQs catchments were scored on:

- *Expected dependence on the mainstem river;*
- *Wetland size;*
- *Presence of Important Birding Areas as an indication of avian importance; and*
- *river condition as an indication of potential wetland condition (river condition as indicated in the 2012 PESEIS assessments conducted by Groundtruth on behalf of DWA).*

These were then ranked based on their expected importance, condition and dependence on river flows.

10.1.3 Socio-cultural importance

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

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

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

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

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

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

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

The final scores were then combined to generate an overall score between 0 and 5. The meaning of the score is as set out in Table 10.1 below.

Table 10.1 SCI rating

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

10.1.4 Integrated Environmental Importance assessment

As described above, the Ecological and Socio-Cultural importance were assessed separately and were then integrated with the PES to determine the Integrated Environmental Importance. The PES forms part of the Integrated Environmental Importance as rivers (or wetlands) in good condition are scarce, and therefore important in their own right. A river that is in very good

condition, but of low EIS, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that type of river that is in good condition. The Integrated Environmental Importance also provides an indication of the restoration potential. The restoration potential refers to the probability of achieving the rehabilitation of the river to an improved state. For example, if a river has very high Ecological and Socio-Cultural importance, but is in bad condition, the restoration potential is often low and that will result in a low Integrated Environmental Importance.

The EIS and SCI ratings were not averaged, but the highest score of the two are used to integrate it with the PES. A matrix (Table 10.2) to aid in consistently providing an integrated rating comparing EIS, SCI, and PES was designed during 2006 (Louw and Huggins, 2007) and modified during this study to automate the process and thereby produce more consistent answers.

Table 10.2 Matrix used to determine a combined EIS/SCI and PES value which provides an Integrated Environmental Importance value

EIS &SCI (max)											
	Very high	4.5-5	<5.1	3	3	3	4	5	5	5	5
	High	3.5-4.4	<4.5	3	3	3	3	4	5	5	5
	Moderate	2.1-3.4	<3.5	2	2	2	3	3	4	5	5
	Low	1.1-2	<2.1	1	1	2	2	3	4	4	4
	Very low	0-1	<1.1	1	1	1	2	2	3	4	4
				D/E to F	D	C/D	C	B/C	B	A/B	A
				>3.2	>2.6	>2.2	>1.6	>1.2	>0.6	>0.2	>=0
				>3.2	2.7-3.2	2.3-2.6	1.7-2.2	1.3-1.6	0.7-1.2	0.3-0.6	<0.3
				PES							

To enable the EI and ES results to be used, the resolution of the ranges had to be adjusted to ensure that all 288 SQ reaches did not result in a HIGH or VERY HIGH EIS. The ES results were not used for the rivers as the results were a 100% HIGH or better. Only the EI results could be used and the numerical ranges which related to the evaluations such as HIGH were adjusted to provide a finer resolution.

10.2 WATER RESOURCE USE IMPORTANCE

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

The variables included in the rating method aimed to represent the status and function of the river reach. The variables and the associated characteristics associated with a score ranging from zero to four are presented in Table 10.3.

Table 10.3 Water Resource Use Priority rating variables and scoring characteristics

Variables	Score range and associated characteristic descriptions	
	0	4
Current water balance of catchment contributing flow to	*Very little water use occurs in the upstream catchment. Low, maintenance and high flow*	*Significant utilisation of water from the upstream catchment. Low and maintenance*

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

10.3 PRIORITY AREAS - HOTSPOTS

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

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

A matrix was designed (Louw and Huggins, 2007) and modified during this study to guide the consistent identification of hotspots (Table 10.4). The Y-axis is based on the Integrated Environmental Importance value derived from the first matrix (Table 10.2). The X-axis depicts an estimate of water resource use, with 0 being of no importance and 4 being of very high importance. The information derived from the matrix provides an indication of the level of studies required. Although the terminology used is the same as that used for the different levels of EWR studies in South Africa, it is a descriptive term which is relevant for any environmental assessment required.

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

Table 10.4 Matrix used in assessing hotspots

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

11 IDENTIFICATION OF HOTSPOTS

11.1 INTEGRATED ENVIRONMENTAL IMPORTANCE

11.1.1 PES results

The PES results are provided in Chapter 7.

11.1.2 River Ecological Importance and Sensitivity results

The results are available from the PESEIS study (DWA, 2013). No review or adjustments have been made to these results during this study and they have been taken as is. The number of HIGH or VERY HIGH (≥ 3.5) Ecological Important areas is provided per IUA (Table 11.1). The pink shading shows any IUA with 70% or higher HIGH EI SQs

Table 11.1 Number of High EI SQs per IUA

IUA	Number of SQs	Number of HIGH (≥3.5) SQs	% of HIGH (≥3.5) SQs
T4-1	20	4	20
T5-1	10	1	10
T5-2	39	9	23
T5-3	5	3	60
U8-1	4	4	100
U8-2	4	3	75
SC	10	7	70
U1-1	14	4	29
U1-2	6	4	67
U1-3	9	8	89
U1-4	10	6	60
U7-1	10	1	10
U6-1	6	1	17
U6-2	1	0	0
U6-3	2	2	100
CC	2	1	50
U2-1	9	6	67
U2-2	10	3	30
U2-3	9	1	11
U2-4	9	4	44
U2-5	4	3	75
U2-6	8	0	0
NC	4	4	100
U3-1	3	2	67
U3-2	1	0	0
U3-3	2	1	50
U4-1	8	3	38
U4-2	14	5	36
U4-3	5	4	80

11.1.3 River NFEPA results

The SQs with associated NFEPAs (see Chapter 9) are listed and verified in Table 11.2. Note, that the SQs with a B/C evaluation was taken as verified due to the uncertainty whether it falls in a B or

C PES. The question mark next to the tick indicates that it complies to NFEPA in that it is a B PES but there is no other verification that NFEPA is required.

Table 11.2 FEPA verification based on PES data and fish information

IUA	SQ	River	PES	EI	Veri-fication	FEPA comment
T4-1	T40C-05510	Mtamvuna	B/C	2.8	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40C-05520	Mtamvuna	B/C	2.9	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40C-05530	Mtamvuna	B	2.7	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40C-05566	Ludeke	B	2.7	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40D-05537	Mtamvuna	B	2.8	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40D-05584	Mtamvuna	B	2.9	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40D-05615	Tungwana	B	2.9	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40D-05643	Gwala	B	3	×	FEPA fish spp. listed is BANO: Based on PESEIS (2012) & FROC (2007) this spp. not present in SQ.
T4-1	T40D-05707	Mtamvuna	C	2.8	×	In a C PES, therefore does not qualify.
T4-1	T40D-05719	Londobezi	B	2.9	✓?	Qualify for FEPA based on B PES.
T4-1	T40E-05601	Mtamvuna	B/C	3.7	✓?	Marginally qualify for FEPA - B/C PES.
T4-1	T40E-05767	Hlolweni	B/C	3.5	✓?	Marginally qualify for FEPA - B/C PES.
T5-1	T51A-04431	Umzimkulu	B	3.4	×	In a B, but fish reasoning based on common fish.
T5-1	T51A-04522	Mzimude	B	3.5	×	In a B, but fish reasoning based on common fish.
T5-1	T51A-04608		B	3.5	×	In a B, but fish reasoning based on common fish.
T5-1	T51A-04551	Mzimude	B/C	3.2	×	In a B/C, but fish reasoning based on common fish.
T5-1	T51F-04566	Boesmans	A	3.4	×	In an A, but fish reasoning based on common fish.
T5-1	T51F-04674		C	3.5	×	In a C PES, therefore does not qualify.
T5-1	T51G-04722	Ndawana	C	3.2	×	In a C PES, therefore does not qualify.
T5-2	T51F-04611	Ngwangwane	A	3.5	×	In an A PES, but fish reasoning based on common fish.
T5-2	T51F-04605	Ngwangwane	B/C	3.5	×	In a B/C PES, but fish reasoning based on common fish.
T5-2	T51F-04621	Ngwangwane	B/C	2.9	×	In a B/C PES, but fish reasoning based on common fish.
T5-2	T51G-04751		B	2.9	✓?	Uncertain about FEPA classification although river condition in B, no important fish spp. indicated and uncertain about FEPA rationale.
T5-2	T51J-04747	Ngwangwane	C	3.3	×	In a C PES, therefore does not qualify.
T5-2	T52A-04690	Umzimkulu	C	3.6	×	In a C PES, therefore does not qualify.
T5-2	T52C-04880		C	3.2	×	In a C PES, therefore does not qualify.
T5-2	T52C-04960	Umzimkulu	B	3.3	×	In a B PES, but fish reasoning is based on common fish.
T5-2	T52E-05053	Upper Bisi	B/C	3.5	×	In a B/C PES, but fish reasoning is based on common fish.
T5-2	T52K-05353	Mzimkhulwana	C	3.3	×	In a C PES, therefore does not qualify.
T5-3	T52D-05155	Umzimkulu	B	3.7	✓?	Uncertain about FEPA classification although river condition in B, no important fish spp. indicated and uncertain about FEPA rationale.
T5-3	T52H-05189	Bisi	B	3.5	✓?	Uncertain about FEPA classification although river condition in B, no important fish spp. indicated and uncertain about FEPA rationale.
T5-3	T52J-05276	Umzimkulu	B	4.5	✓?	Uncertain about FEPA classification although river condition in B, no important fish spp. indicated and uncertain about FEPA rationale.
U8-2	U80E-05028	Mtwalume	C	3.6	×	In a C PES, therefore does not qualify

IUA	SQ	River	PES	EI	Veri-fication	FEPA comment
U1-2	U10A-04115	Lotheni	A/B	3.3	×	A/B PES, but fish reasoning based on common sp.
U1-2	U10A-04202	Nhlathimbe	B	3.0	×	B PES, but fish reasoning based on common sp.
U1-2	U10A-04301	Lotheni	B	3.0	×	B PES, but fish reasoning based on common sp.
U1-2	U10B-04239	Mkomazi	B	3.1	×	B PES, but fish reasoning based on common sp.
U1-2	U10B-04337	Mkomazi	B	3.0	×	B PES, but fish reasoning based on common sp.
U1-2	U10B-04343	Mqatsheni	B	2.9	×	B PES, but fish reasoning based on common sp.
U1-2	U10C-04347	Mkhomazana	B	3.6	×	B PES, but fish reasoning based on common sp.
U1-2	U10D-04298	Nzinga	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U1-2	U10D-04349	Mkomazi	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U1-2	U10D-04434	Mkomazi	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U1-2	U10E-04380	Mkomazi	C	3.5	×	In a C PES, therefore does not qualify.
U1-2	U10F-04528	Mkomazi	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U1-3	U10J-04679	Mkomazi	B	3.8	×	B/C PES, but fish reasoning based on common sp.
U1-4	U10J-04799	Mkomazi	C	3.5	×	In a C PES, therefore does not qualify.
U1-4	U10J-04833	Mkomazi	B/C	3.5	✓?	Agree on FEPA based on river condition B/C - however no important fish spp. indicated and uncertain about FEPA rationale.
U1-4	U10J-04837		A/B	3.7	✓?	Agree on FEPA based on river condition A/B - however no important fish spp. indicated and uncertain about FEPA rationale.
U1-4	U10K-04838	Mkomazi	B/C	3.0	✓?	Agree on FEPA based on river condition B/C - however no important fish spp. indicated and uncertain about FEPA rationale.
CC	U70E-04974	uMgababa	C	3.6	×	In a C PES, therefore does not qualify.
U6-1	U60C-04613	Wekeweke	C	3.3	×	In a C PES, therefore does not qualify.
U2-1	U20A-04253	Mgeni	B/C	3.7	×	B/C PES, but fish reasoning based on common sp.
U2-1	U20B-04074	Ndiza	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U2-1	U20B-04144	Mpofana	C	3.3	×	In a C PES, therefore does not qualify.
U2-1	U20B-04173	Lions	C	3.7	×	In a C PES, therefore does not qualify.
U2-1	U20B-04185	Lions	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U2-1	U20C-04332	Gqishi	B/C	3.5	✓?	Agree on FEPA based on river condition B/C - however no important fish spp. indicated and uncertain about FEPA rationale.
U2-2	U20D-04029	Yarrow	B/C	3.5	×	In a B/C, but fish reasoning is based on common fish.
U2-2	U20D-04032	Karkloof	C	3.2	×	Disagree with FEPA classification, C/D - river condition
U2-2	U20D-04151	Karkloof	B/C	3.5	×	B/C PES, but fish reasoning based on common sp.
U2-3	U20F-04095	Mpolweni	C/D	3.2	×	In a C/D PES, therefore does not qualify.
U2-3	U20G-04194	Mkabela	C/D	3.2	×	In a C/D PES, therefore does not qualify.
U2-5	U20K-04181	Mqeku	C	3.1	×	In a C PES, therefore does not qualify.
U2-5	U20K-04296	Tholeni	C	3.6	×	In a C PES, therefore does not qualify
U3-1	U30A-04360	Mdloti	D	3.2	×	In a D PES, therefore does not qualify.
U3-1	U30A-04363	Mwangala	B/C	3.8	✓?	Agree on FEPA based on river condition B/C - however no important fish spp. indicated and uncertain about FEPA rationale.
U4-1	U40A-03869	Mvoti	B/C	3.8	×	B/C PES, but fish reasoning based on common sp.
U4-1	U40B-03832	Mvozana	C/D	2.9	×	In a C/D PES, therefore does not qualify.
U4-1	U40D-03867	Mvoti	B/C	3.5	✓?	Agree on FEPA based on river condition B/C - however no important fish spp. indicated and uncertain about FEPA rationale.
U4-2	U40D-03908	Mtize	B	3.4	✓?	Agree on FEPA based on river condition B - no important fish spp. indicated and uncertain about FEPA rationale.
U4-2	U40D-03957	Mvoti	B	3.4	✓?	Agree on FEPA based on river condition B - no important fish spp. indicated and uncertain about FEPA rationale.

IUA	SQ	River	PES	EI	Veri-fication	FEPA comment
U4-2	U40F-03690	Potspruit	C	2.8	×	In a C PES, therefore does not qualify.

11.1.4 Priority river-linked wetlands in the Mvoti WMA

Twenty four moderate, high and very high priority sub-quaternary catchments were identified from the NFEPA database of wetlands within the study area that are likely to be important wetland systems linked to main rivers or large tributaries (Table 11.3).

Table 11.3 Wetlands with high importance

SQ	Name	IBAs or high priority conservation area	NFEPA wetlands present	Priority category
T51D-04460	Pholelana		Large valley bottom wetlands in headwater area.	VERY HIGH
T51E-04478	Pholela	Priority KZN Ezemvelo wetland monitoring site ("the Swamp").	Large valley bottom wetlands.	VERY HIGH
U10K-04899	Xobho	Partial IBA.	Many narrow valley bottom wetlands.	VERY HIGH
U40J-03998	Mvoti		Large valley bottom wetlands.	VERY HIGH
T51H-04846	Lubhukwini	RAMSAR site (Ntsikeni wetland and nature reserve) and priority KZN Ezemvelo wetland monitoring site.	Fairly extensive valley bottom (mainstem and tributary) wetlands.	HIGH
T52D-04948	Umzimkulu		Fairly extensive valley bottom (mainstem) wetlands.	HIGH
U10M-04746	Mkomazi		Small valley bottom pockets and estuary.	HIGH
U20J-04364	Msunduze		Small valley bottom pockets and estuary.	HIGH
U20J-04391	Msunduze		Very narrow valley bottom wetlands.	HIGH
U20J-04461	Slang Spruit		Extensive narrow valley bottom wetlands.	HIGH
U30B-04475	Mdloti		Extensive narrow valley bottom wetlands.	HIGH
U30B-04498	Ohlanga		Some mainstem valley bottom, a few isolated wetlands.	HIGH
U40A- 03869	Mvoti vlei	Priority KZN Ezemvelo monitoring site.	Large wetland complex.	HIGH
U20A-04253	Mgeni sponge	RAMSAR site, Priority KZN Ezemvelo monitoring site.	Pockets of valley bottom and tributary wetlands.	MODERATE
U20D-04098	Kusane		Isolated patches and tributary valley bottom wetlands.	MODERATE
U20E-04221	Mgeni		Some tributary, some mainstem, valley bottom wetlands.	MODERATE
U20E-04243	Mgeni		Very small pockets in a narrow valley.	MODERATE
U20G-04259	Mgeni		Few very small wetland pockets	MODERATE
U20J-04401	Msunduze		Some tributary, some mainstem, valley bottom wetlands.	MODERATE
U20J-04452	Mpushini		Very small floodplain pockets.	MODERATE
U20K-04411	Mqeku		Numerous, primarily tributary valley bottom wetlands.	MODERATE
U40E-03985	Mvoti			MODERATE
U60A-04533	Mlazi	IBA	Isolated small wetlands and some valley bottom (narrow) wetlands.	MODERATE
U60C-04556	Sterkspruit		Pockets of valley bottom and tributary wetlands.	MODERATE

11.1.5 Socio-cultural importance

The following SQs, as set out in Table 11.4 below, scored "High". There were no scores in the "Very High" range. The bulk of those scoring HIGH did so either because of the recreation and aesthetic value associated with the Drakensberg or the high dependence on resources associated with poor and vulnerable communities located within the SQ.

Table 11.4 SCI that cored HIGH

SQ	River	SCI score
U10C-04347	*Mkhomazana*	*3.5*
U20K-04296	*Tholeni*	*3.6*
U20M-04396	*Mgeni*	*3.4*
U30A-04228	*Mdloti*	*3.1*
U30A-04363	*Mwangala*	*3.1*
U30C-04227	*Tongati*	*3.1*
U30C-04272	*Mona*	*3.6*
U60E-4795	*Bivane*	*3.0*
U70D-4905	*Lovu*	*3.5*
U70E-4942	*Lovu*	*3.5*
T51C-04582	*Umzimkulu*	*3.2*
T51E-04536	*Polela*	*3.0*
T51F-04566	*Boesmans*	*3.0*
T51F-04611	*Ngwangwane*	*3.0*
T51H-04808	*Gungununu*	*3.4*
T52K-05467	*Mzimkhulwana*	*3.1*

11.1.6 Integrated Environmental Importance results

The results are illustrated in Figures 11.1 to 11.4. These results are similar to the Ecological Importance results provided in Table 11.1. The secondary catchments that have many HIGH or VERY HIGH IEI results are T4 (Mtamvuna), T5 (Umzimkulu), U1 (Mkomazi) and U4 (Mvoti). These are mostly in mountainous and gorge areas.

11.2 WATER RESOURCE USE IMPORTANCE

The Water Resource Use Importance (WRUI) was assessed by assigning a qualitative score to a river reach for four variables that represent the status of the in-stream flow as discussed in Section 10.2. The detailed Excel spreadsheet will be made available on the CD with all data provided with the main report. The HIGH evaluation and the metric resulting in the evaluation are provided in Table 11.5.

Table 11.5 WRUI evaluation for SQ with a VERY HIGH rating

SQ	River	Comment
U40E-03985	*Mvoti*	*Future Development.*
U40H-04064	*Mvoti*	*Future Development.*
U40H-04064	*Mvoti*	*Future Development.*
U40J-03998	*Mvoti*	*Future Development.*
U30A-04360	*Mdloti*	*Operational implications - river used for Hazelmere Dam releases.*
U30B-04475	*Mdloti*	*Operational implications - river used for Hazelmere Dam releases.*
U30B-04498	*Ohlanga*	*Current water balance.*

SQ	River	Comment
U30D-04315	Tongati	Current water balance.
U20B-04144	Mpofana	IBT from Mooi Catchment.
U20B-04185	Lions	IBT from Mooi Catchment.
U20C-04190	Lions	IBT from Mooi Catchment.
U20C-04275	Mgeni	IBT from Mooi Catchment.
U20E-04221	Mgeni	Operational implications - river used for dam releases from Midmar and Albert Falls Dams.
U20E-04243	Mgeni	Operational implications - river used for dam releases from Midmar Dam.
U20G-04240	Mgeni	Operational implications - river used for dam releases from Midmar and Albert Falls Dams.
U20G-04259	Mgeni	Operational implications - river used for dam releases from Midmar and Albert Falls Dams.
U20G-04385	Mgeni	Operational implications - river used for dam releases from Midmar and Albert Falls and Nagle Dams.
U20J-04364	Msunduze	Return flows from Darvill WWTW.
U20J-04391	Msunduze	Return flows from Darvill WWTW.
U20J-04401	Msunduze	Return flows from Darvill WWTW.
U20J-04459	Msunduze	Return flows from Darvill WWTW.
U20J-04461	Slang Spruit	Water quality score - Edendale, urban, industries.
U20L-04435	Mgeni	Water quality issues.
U20M-04396	Mgeni	Water quality issues.
U60C-4556	Sterkspruit	Water quality - Hammarsdale Industrial WWTW return flows.
U60D-4661	Mlazi	Water quality – WWTW.
U60F-4597	Mhlatuzana	Water quality.
U60F-4632	Umbilo	Water quality.
U10F-04528	Mkomazi	Future development.
U10H-04638	Mkomazi	Future development.
U10H-04675	Mkomazi	Future development.
U10J-04679	Mkomazi	Future development.
U10J-04799	Mkomazi	Future development.
U10J-04807	Mkomazi	Future development.
U10J-04833	Mkomazi	Future development.
U10K-04838	Mkomazi	Future development.
U10M-04746	Mkomazi	Future development.
T51D-04460	Pholelana	Current water balance.

11.3 PRIORITY AREAS – HOTSPOTS

The identified hotspots are illustrated in Table 11.6 and the maps in Figure 11.5 to 11.8. Only hotspots with the maximum evaluation, i.e. a 4 scoring, has been provided.

Table 11.6 Hotspot results

SQ	River	IEI (0 - 5)	WRUI (0 - 4)	Hotspot
T40G-05616	Vungu	4	3	**4**
T51F-04621	Ngwangwane	4	3	**4**
T52K-05467	Mzimkhulwana	4	3	**4**
U10F-04528	Mkomazi	4	4	**4**
U10H-04638	Mkomazi	5	4	**4**
U10H-04675	Mkomazi	5	4	**4**

SQ	River	IEI (0 - 5)	WRUI (0 - 4)	Hotspot
U10J-04679	Mkomazi	5	4	**4**
U10J-04799	Mkomazi	3	4	**4**
U10J-04807	Mkomazi	5	4	**4**
U10J-04833	Mkomazi	4	4	**4**
U10K-04838	Mkomazi	3	4	**4**
U10M-04746	Mkomazi	4	4	**4**
U60C-04556	Sterkspruit	3	4	**4**
U60F-04597	Mhlatuzana	3	4	**4**
U60F-04632	Umbilo	3	4	**4**
U20B-04144	Mpofana	3	4	**4**
U20B-04185	Lions	4	4	**4**
U20C-04190	Lions	4	4	**4**
U20C-04275	Mgeni	3	4	**4**
U20C-04332	Gqishi	4	3	**4**
U20E-04221	Mgeni	3	4	**4**
U20E-04243	Mgeni	3	4	**4**
U20G-04240	Mgeni	3	4	**4**
U20G-04259	Mgeni	4	4	**4**
U20J-04391	Msunduze	3	4	**4**
U20J-04459	Msunduze	3	4	**4**
U20L-04435	Mgeni	4	4	**4**
U20M-04396	Mgeni (upstream of Inanda Dam)	3	4	**4**
U40A-03869	Mvoti	4	3	**4**
U40D-03867	Mvoti	4	3	**4**
U40D-03957	Mvoti	5	3	**4**
U40E-03985	Mvoti	4	4	**4**
U40F-03806	Hlimbitwa	4	3	**4**
U40H-04064	Mvoti	4	4	**4**
U40J-03998	Mvoti	3	4	**4**

The rivers where hotspots dominate are:

- *Mvoti and Mkomazi due to the potential for large dam development in the near future.*
- *Mgeni due to its WRUI importance and existing dam developments.*
- *Msunduze due to its water quality issues.*

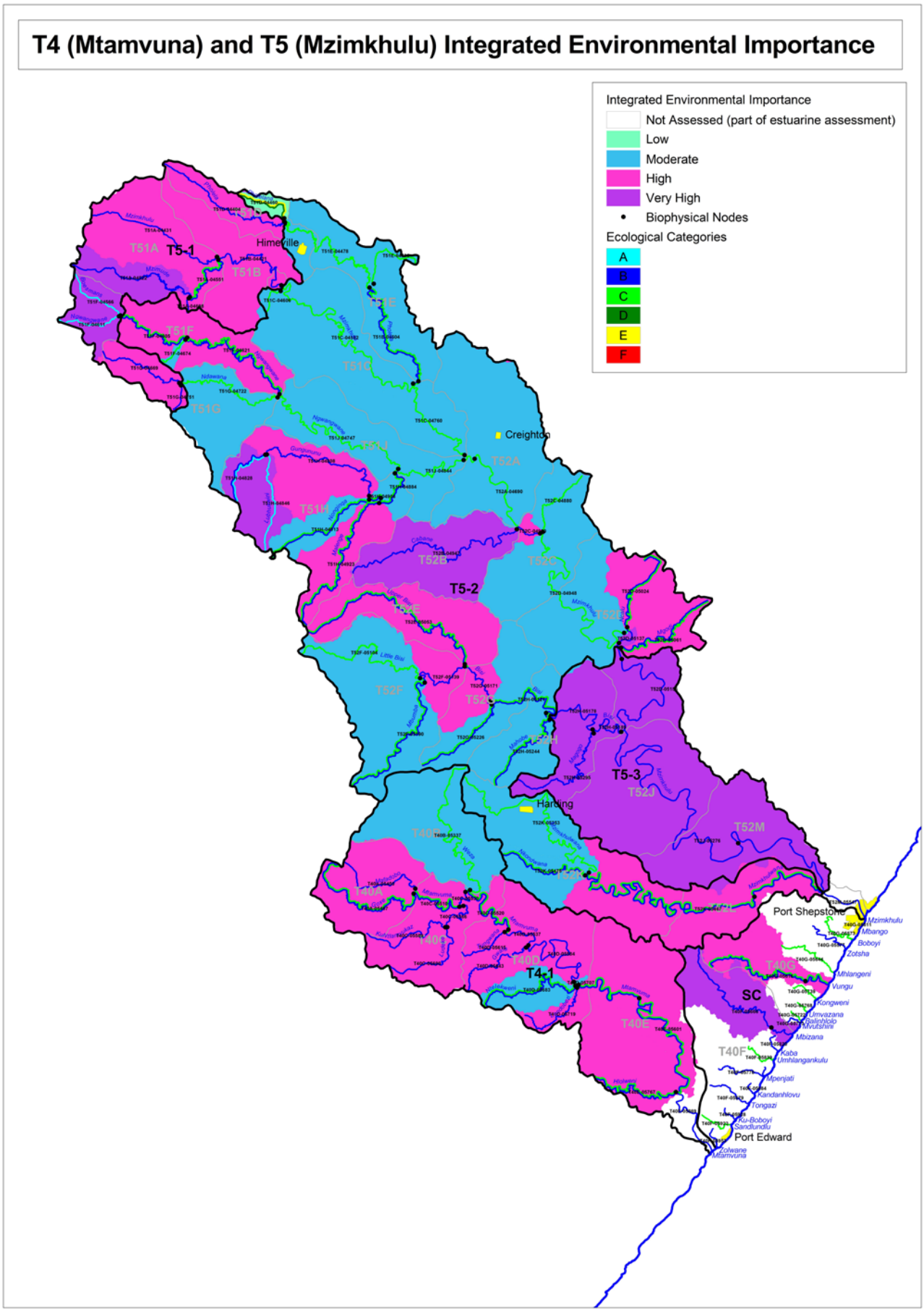


Figure 11.1 IEI of the T4 (Mtamvuna) and T5 (Umzimkulu) secondary catchments

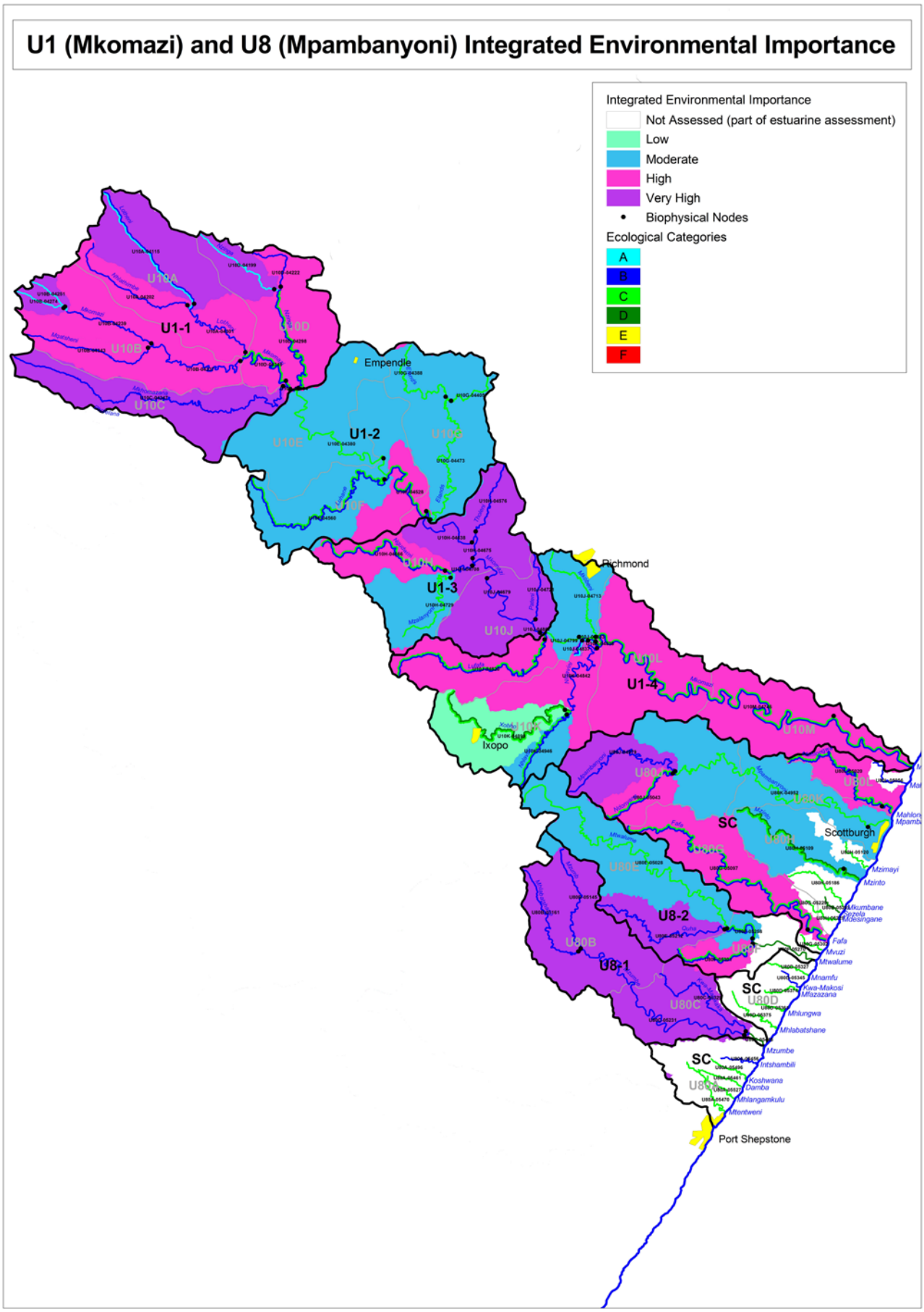


Figure 11.2 IEI of the U1 (Mkomazi) and U8 (Mpambanyoni) secondary catchments

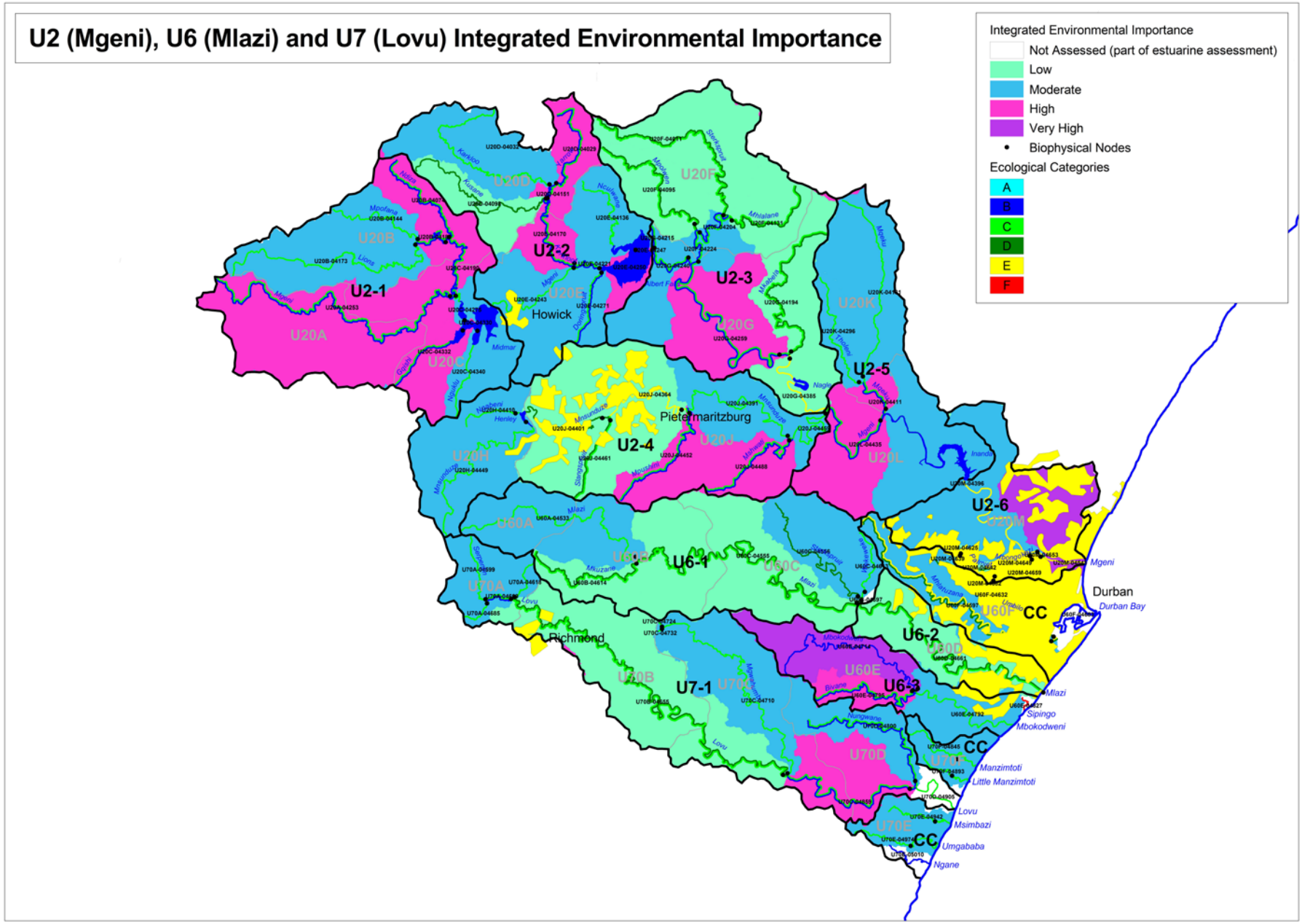


Figure 11.3 IEI of the U2 (Mgeni), U6 (Mlazi) and U7 (Lovu) secondary catchments

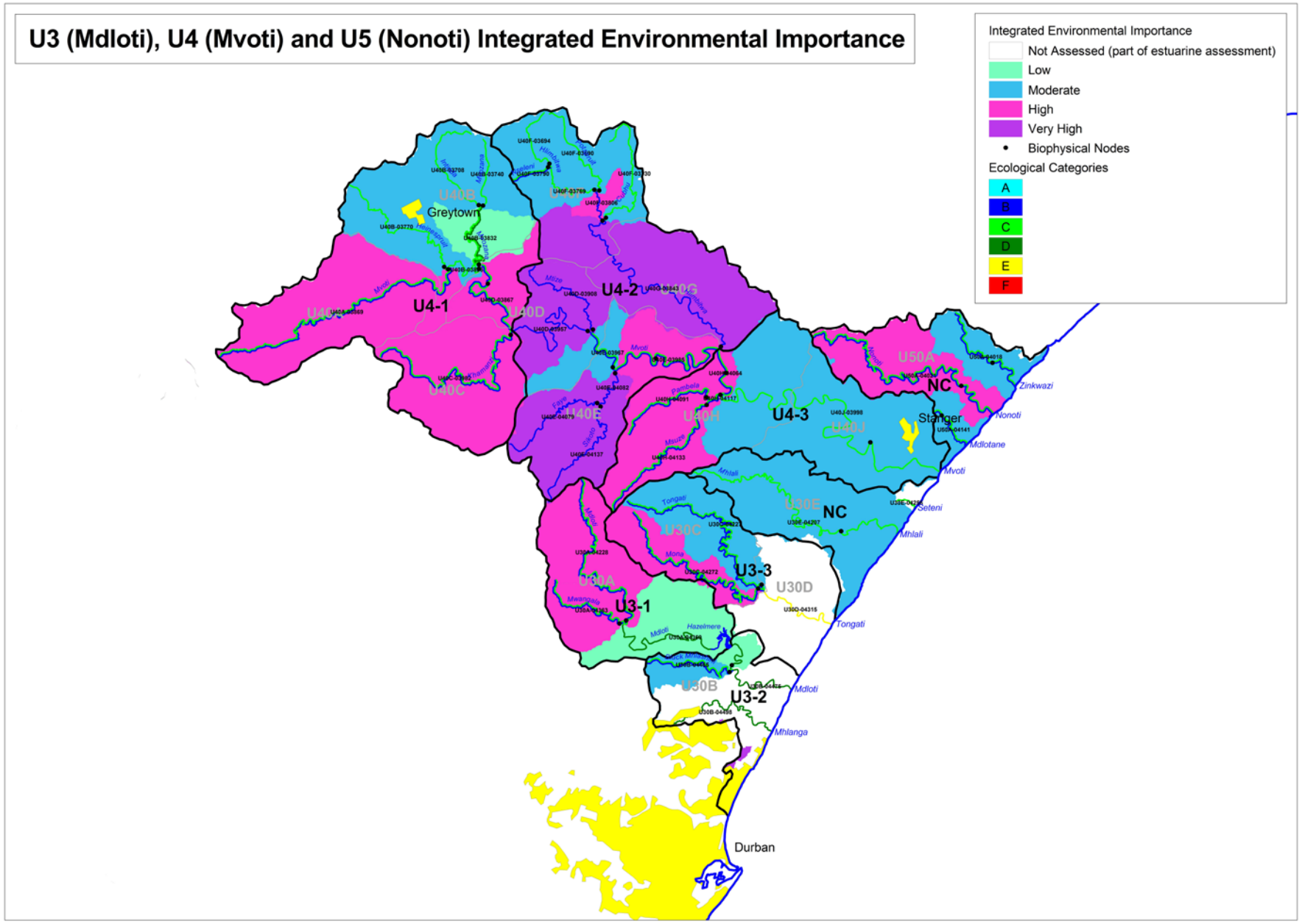


Figure 11.4 IEI of the U3 (Mdloti) and U4 (Mvoti) secondary catchments

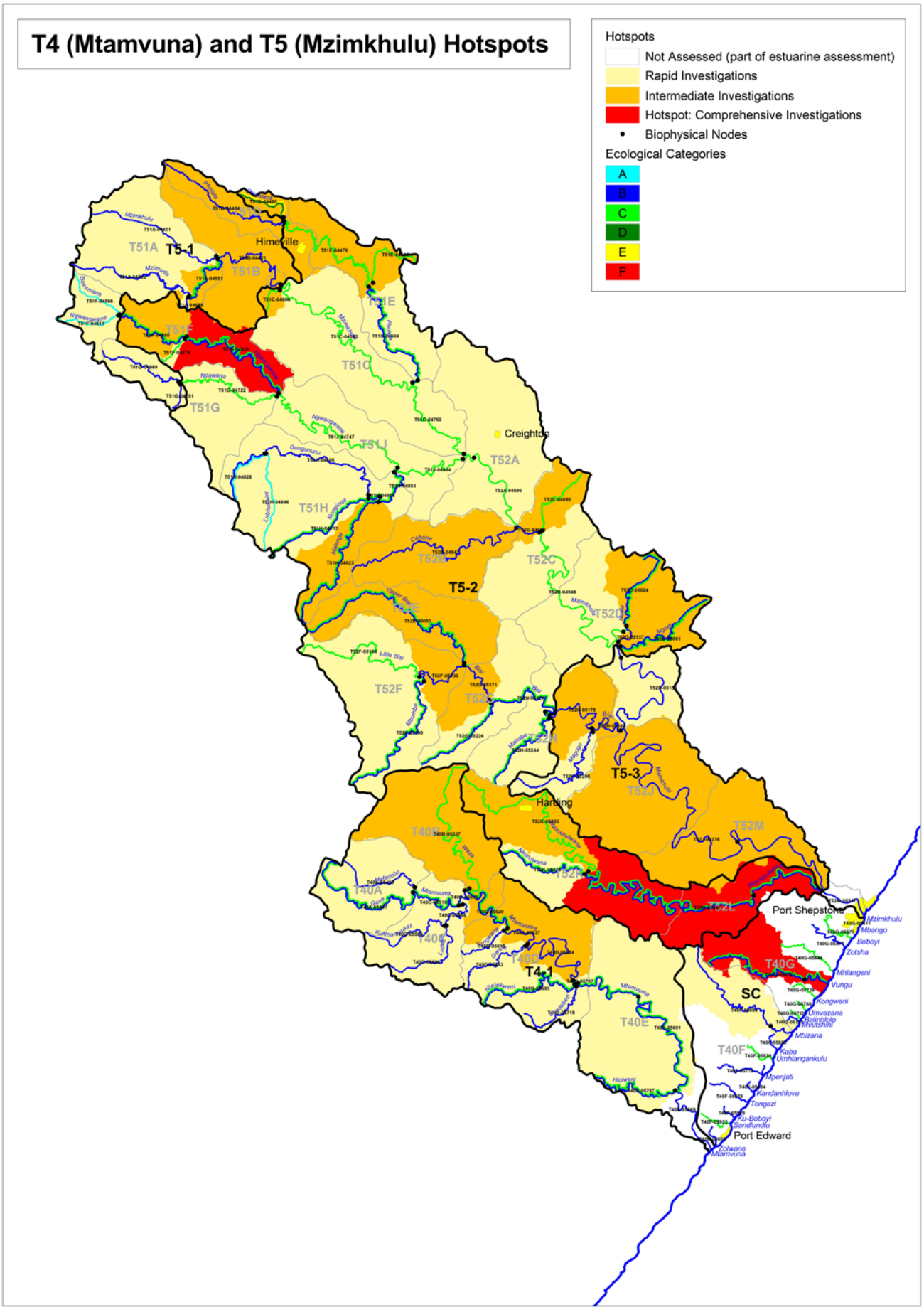


Figure 11.5 Hotspots in the T4 (Mtamvuna) and U5 (Umzimkulu) secondary catchments

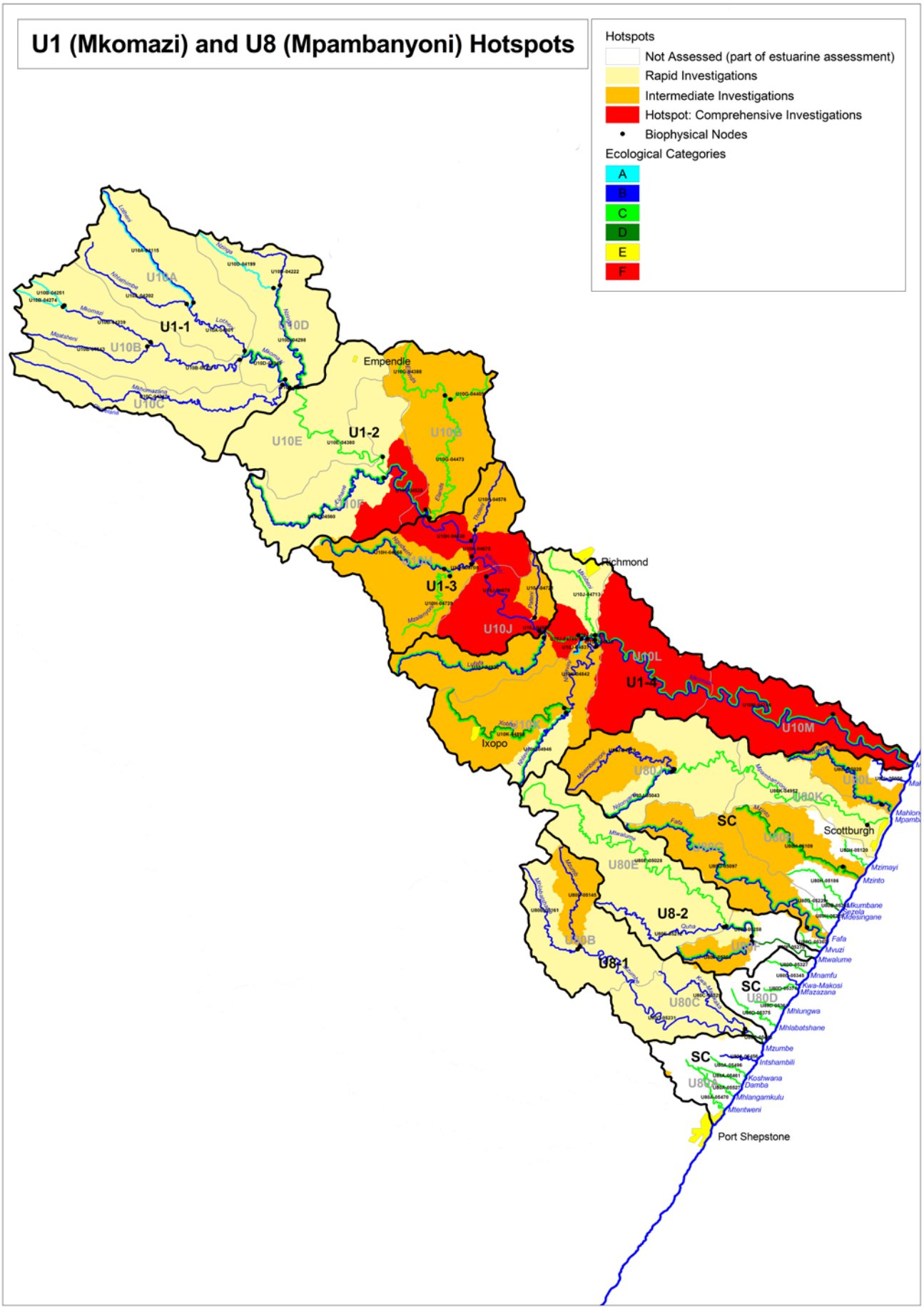


Figure 11.6 Hotspots in the U1 (Mkomazi) and U8 (Mpambanyoni secondary catchments

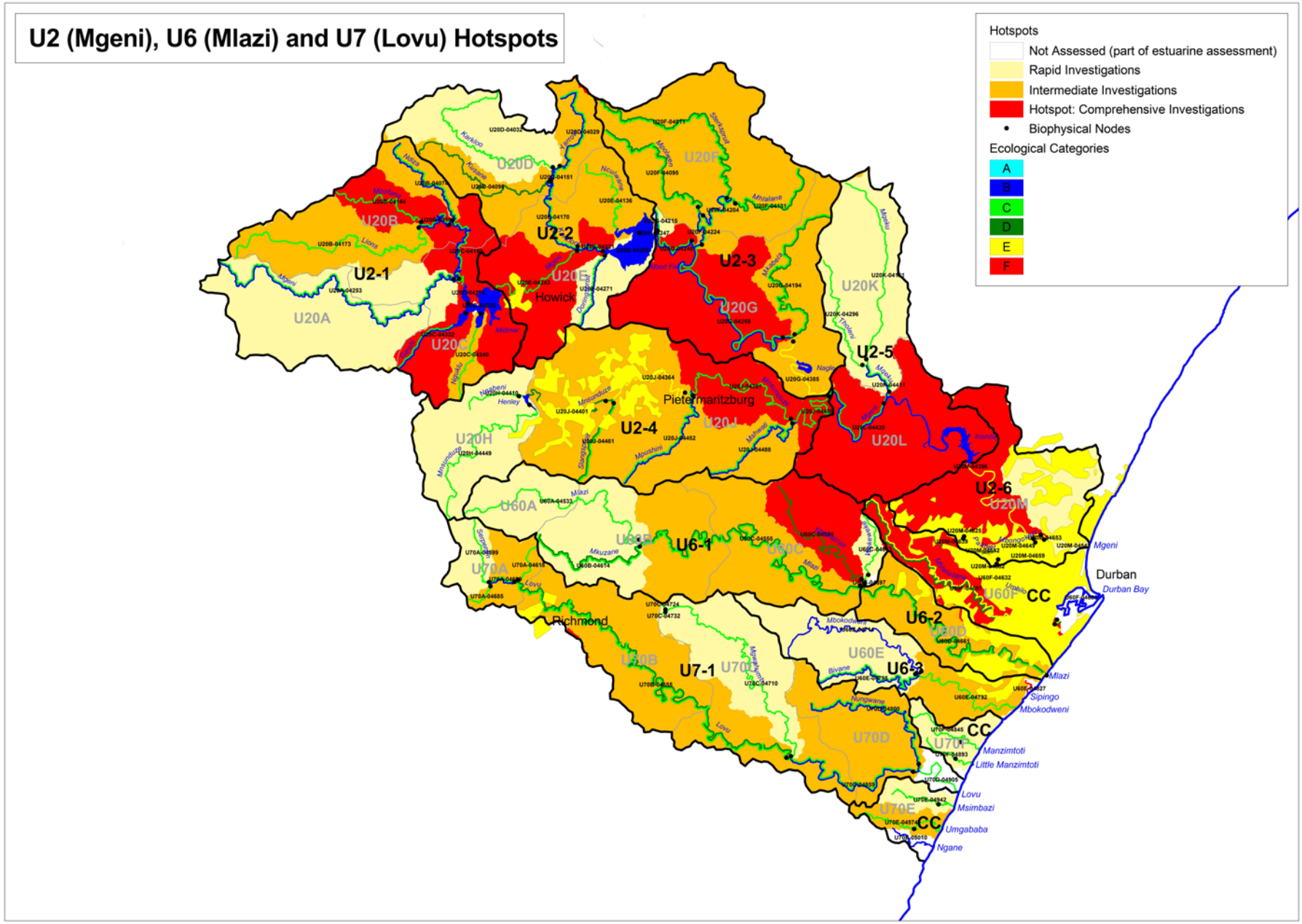


Figure 11.7 Hotspots in the U2 (Mgeni), U6 (Mlazi) and U7 (Lovu) secondary catchments

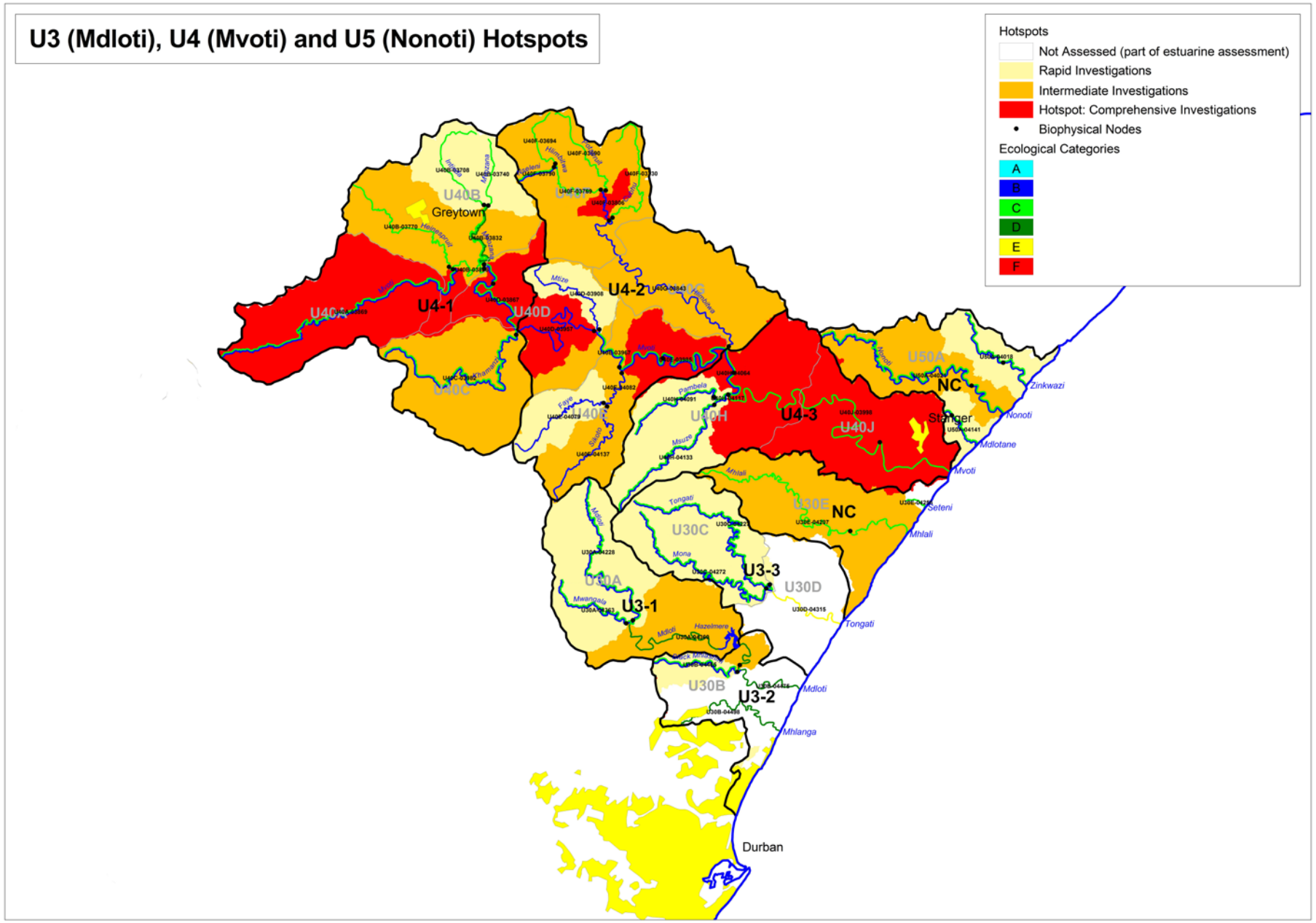
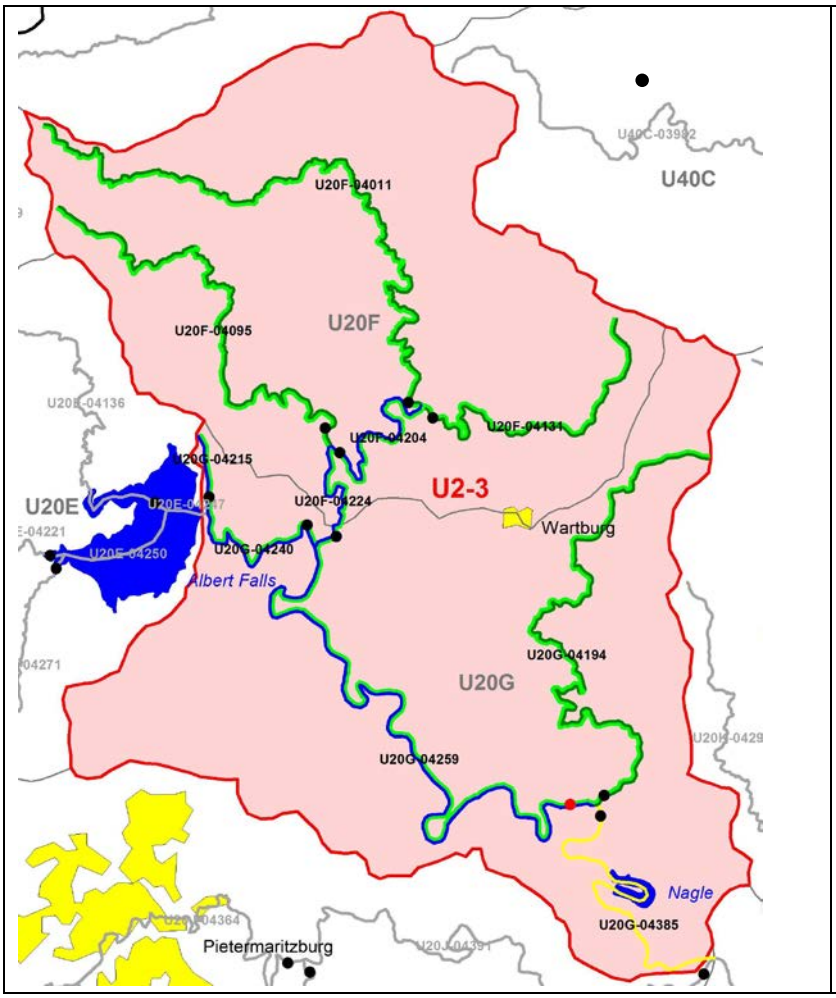


Figure 11.8 Hotspots for U3 (Mdloti) and U4 (Mvoti) secondary catchments

12 BIOPHYSICAL NODES AND LEVEL OF EWR ASSESSMENT

12.1 IDENTIFICATION OF BIOPHYSICAL NODES

IUAs are a combination of the socio-economic zones defined in watershed boundaries, within which ecological information is provided at a finer scale. IUAs therefore represent a catchment or a linear stretch of river. Nested in an IUA are Resource Units (RUs) (lengths of river referred to in this study as SQ reaches). Each RU is represented by a biophysical node. Biophysical nodes are therefore nested within the IUAs (DWAF, 2007b) and represents flow requirements and ecological state relevant for the RU (SQ). This is illustrated in Figure 12.1



- *IUA represented by the pink catchment.*
- *RUs or SQ reaches represented by 9 river reaches each identified by a code e.g. U20F-04011.*
- *Each SQ is represented by a node - the 9 black and red dots within the IUA*

Figure 12.1 Illustration of biophysical nodes and RU (SQ reaches) nested within an IUA

12.2 BIOPHYSICAL NODES

Each SQ unit is a surrogate for a desktop RU and must be represented by a desktop biophysical node. As there were 288 SQs, this meant 288 initial biophysical nodes. To determine the number of river biophysical nodes, the following were taken into account:

- *46 desktop biophysical nodes are short rivers consisting of one SQ only and will be dealt with through estuarine requirements.*
- *5 SQs fall within dams and were deleted as nodes.*
- *This left a total of 237 river biophysical nodes.*

To calculate the number of desktop biophysical nodes (preliminary at this stage), the following were taken into account:

- *8 desktop nodes were allocated for Rapid III assessments, becoming key biophysical nodes. The hotspot identification and the availability of a yield model guided the allocation.*
- *6 desktop nodes were allocated for Intermediate assessments of which 3 nodes are existing EWR sites. The hotspot identification, previous EWR studies and the availability of a yield model guided the allocation.*
- *5 desktop nodes were allocated for Comprehensive assessments of which 3 are existing EWR sites. The hotspot identification, previous EWR studies and the availability of a yield model guided the allocation*
- *37 desktop nodes would be addressed by yield modelling for the above Rapid, Intermediate and Comprehensive EWR sites.*
- *3 nodes are excluded as the desktop model would not be applicable due to an Interbasin Transfer (IBT).*

This resulted in a total of 178 river desktop biophysical nodes. The key biophysical nodes are (preliminary) and consist of 19 EWR sites and 37 nodes which are addressed by yield modelling for the EWR sites. These calculations per secondary are illustrated in the Table 12.1.

Table 12.1 Desktop and key biophysical nodes

Secondary	No of Nodes	No of Estuaries	Other (in dams e.g.)	No of river nodes	Desktop	Rapid	Yield	Intermediate	Compre-hensive	Other
T4	*37*	*17*		*20*	*13*	*1*	*6*	*0*		
T5	*55*	*1*		*54*	*41*	*2*	*7*	*4*		
U8	*33*	*19*		*14*	*14*	*0*	*0*	*0*		
U1	*39*	*0*		*39*	*29*	*0*	*7*	*0*	*3*	
U7	*16*	*2*		*14*	*10*	*1*	*3*	*0*	*0*	
U6	*14*	*2*	*1*	*11*	*11*	*0*	*0*	*0*	*0*	
U2	*53*	*1*	*4*	*48*	*35*	*1*	*7*	*2*	*0*	*3*
U3	*11*	*4*	*0*	*7*	*7*	*0*	*0*	*0*	*0*	*0*
U4	*27*	*0*	*0*	*27*	*16*	*2*	*7*	*0*	*2*	*0*
U5	*3*	*0*	*0*	*3*	*2*	*1*	*0*	*0*	*0*	*0*
TOTAL	**288**	**46**	**5**	**237**	**178**	**8**	**37**	**6**	**5**	**3**

The list of preliminary biophysical nodes and their coordinates are attached as Appendix A. The desktop biophysical zone has been set at the end of each SQ and upstream of the estuary (where relevant). In some cases the node has been placed upstream of dams where the dams inundate the downstream section of the SQ. The locality of the Rapid and new EWR sites are not known at this stage as must still be selected. Therefore the nodes are allocated still at the end of the SQs. Where there are existing key biophysical nodes (intermediate or comprehensive), the existing locations have been used which can be changed if deemed necessary.

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14 APPENDIX A: LIST OF BIOPHYSICAL NODES

SQ Number	River biophysical nodes	Latitude	Longitude
T4 - Mtamvuna			
T40A-05450	Mafadobo	-30.690902	29.694044
T40A-05487	Goxe	-30.698274	29.691309
T40B-05337	Weza	-30.693868	29.78712
T40C-05510	Mtamvuna	-30.7183	29.76887
T40C-05520	Mtamvuna	-30.752671	29.851594
T40C-05530	Mtamvuna	-30.69659	29.779391
T40C-05566	Ludeke	-30.717171	29.775692
T40C-05589	KuNtlamvukazi	-30.748202	29.744504
T40C-05600	Ludeke	-30.748021	29.74781
T40D-05537	Mtamvuna	-30.776056	29.885599
T40D-05584	Mtamvuna	-30.830325	29.962181
T40D-05615	Tungwana	-30.756161	29.845444
T40D-05643	Gwala	-30.779334	29.881653
T40D-05683	Ntelekweni	-30.836439	29.964857
T40D-05707	Mtamvuna	-30.83478	29.970393
T40D-05719	Londobezi	-30.839073	29.967781
T40E-05601	Mtamvuna	-30.85528	30.07333
T40E-05767	Hlolweni	-30.993709	30.13475
T40F-05666	Mbizana	-30.899889	30.298321
T40G-05616	Vungu	-30.831797	30.356608
T5 - Umzimkulu			
T51A-04431	Umzimkulu	-29.758499	29.372448
T51A-04522	Mzimude	-29.817032	29.325827
T51A-04608		-29.8188	29.323762
T51A-04551	Mzimude	-29.762808	29.374547
T51B-04421	Umzimkulu	-29.801664	29.480135
T51C-04606		-29.810073	29.478868
MzEWR2i	Umzimkulu	-29.83178	29.52211
T51C-04760	Umzimkulu	-30.054363	29.785893
T51D-04404	Pholela	-29.708068	29.486262
T51D-04460	Pholelana	-29.679562	29.448576
T51E-04536		-29.801083	29.635797
T51E-04478	Pholela	-29.806631	29.628665
T51E-04604	Pholela	-29.945187	29.70938
T51F-04566	Boesmans	-29.842435	29.208384
T51F-04611	Ngwangwane	-29.843783	29.205752
T51F-04674		-29.879664	29.317282
T51F-04605	Ngwangwane	-29.876721	29.320332
T51F-04621	Ngwangwane	-29.961628	29.474469
T51G-04669	Ndawana	-29.943088	29.305723
T51G-04751		-29.94671	29.308547
T51G-04722	Ndawana	-29.966358	29.471274
T51H-04828	Gungununu	-30.050287	29.449345
T51H-04846	Lubhukwini	-30.050047	29.451872

SQ Number	River biophysical nodes	Latitude	Longitude
T51H-04913	Nonginqa	-30.118295	29.623796
T51H-04923	Malenge	-30.12354	29.640642
T51H-04808	Gungununu	-30.11281	29.623809
T51H-04884	Gungununu	-30.080067	29.667831
T51H-04908	Gungununu	-30.116186	29.643505
T51J-04747	Ngwangwane	-30.073731	29.673599
T51J-04844	Ngwangwane	-30.061714	29.784177
MzEWR3i	Umzimkulu	-30.06014	29.80277
T52B-04947	Cabane	-30.164181	29.872909
T52C-04880		-30.168493	29.91684
T52C-04960	Umzimkulu	-30.170693	29.912183
T52D-05024	Ncalu	-30.309774	30.058164
T52D-05061	Mgodi	-30.339594	30.047579
T52D-04948	Umzimkulu	-30.318105	30.052932
T52D-05137	Umzimkulu	-30.332842	30.044077
MzEWR5i	Umzimkulu	-30.35646	30.04861
T52E-05053	Upper Bisi	-30.361748	29.782562
T52F-05104	Little Bisi	-30.381686	29.706458
T52F-05190	Mbumba	-30.388283	29.714208
T52F-05139	Little Bisi	-30.365122	29.782312
T52G-05226	uMbumbane	-30.421586	29.82723
T52G-05171	Bisi	-30.416679	29.82517
T52H-05244	Mahobe	-30.444445	29.925452
T52H-05295	Magogo	-30.465308	29.999871
T52H-05121	Bisi	-30.434721	29.919441
T52H-05178	Bisi	-30.459693	29.998082
T52H-05189	Bisi	-30.463437	30.04658
MzEWR6i	Umzimkulu	-30.62849	30.2437
T52K-05353	Mzimkhulwana	-30.670059	29.989649
T52K-05475	Nkondwana	-30.67398	29.983284
MzEWR17i	Mzimkhulwana	-30.70741	30.27066
U8 - Mpambanyoni			
U80B-05145	Mzumbe	-30.466135	30.238371
U80B-05161	Mhlabatshane	-30.470474	30.234295
U80C-05231	Mzumbe	-30.594731	30.515096
U80C-05329	Kwa-Malukaka	-30.589158	30.51785
U80E-05028	Mtwalume	-30.437881	30.486772
U80E-05212	Quha	-30.439188	30.482658
U80F-05258	Mtwalume	-30.452907	30.529858
U80F-05301	uMgeni	-30.460696	30.53029
U80G-05097	Fafa	-30.440084	30.623554
U80H-05109	Mzinto	-30.35089	30.684916
U80J-04979	Mpambanyoni	-30.206547	30.400091
U80J-05043	Ndonyane	-30.209605	30.396252
U80K-04952	Mpambanyoni	-30.289502	30.726454
U80L-05020	aMahlongwa	-30.259052	30.750066
U1 - Mkomazi			
U10A-04115	Lotheni	-29.513289	29.596045

SQ Number	River biophysical nodes	Latitude	Longitude
U10A-04202	Nhlathimbe	-29.515233	29.584607
U10A-04301	Lotheni	-29.585454	29.681233
U10B-04239	Mkomazi	-29.570646	29.523165
U10B-04251	Mkomazi	-29.515045	29.379081
U10B-04274	Nhlangeni	-29.51701	29.376609
U10B-04337	Mkomazi	-29.598251	29.672503
U10B-04343	Mqatsheni	-29.577025	29.51757
U10C-04347	Mkhomazana	-29.635843	29.743924
U10D-04199	Nzinga	-29.493241	29.730762
U10D-04222	Rooidraai	-29.489644	29.741639
U10D-04298	Nzinga	-29.63871	29.769527
U10D-04349	Mkomazi	-29.62805	29.748815
U10D-04434	Mkomazi	-29.641292	29.756332
EWR 1	Mkomazi	-29.74338	29.91165
U10F-04528	Mkomazi	-29.82179	29.98284
U10F-04560	Luhane	-29.774378	29.913086
U10G-04388	Elands	-29.653705	30.017244
U10G-04405		-29.659684	30.026352
U10G-04473	Elands	-29.834001	29.989613
U10H-04576	Tholeni	-29.852085	30.066039
U10H-04638	Mkomazi	-29.868077	30.059559
U10H-04666	Ngudwini	-29.909342	30.013621
U10H-04675	Mkomazi	-29.891325	30.060343
U10H-04708	Ngudwini	-29.902351	30.059769
U10H-04729	Mzalanyoni	-29.919781	30.023069
EWR 2	Mkomazi	-29.921	30.08448
U10J-04713	Mkobeni	-30.008222	30.267209
U10J-04721	Pateni	-29.981782	30.165666
EWR 3	Mkomazi	-30.0082	30.23903
U10J-04807	Mkomazi	-30.001591	30.173311
U10J-04820	Lufafa	-30.011667	30.180882
U10J-04833	Mkomazi	-30.013479	30.254233
U10J-04837		-30.013496	30.244326
U10K-04838	Mkomazi	-30.015187	30.266885
U10K-04842	Nhlavini	-30.024874	30.269267
U10K-04899	Xobho	-30.115238	30.214291
U10K-04946	Nhlavini	-30.122052	30.217536
EWR 4	Mkomazi	-30.12625	30.6687
U7 - Lovo			
U70A-04599	Serpentine	-29.852681	30.189341
U70A-04609	Lovu	-29.852541	30.225412
U70A-04618		-29.850154	30.230707
U70A-04685	Lovu	-29.857699	30.191571
U70B-04655	Lovu	-30.06965	30.60935
U70C-04710	Mgwahumbe	-30.067697	30.615816
U70C-04724		-29.887402	30.438887
U70C-04732		-29.890355	30.438874
U70C-04859	Lovu	-30.087085	30.789081

SQ Number	River biophysical nodes	Latitude	Longitude
U70D-04800	Nungwane	-30.077653	30.796919
U70E-04942	Umsimbazi	-30.12712	30.824839
U70E-04974	uMgababa	-30.157182	30.79013
U70F-04845	Manzimtoti	-30.050902	30.856164
U70F-04893	Little Manzimtoti River	-30.071129	30.848965
U6 - Mlazi			
U60A-04533	Mlazi	-29.801733	30.40189
U60B-04614	Mkuzane	-29.81005	30.403202
U60C-04555	Mlazi	-29.859464	30.714491
U60C-04556	Sterkspruit	-29.851257	30.71615
U60C-04613	Wekeweke	-29.84588	30.725983
U60D-04661	Mlazi	-29.856284	30.721183
U60E-04714	Mbokodweni	-29.969338	30.97836
U60E-04792	Mbokodweni	-29.964454	30.800669
U60E-04795	Bivane	-29.967427	30.792309
U60F-04597	Mhlatuzana	-29.906537	30.98959
U60F-04632	Umbilo	-29.901052	30.9929
U2 - Mgeni			
U20A-04253	Mgeni	-29.481085	30.142466
U20B-04074	Ndiza	-29.408718	30.141896
U20B-04144	Mpofana	-29.410887	30.097516
U20B-04173	Lions	-29.41778	30.094117
U20B-04185	Lions	-29.414879	30.136862
U20C-04190	Lions	-29.480764	30.150506
U20C-04332	Gqishi	-29.523194	30.159976
U20C-04340	Nguklu	-29.523875	30.180761
U20D-04029	Yarrow	-29.343523	30.293094
U20D-04032	Karkloof	-29.344965	30.283475
U20D-04098	Kusane	-29.362266	30.278451
U20D-04151	Karkloof	-29.361785	30.28065
U20E-04136	Nculwane	-29.425958	30.40438
U20E-04170	Karkloof	-29.441683	30.317831
U20E-04221	Mgeni	-29.448153	30.353136
U20E-04243	Mgeni	-29.447502	30.316872
U20E-04271	Doring Spruit	-29.453566	30.355976
U20F-04011	Sterkspruit	-29.383814	30.528045
U20F-04095	Mpolweni	-29.394523	30.48753
U20F-04131	Mhlalane	-29.390377	30.539896
U20F-04204	Sterkspruit	-29.404914	30.494593
U20F-04224	Mpolweni	-29.440642	30.49268
U20G-04194	Mkabela	-29.551091	30.622879
U20G-04215	Cramond Stream	-29.423475	30.43066
U20G-04240	Mgeni	-29.435624	30.478521
U20G-04259	Mgeni	-29.554925	30.606313
U20G-04385	Mgeni	-29.559797	30.62101
U20H-04410	Nqabeni	-29.625154	30.233685
U20H-04449	Msunduze	-29.635844	30.248433
U20J-04364	Msunduze	-29.621956	30.468012

SQ Number	River biophysical nodes	Latitude	Longitude
U20J-04391	Msunduze	-29.654452	30.617599
U20J-04401	Msunduze	-29.631631	30.356116
U20J-04452	Mpushini	-29.625818	30.47886
U20J-04459	Msunduze	-29.627266	30.671235
U20J-04461	Slang Spruit	-29.634439	30.367353
U20J-04488	Mshwati	-29.660151	30.619663
U20K-04181	Mqeku	-29.581859	30.723985
U20K-04296	Tholeni	-29.588829	30.718478
U20K-04411	Mqeku	-29.621747	30.756283
U20L-04435	Mgeni	-29.635893	30.748636
U20M-04396	Mgeni (upstream of Inanda)	-29.636996	30.767406
U20M-04625		-29.79905	30.861659
U20M-04639	Palmiet	-29.801751	30.860434
U20M-04642	Palmiet	-29.827234	30.909617
U20M-04649	Mbongokazi	-29.802127	30.959509
U20M-04653	Palmiet	-29.803096	30.974639
U20M-04659	Palmiet	-29.806437	30.962195
U20M-04682		-29.832584	30.907706
U3 - Mdloti			
U30A-04228	Mdloti	-29.567275	30.895157
U30A-04360	Mdloti	-29.622204	31.044408
U30A-04363	Mwangala	-29.571076	30.885882
U30B-04465	Black Mhlashini	-29.630603	31.041174
U30C-04227	Tongati	-29.52338	31.086328
U30C-04272	Mona	-29.528089	31.081412
U30E-04207	Mhlali	-29.45767	31.198498
U4 - Mvoti			
U40A-03869	Mvoti	-29.136051	30.645195
U40B-03708	Intinda	-29.057253	30.688527
U40B-03740	Mvozana	-29.057982	30.694551
U40B-03770	Heinespruit	-29.132976	30.639774
U40B-03832	Mvozana	-29.130249	30.688432
U40B-03896	Mvoti	-29.135416	30.688497
U40C-03982	Khamanzi	-29.216716	30.73297
IFR1	Mvoti	-29.15385	30.70105
U40D-03908	Mtize	-29.21031	30.848761
U40D-03957	Mvoti	-29.212123	30.841478
U40E-03967	Mvoti	-29.256593	30.876609
IFR2	Mvoti	-29.24579	30.93703
U40E-04079	Faye	-29.300545	30.854643
U40E-04082	Sikoto	-29.263964	30.879872
U40E-04137	Sikoto	-29.30485	30.859289
U40F-03690	Potspruit	-29.039661	30.857922
U40F-03694	Hlimbitwa	-29.006712	30.78793
U40F-03730	Cubhu	-29.073198	30.867223
U40F-03769	Hlimbitwa	-29.03886	30.851102
U40F-03790	Nseleni	-29.010978	30.786097
U40F-03806	Hlimbitwa	-29.076696	30.862317

SQ Number	River biophysical nodes	Latitude	Longitude
U40G-03843	Hlimbitwa	-29.231213	31.028873
IFR3	Mvoti	-29.26353	31.0357
U40H-04091	Pambela	-29.293441	31.008529
U40H-04117	Nsuze	-29.290357	31.028146
U40H-04133	Nsuze	-29.302844	31.008722
IFR4	Mvoti	-29.34862	31.23943
U5 - Nonoti			
U50A-04018	Zinkwazi	-29.250597	31.411106
U50A-04021	Nonoti	-29.279003	31.367175
U50A-04141	Mdlotane	-29.315395	31.33983

15 APPENDIX B: REPORT COMMENTS

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
21 June 2013: Comments from Adaora Onkonkwo				
		How was groundwater delineated in the water resource zone?	*Yes*	*Groundwater was delineated by quaternary and identified groundwater regions based on lithology and structure.*
		Was recharge and discharge areas considered?	*Yes*	*Recharge and discharge was gathered from GRA2.*
		Was the process in the establishment of groundwater nodes as stated in the guidelines followed?		
		Is there any groundwater –surface water interaction?	*Yes*	*Yes. Every catchment has baseflow.*
		A brief description of groundwater in each water resource zone is required.	*Yes*	*Groundwater regions were described.*
		How was groundwater use estimated? This needs to be clearly explained.		
		Which data source was used in the estimation?		*GRA2. KwaZulu Natal groundwater characterisation project. SRK GRDM report.*
		Was recharge and discharge areas considered?		*Duplicate question.*
21 June 2013: Comments from Yakeen Atwaru				
Page 9-3. Page 10-1		*Why the incomplete references highlighted in pink?* *"(Front end model, user guide)" – what does this mean?* *Same issue, "(Front end model, user guide)" – what does this mean?*	*Yes*	*The reference was not available for the first draft report.*
Table 10.2, page 10.2 and page 10.3		*Verification column, why are there question marks next to the ticks*	*Yes*	*An explanation of the ticks has been provided.*
21 June 2013: Comments from Tovhowani Nyamande				

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
		The inclusion of Status Quo Assessment: Social component as a subheading like Economics. Under the heading you include information like Demographic overview, population, employment % and household income % of the area. The problem is if the subheading is not clearly visible, at a later stage we might be queried that the component was not considered.		
9-4		*Socio cultural importance paragraphs indicated in page 9-4 will have a basis in the beginning of the report, if Social component is indicated.*		
21 June 2013: Comments from Nancy Motebe				
		The status quo report refers to water resources, however emphasis is more towards surface water, particularly rivers	*Yes*	*Groundwater regions were described.*
		Groundwater potential is referred to in the status quo report tables, based on groundwater strategy report/ or NWRS report. Ideally recent and representative data needs to be availed from the GRDM report by SRK which provided data on what is available in as far as groundwater is concerned	*No*	*The SRK report only included figures from GRA2 and older baseflow figures from Pitman and Hughes. No new information was included and such information would require remodelling.* *No groundwater potential figures are in the SRK report, consequently, the most recent figures are those in GRA2.*
		In the inception report of the same, there was more emphasis on non-availability of groundwater information		
		No reference(refer to references) is made to the report we availed, re GRDM for Mvoti to Mzimkhulu	*Yes*	*The report was considered, however, the GRUs proposed were not based on lithological units of similar properties, simply groups of quats, nor was any logical process given for the selection of GRUs. Hence the GRUs were reconsidered. For example, Dwyka tillites, known as a very*

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
				poor aquifer, are grouped with faulted natal Group and NMP rocks. Inland Karoo rocks are lumped with NMP and heavily faulted Natal group rocks.
		Now that it was made available; the contents of this GRDM report are overlooked or simply ignored		*The report was considered, but the groupings were not considered to be the most appropriate for this study. The Report No 41182/3 (DWA, 2012) included geohydrological response units. These were evaluated and it was found that refinement is required for this study as the DWA (2012) report mostly used groupings of quaternary catchments.*
21 June 2013: Comments from Sadimo Manamela				
The report is based mainly on the surface water description whereas the principal objective of the project is the setting of the Management Classes, Reserve and Resource quality Objectives for significant water resources within Mvoti to Umzimkulu Water Management Area. The groundwater as part of significant water resources in the WMAs is not described in the report as such the following cannot be achieved as required in the Classification of water resources and determination of Resource Quality Objectives:				
		Identification of areas of interaction between ecosystem specific units e.g. river- groundwater interactions, estuary-groundwater interactions and groundwater-wetlands interactions (step 1c guidelines Water Resource Classification System)	*Yes, described groundwater characteristic.*	*Substantial further detail on the groundwater characteristics have been added to the report based on this and also comments from other reviewers. At the PMC (26 July 2013) it was reported that the further numerical information will be made available for use in the study.*
		The identification of nodes to account for interactions between ecosystem-specific units (step 1c guidelines Water Resource Classification System).	*No, new information to be incorporated.*	*At the PMC (26 July 2013) it was reported that the further numerical information will be made available for use in the study to address this requirement.*
		Resource Quality Objectives determination that takes into account all significant water resources within the WMA.	*Yes, described groundwater characteristic.*	*Qualitative descriptions were provided and numerical information will be incorporated as was discussed at the PMC meeting of 26 July 2013.*
Comments Received from Dr Marilyn Govender, South Africa Sugar Association				
		Page 8 - Please define what unregulated means. Are the users not registered as	*Yes*	*The comment actually referred to pageii of the exuctive summary and the sentence*

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
		water users or water allocations not registered with DWA, etc.		*was changed to explan the concept.*
		• *Page 8 - What would regulations entail in the catchment?*		*The word "unregulated" refer to the fact that no major dams are present in the Mzimkulu catchment and that the water flows freely to the ocean.*
		• *Many of the towns in the catchment would become "ghost towns" if it were not for the sugarcane production and sugar mills in these areas. So the economic value add from the water use should be considered.*	*Yes*	*It is trus that many of the towns where sugar mills are operating is also service towns for the community, the same applies to saw mils and pulp units. The concept was taken into consideration.*
		• *Page 9 – The two sentences contradict each other in terms of agricultural activity?*	*Yes*	*The two sentences were reformulated.*
		• *Page 12 - Are these illegal sugarcane farms? If not then maybe we need to change the terminology from encroaching as it has an invasive connotation.*	*Yes*	*The word"encroaching" was removed from the sentence.*
		• *Is the water quality hotspots being informed by primary water quality data collected by the DWA*	*Yes*	
		• *Page 67 - Verifying hectares under*	*Yes*	*The total hectares under sugar cane was received from the cane growers per sugar*

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE?	AUTHOR COMMENT
		sugarcane		*mill area. The subdivision per catchment was done by the economists.*
		• *Page 68 - Only 8 mills in the table, is the 9th one Amatikulu on the North Coast*	*Yes*	*Amatikulu has been added.*
		• *Page 71 - How were the jobs numbers determined, is there a specific reference that was used?*	*No*	*Job numbers has been calculated using the numbers in the latest report by the National Agricultural Marketing Council report prepared for the the South African Sugar Association (SASA)*