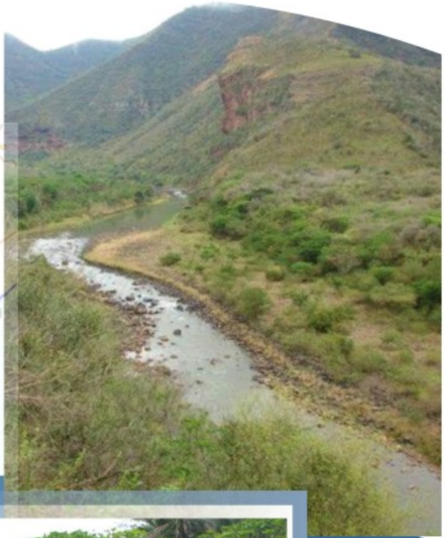
REPORT NUMBER: RDM/WMA11/00/CON/CLA/0313

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



Desktop Estuary EcoClassification and EWR Report

JUNE 2013

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

RfA03_2013

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

DESKTOP ESTUARY ECOCLASSIFICATION AND ECOLOGICAL WATER REQUIREMENT REPORT

Report Number: RDM/WMA11/00/CON/CLA/0313

June 2013

REFERENCE

This report is to be referred to in bibliographies as:

Department of Water Affairs, South Africa, June 2013. Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to Umzimkulu WMA: Desktop Estuary EcoClassification and Ecological Water Requirement. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd.

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11	*Report Number: RDM/WMA11/00/CON/CLA/0415*	*Classification of Water Resources and Determination of the Comprehensive Reserve and Resource Quality Objectives in the Mvoti to UmzimkuluWMA:* **Main report**

DEPARTMENT OF WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

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

DESKTOP ESTUARY ECOCLASSIFICATION AND EWR REPORT

Approved for RFA by:

…………………………………….	…………………………………….
Delana Louw	*Date*
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DEPARTMENT OF WATER AFFAIRS (DWA)
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The hydrology used in this study was provided by Mr S Mallory, Institute for Water Research (IWR) water resources, and was generated as as part of a WRC Project K5/2187: The resilience of South Africa's estuaries to future water resource development based on a provisional ecological classification of these systems. The hydrology was reviewed and refined by WRP Consulting Engineers (Pty) Ltd.

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REPORT SCHEDULE

Version	Date
First draft	*June 2013*
Second draft	*October 2013*
Third draft	*November 2013*

EXECUTIVE SUMMARY

INTRODUCTION

The objective of this task was to describe and document the status quo of the 64 estuaries occurring within the Mvoti to Umzimkulu Water Management Area (WMA). This requires that the status quo (Present Ecological Status), importance, and hotspots be identified for all the systems in the WMA. It also requires that the EWRs be addressed for the all the estuaries. Since these processes cannot be addressed at a detailed level for all the systems within the time frames of this study, using the above principles, a process of prioritization had to be followed to determine which of the 64 estuaries must be addressed at higher than desktop levels. The output of this study is therefore that a desktop level of information on EcoClassification is available for all estuaries; including hotspots identified and levels of EWR assessment determined for each estuary. The output of this task will serve as a strategic tool that can guide current and future monitoring requirements, and ultimately EWR determinations.

ESTUARY HEALTH

The assessment clearly shows the footprint of urbanisation on the estuaries in Mvoti to UmzimkuluWater Management Area (WMA) (Table 1). In most cases inflowing-hydrology is still in relatively good condition, with the exception of the urbanised systems where Waste Water Treatment Works (WWTWs) have elevated base flows significantly. The hydrodynamics (Mouth State) and salinity distributions therefore show a similar pattern.

In contrast to the hydrology, the water quality in a large number of estuaries in this WMA has been modified significantly. This is largely attributed to diffuse agricultural runoff in rural areas (e.g. fertilizers, herbicides and pesticides) and contaminated stormwater runoff from urban development (e.g. nutrients and toxic substances). In some estuaries, water quality has been compromised by point source WWTWs' effluent being discharged into estuaries or into rivers near the head of estuaries. With the exception of the larger fast-flowing estuaries, namely the Mtamvuna, uMkhomazi, uMngeni and Umzimkulu, most systems along this stretch of coast are relatively small with a very high vulnerability to increased nutrient loading. It should also be noted that while the overall water quality condition score for Durban Bay was relatively good this is largely as a result of tidal flushing of the lower reaches of this system. Important estuarine habitats (mangroves, mud and sand banks) in this Bay occur in the upper reaches however, and these are subject to reduced flushing and direct impacts of very poor water quality inflows from surround urban areas. In addition to the historic and ongoing physical alteration and destruction of habitat due to port development, water quality in these regions of the Bay significantly threatens ecological integrity.

Generally urbanisation led to significant habitat modification. Road and rail infrastructure has to a greater or lesser degree impacted every system along this stretch of coast whereby most estuaries in the Mvoti to UmzimkuluWMA have one or two large bridges across them. Bridge foundations and abutments, road and rail berms have led to infilling of systems and consequent habitat destruction, or development across floodplain and channel stabilisation has impacted natural flow patterns which have resulted in localised scour and deposition. The Port of Durban Bay also stands out as a highly transformed estuary as a result of port development. Sugar cane farming along the banks of a large number of systems has led to infilling of floodplains and general constriction of tidal flows as well as large scale loss of marginal vegetation and natural estuarine buffers.

Table 1 Present Ecological State of the estuaries of Mvoti to UmzimkuluWMA.

IUA Code	Name	Hydrology	Hydrodynamics	Water Quality	Physical habitat	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Score	PES
T40E-05869	*Mtamvuna*	B	A	A	B	B	B	B	C	C	B	B	B
T40F-05953	*Zolwane*	A	A	A	A	A	A	B	B	C	B	B	B
T40F-05923	*Sandlundlu*	A	A	B	C	B	B	C	D	E	D	D	C
T40F-05928	*Ku-Boboyi*	A	B	B	B	B	B	B	B	C	C	B	B
T40F-05879	*Tongazi*	A	A	B	B	B	B	C	D	C	C	C	B
T40F-05884	*Kandandhlovu*	A	B	C	C	B	B	C	D	C	C	C	B
T40F-05770	*Mpenjati*	A	A	B	D	B	B	C	D	D	B	C	B
T40F-05839	*Umhlangankulu*	A	A	D	D	C	C	D	E	D	C	D	C
T40F-05820	*Kaba*	A	A	C	C	B	B	C	C	D	C	C	C
T40F-05666	*Mbizana*	A	A	B	C	B	B	C	C	C	B	B	B
T40G-05773	*Mvutshini*	A	B	C	B	B	B	C	C	C	C	C	B
T40G-05722	*Bilanhlolo*	A	A	C	D	B	C	D	D	D	D	D	C
T40G-05768	*Uvuzana*	A	A	C	C	B	B	C	D	D	D	C	C
T40G-05739	*Kongweni*	E	E	D	D	D	E	E	D	D	D	D	D
T40G-05616	*Vungu*	B	A	C	B	B	C	B	C	C	C	C	B
T40G-05644	*Mhlangeni*	B	B	C	D	C	C	D	D	D	C	C	C
T40G-05577	**Zotsha***	B	C	C	B	B	B	C	C	B	B	B	B
T40G-05573	*Boboyi*	B	A	B	C	B	B	C	C	C	C	C	B
T40G-05611	*Mbango*	D	D	D	D	D	D	E	F	F	D	E	E
T52M-05547	*Umzimkulu*	B	B	C	C	B	B	B	C	B	B	B	B
U80A-05470	*uMthente (Mtentweni)*	B	B	B	D	B	B	D	C	D	C	C	C
U80A-05527	*Mhlangamkulu*	D	C	B	C	C	C	D	C	D	C	C	C
U80A-05461	*Damba*	D	D	B	D	C	C	C	C	D	C	C	C
U80A-05496	*Koshwana*	D	C	C	D	C	C	C	C	D	C	C	C
U80A-05456	*Intshambili*	D	C	C	C	C	C	C	C	C	C	C	C
U80C-05448	*Mzumbe*	B	B	C	D	C	C	E	D	D	E	D	C
U80D-05375	*Mhlabatshane*	A	A	B	C	B	B	D	C	C	C	C	B
U80D-05361	*Mhlungwa*	A	A	B	E	B	B	E	D	D	C	C	C
U80D-05374	*Mfazazana*	B	C	C	D	C	C	D	D	D	C	C	C
U80D-05345	*Kwa-Makosi*	B	B	B	C	B	B	C	C	C	C	C	B
U80D-05327	*Mnamfu*	C	C	C	C	C	C	C	D	D	C	C	C
U80F-05270	*Mtwalume*	B	C	C	C	C	C	C	D	D	D	C	C
U80G-05302	*Mvuzi*	B	C	C	D	C	C	C	C	C	C	C	C
U80G-05097	*Fafa*	C	B	C	D	C	C	D	D	D	D	C	C
U80H-05229	*Mdesingane*	A	A	C	D	B	C	E	E	E	D	D	C
U80H-05202	*Sezela*	B	B	C	D	C	C	C	D	D	D	C	C
U80H-05186	*Mkumbane*	B	B	C	C	B	C	D	D	D	D	D	C
U80H-05109	*uMuziwezinto (Mzinto)*	C	B	C	D	C	C	D	D	D	D	D	C
U80H-05120	*Nkomba*	A	A	C	C	B	C	C	B	B	C	B	B
U80H-05120	*Mzimayi*	C	B	C	C	C	C	C	D	C	C	C	C
U80K-04952	*Mpambanyoni*	B	A	B	D	B	B	D	D	D	D	D	C

IUA Code	Name	Hydrology	Hydrodynamics	Water Quality	Physical habitat	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Score	PES
U80L-05020	*Mahlongwa*	B	A	B	D	B	B	D	C	D	D	C	C
U80L-05056	*Mahlongwane*	B	A	C	D	B	C	D	B	C	C	C	C
U10M-04746	*uMkhomazi*	C	A	C	D	C	C	D	C	D	D	C	C
U70E-05010	*Ngane*	B	B	C	D	C	C	D	D	D	D	D	C
U70E-04974	*Umgababa*	C	B	B	C	B	B	D	D	D	B	C	C
U70E-04942	*Msimbazi*	A	A	B	C	B	B	C	B	C	B	B	B
U70D-04905	*Lovu*	D	C	C	D	D	C	D	C	C	C	C	C
U70F-04893	**Little aManzimtoti***	D	F	E	B	D	F	D	F	F	D	E	E
U70F-04845	*aManzimtoti*	C	C	E	D	D	D	E	F	F	E	E	D
U60E-04792	**Mbokodweni***	C	E	E	D	D	E	E	F	E	F	F	E
U60E-04827	**Sipingo***	F	F	F	F	F	F	E	F	F	F	F	F
U60F-04684	*Durban Bay*	F	A	B	F	D	B	F	F	F	F	E	E
U20M-04543	**uMngeni**	D	B	E	E	D	D	F	F	F	E	E	E
U30B-04498	**Mhlanga**	D	E	D	D	D	D	C	E	E	D	D	D
U30B-04475	**uMdloti**	B	C	E	C	C	F	E	F	E	F	E	D
U30D-04315	**uThongathi**	A	A	F	D	C	C	E	E	E	F	E	D
U30E-04207	*Mhlali*	B	B	C	D	C	C	D	C	D	D	C	C
U30E-04256	*Bob's Stream*	A	A	C	D	B	B	C	B	B	C	B	B
U30E-04256	*Seteni*	A	A	B	D	B	B	C	B	B	C	B	B
U40J-03998	*Mvoti*	C	B	E	D	C	D	D	F	D	F	E	D
U50A-04141	*Mdlotane*	A	A	B	B	B	B	B	B	C	B	B	B
U50A-04021	*Nonoti*	B	A	D	C	B	C	D	D	F	D	D	C
U50A-04018	*Zinkwasi*	A	A	B	C	B	B	C	B	B	D	C	B

**Determined with an Ecological Water Requirement study*
***Mvoti based on historical EFR flow information*

Catchments of estuaries in Tribal Trust areas are also subjected to increased poor agricultural practise, overstocking and increased sediment loads contributing to sedimentation in estuaries.

Macrophytes, in most cases, also reflected the effect of urbanisation, with a significant number of systems showing signs of severe degradation of floodplain vegetation. The effect of nutrient enrichment was clearly evident in reed encroachment in a number of systems. In most cases there was also a significant loss of habitat due to the presence of bridge abutments and berms.

Increased stormwater and nutrient inputs from wastewater treatment have caused eutrophication. Emergent species thrive under these conditions and invasive aquatic macrophytes such as water hyacinth (Eicchornia crassipes) and water cabbage (Pistia stratiotes) outcompete indigenous plants. Disturbed floodplain areas and riparian zones have been invaded by Brazilian pepper tree (Schinus terebinthifolia) and Lantana camara. In many areas, drains have been used to dry out aquatic habitats in order to cultivate the floodplain. Overall, this has resulted in more woody vegetation, encroachment by terrestrial vegetation and a loss of aquatic habitat. Reduction in freshwater inflow to estuaries and an increase in the frequency and duration of closed mouth conditions are also threats.

Microalgae have responded positively to increased nutrient loading and concomitant increase in growth of reed habitat, but these effects were somewhat buffered by the fact that the estuaries were fast flowing in their open state.

Alteration and destruction of habitat has resulted in impacts to estuarine invertebrate communities in the systems in the study areas. These have arisen mostly due to development around (and in some case over) estuarine systems. Rail and road infrastructure, urban and sub-urban development has resulted in a loss of reed banks and soft sediment habitat as well as volume of estuarine basins. Changes in hydrology are likely to have had impacts, especially to marine invertebrates, both though reduced connectivity (increased closure and therefore reduced opportunity to recruit into estuaries) and through changes to the salinity regimes in some systems. The alien invasive snail Tarebia granifera has established in many systems and proliferates at the expense of indigenous gastropods. Although unstudied in South Africa, ecosystem impacts are highly likely to occur as a result of the proliferation of this alien species. Little is known of populations of several important invertebrates, such as the sandprawnCallichirus kraussi. Water quality is likely to have played a role in impacting invertebrates in many systems, and certainly to have done so in most estuaries in densely populated urban areas. Small TOCEs that are predominantly closed are especially prone to water quality impacts. Most of these systems exhibit some natural tendency towards depressed oxygen levels in deeper water and this in exacerbated by the influence of increased nutrient input from surrounding land use and WWTWs.

Fish communities have responded to changes in hydrology in some systems because they are sensitive to changes in mouth conditions. Most, if not all of the systems in the study area have experienced loss of estuarine habitat and loss of natural buffer on their perimeters and inflowing rivers. Critical habitat has been lost in some cases, which has resulted in marked reductions in fish diversity and nursery function. In this regard the loss of submerged aquatic vegetation, especially Zostera capensis (Sandlundlu, Umgababa, Sipingo, Durban Bay, and probably others) has undoubtedly played a significant role. In some systems, especially those in high density urban areas and those subject to inflow from WWTWs, water quality is increasing becoming an issue. Fish kills have occurred in recent years in several estuaries in the eThekwini Municipal area (including Durban Bay) and in recent months north of Durban in the Mdlotane. These kills have been related to eutrophication and/or low oxygen events, probably triggered by waste water flows (due to infrastructure failure and/or overloading). In some cases trophic impacts are likely to have manifest with favoured prey items (e.g. sandprawn Callichirus kraussi) either lost or reduced in some systems due to habitat loss, modification or water quality impacts.

Birds are very sensitive to human disturbance with most systems in urban areas having suppressed numbers. This was further exacerbated in some systems by a reduction in food availability and suitable habitat.

RECOMMENDED ECOLOGICAL CATEGORY

The Recommended Ecological Category (REC) represents the level of protection assigned to an estuary. The first step is to determine the 'minimum' EC, based on its PES. The relationship between Estuary Health Index (EHI) Score, PES and minimum REC is set out in Table 2.

Table 2 Relationship between the EHI, PES and minimum REC.

EHI score	PES	Description	Minimum EC
91 – 100	*A*	*Unmodified, natural*	*A*
76 – 90	*B*	*Largely natural with few modifications*	*B*
61 – 75	*C*	*Moderately modified*	*C*
41 – 60	*D*	*Largely modified*	*D*
21 – 40	*E*	*Highly degraded*	*D*
0 – 20	*F*	*Extremely degraded*	*D*

The PES sets the minimum REC. The degree to which the REC needs to be elevated above the PES depends on the level of importance and level of protection or desired protection of a particular estuary (Table 3).

Table 3 Estuary protection status and importance, and the basis for assigning a recommended ecological reserve category (modified from DWA 2008).

Protection status and importance	REC	Policy basis
Protected area	*A or BAS**	*Protected and desired protected areas should be restored to and maintained in the best possible state of health*
Desired Protected Area		
Extremely important (Ranked as 1)	*PES + 1, min B*	*Highly important estuaries should be in an A or B category*
Very Important (Ranked as 2)	*PES + 1, min C*	*Important estuaries should be in an A, B or C category*
Of low to average importance (Ranked as 3-1)	*PES, min D*	*Estuaries to remain in a D category*

** BAS = Best Attainable State*

The Recommended Ecological Category for the Mvoti to Umzimkulu WMA estuaries is listed in Table 4.

Table 4 The Recommended Ecological Categorybased on their importance for the estuaries of the Mvoti to UmzimkuluWMA.

Estuary	Importance(rated 1- 5)						PES	REC
	Conser-vation	National Biodiversity	Regional biodiversity			Overall		
			Macro-phytes	Fish	Birds			
Mtamvuna	5	4	3	4	2	5	B	A or BAS
Zolwane	1	1		3		3	B	B
Sandlundlu	1	2	1	3		3	C	C
Ku-boboyi	1	1		2		2	B	B
Tongazi	1	2		3		3	B	B
Kandandhlovu	1	2	3	3		3	B	B
Mpenjati	5	3	1	3	1	5	B	A or BAS
Umhlangankulu	1	3	2	3		3	C	C
Kaba	1	2	1	3		3	C	C
Mbizana	1	3		3	2	3	B	B

Estuary	Importance(rated 1- 5)						PES	REC
	Conser-vation	National Biodiversity	Regional biodiversity			Overall		
			Macro-phytes	Fish	Birds			
Mvutshini	1	1		3		3	B	B
Bilanhlolo	1	3	2	3		3	C	C
Uvuzana	1	1		3		3	C	C
Kongweni	1	2	2	3		3	D	D
Vungu	1	2		3		3	B	B
Mhlangeni	1	2	1	3		3	C	C
Zotsha	5	3		3		5	B	A/B or BAS
Boboyi	1	2		3		3	B	B
Mbango	1	2		3		3	E	D
Umzimkulu	5	4	5	3	1	5	B	A/B or BAS
uMthente	1	3		3		3	C	C
Mhlangamkulu	1	1	4	3		4	C	C
Damba	5	2	3	3		5	C	A/B or BAS
Koshwana	5	2		3		5	C	A/B or BAS
Intshambili	5	2	1	3	1	5	C	A/B or BAS
Mzumbe	1	3		3	1	3	C	C
Mhlabatshane	5	2	3	3		5	B	A/B or BAS
Mhlungwa	1	2	3	3		3	C	C
Mfazazana	5	3		3		5	C	A/B or BAS
Kwa-Makosi	5	3	1	3		5	B	A/B or BAS
Mnamfu	1	2		3		3	C	C
Mtwalume	1	3		3	1	3	C	C
Mvuzi	1	2		3		3	C	C
Fafa	1	4	3	4	1	4	C	C
Mdesingane	1	1	2	3		3	C	C
Sezela	1	3		3	1	3	C	C
Mkumbane	1	2		3		3	C	C
uMuziwezinto	1	3		3		3	C	C
Nkomba	1	1		1		1	B	B
Mzimayi	1	2		3		3	C	C
Mpambanyoni	1	2		3		3	C	C
Mahlongwa	5	2		3		5	C	A/B or BAS
Mahlongwana	5	3	4	3		5	C	A/B or BAS

Estuary	Importance(rated 1- 5)						PES	REC
	Conser-vation	National Biodiversity	Regional biodiversity			Overall		
			Macro-phytes	Fish	Birds			
uMkhomazi	5	4	5	4	3	5	C	B
Ngane	1	2		3		3	C	C
Umgababa	5	3	4	4		5	C	A/B or BAS
Msimbazi	5	3	1	3	2	5	B	A/B or BAS
Lovu	5	3		3	1	5	C	A/B or BAS
Little aManzimtoti	1	2		3		3	E	D
aManzimtoti	1	3		3	1	3	D	D
Mbokodweni	1	3		3		3	E	D
Sipingo	1	3	5	3	1	5	F	E
Durban Bay	5	5	5	4	5	5	E	D
uMngeni	5	4	5	4	4	5	E	D
Mhlanga	5	4	1	4	2	5	D	B*
uMdloti	1	4	3	4	2	4	D	C*
uThongathi	1	4		3	2	4	D	D*
Mhlali	5	4	2	4	3	5	C	B
Bob' Stream	1	1		1		1	B	B
Seteni	1	2		3		3	B	B
Mvoti	5	3		3	3	5	D	D
Mdlotane	5	4	5	4	1	5	B	A/B or BAS
Nonoti	1	3	3	3		3	C	B
Zinkwasi	5	4	5	3	2	5	B	A/B or BAS

PRIORITY AREAS – HOTSPOTS

Hotspots (priority areas with overall importance) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. In the context used here, a hotspot represents an estuary with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use. 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 monitoring and EWR studies. Following the process described above the thirteen estuaries standout out as hotspots (see Table 5 below).

Table 5 Mvoti to Umzimkulu WMA Estuary hotspots with a 4 rating.

NAME	PES	Ecological Importance (rated 1- 5)	Socio-Cultural Importance (rated 1 - 5)	Water Resource Utilisation (rated 0 - 4)	EWR Status
Kandandhlovu	*B*	*2*	*2.25*	*3*	**Potential focus**
Vungu	*B*	*2*	*2.82*	*3*	EWR done
Zotsha	*B*	*5*	*2.07*	*3*	EWR done
uMkhomazi	*C*	*5*	*2.82*	*4*	**The focus of this study**
Umgababa	*C*	*5*	*2.65*	*3*	**Potential focus**
Sipingo	*F*	*3*	*1.65*	*3*	*Diversions of catchment for airport development*
Durban Bay	**E**	*5*	*2.79*	*4*	*Port, non-flow related Issues*
uMngeni	**E**	*5*	*3.82*	*4*	EWR done
Mhlanga	**D**	*5*	*3.25*	*4*	EWR done
uMdloti	**D**	*4*	*2.72*	*4*	EWR done
uThongathi	**D**	*4*	*2.25*	*4*	EWR done
Mhlali	**C**	*5*	*1.39*	*3*	**Potential focus**
Mvoti	**D**	*5*	*1.32*	*4*	**The focus of this study**

Of these thirteen systems, six (the Vungu, Zotsha, uMngeni, Mhlanga, uMdloti and uThongathi estuaries) have been evaluated as part of previous EWR studies. Durban Bay and the Isipingo estuary are in a very poor condition as a result of major infrastructure developments (port and airport development respectively). It is recommended that remedial action be taken to improve their health status to a D Category preferably via the implementation of the Estuary Management Plans currently being developed under the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008). They are not however seen as top-priority systems for EWR studies in the short term.

Existing and future water resourcedevelopments on the Mvoti and uMkhomazi estuaries are driving their selection as the focus areas for the estuaryassessments. They are presently designated for Intermediate EWR level studies. However, there is some concern that the Mvoti Estuary may already be in an E Category due to water resource development, poor water quality and sand-mining. While this decline in health needs to be addressed it may be possible to identify the required actions in a rapid-level assessment and rather invest the resources (e.g. field investigations) available to the remaining hotspots identified.

Of the remaining estuaries (Mhlali, Umgababa and Kandandhlovu), the Mhlali and Umgababa are deemed the more ecologically important. It is therefore recommended that some of the resources of this study be directed towards these two systems, with the Umgababa the most likely study area for a Rapid EWR assessment. Table 6provides a list of the estuaries that are recommeded for futher EWR investigations as part of this study.

Table 6 Estuaries recommended for further EWR studies.

Estuary	EWR level
Mvoti	*Intermediate*
uMkhomazi	*Intermediate*
Mhlali/ Umgababa	*Rapid*

All of the estuaries listed in Table 7 should be prioritized for monitoring of both abiotic (water levels, inflow, water quality) and biological aspects (microalgae, macrophytes, invertebrates, fish and birds).

Note:

The degree to which this Mvoti to Umzimkulu WMA flow requirement study can address the above listed hotspots is seriously hampered by the lack of long-term monitoring data (e.g. 5 to 10 years of continuous river inflow and water level data) available in the study area. Without the supporting information, critical aspects such as river flow-ranges that determine estuary mouth state and related water quality conditions cannot be resolvedwith any degree of confidence.

Therefore, while all estuaries in the catchment are deemed ecologically and socially significant, and sensitive to water resources development, not all of them are under the same degree of pressure. The relevant government departments are therefore strongly urged to invest in the long-term monitoring programmes required to enable higher-level confidence EWR studies on the systems listed above.

EWR AND RECOMMENDATIONS

Of the 64 estuaries occurring in the WMA, 30% (19 systems) had significant flow related pressures on them, while 78% (50 estuaries) were under significant water quality pressure (Table7). More than 90% (58 estuaries) had under gone significant habitat destruction. All of the estuaries could benefit from some remedial actions and more proactive management of the main vectors of change.

In some of the systems additional water resource development would be possible, as long as the baseflows (low flow regime) are maintained, e.g. the inflowing river can be targeted for off-channel development or runoff river abstraction. The majority of the estuarine catchments in the region are small and linked to temporarily open/closed estuaries that require a high percentage of the natural runoff to maintain their required condition. Any increase or decrease in runoff to this type of system rapidly leads to changes in mouth state and related ecological degradation.

The majority of the estuaries in the WMA close from time to time and are therefore very sensitive to nutrient loading from the catchment or immediate surrounding environment. The assessment of nutrient discharge into estuariesfrom WWTWs should consider the impact on the receiving environment rather than relying on adherence to permitted discharge levels. In the case of estuaries it appears that either general or special standards are applied to the waste water stream and the impact of the associated nutrients and any organic material on the receiving environment in the estuaryappears not to be considered. The small estuaries of the Mvoti to Umzimkulu WMA, during periods of closure, will retain and accumulate nutrients with consequent impacts on water quality, the microalgae and macrophytes, and with cascading ripple effects on all other trophic levels.Therefore neither general nor special standards are sufficient to prevent a deterioration in *overall estuarine health in intermittently open estuaries and the application of a receiving water quality evaluation is advocated when assessing the impacts of discharges on these systems. It is recommended that consideration should be given to the appropriateness of using intermittently open estuaries as conduits for waste water.*

Table 7 Estuaries EWR and recommendations.

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Mtamvuna	*275.19*	*239.49*	*B*	*A or BAS*	**5**				*5-10%*	*Flow modification, water quality, some habitat destruction*
Zolwane	*2.19*	*2.31*	*B*	*B*	**3**					
Sandlundlu	*5.07*	*5.00*	*C*	*C*	**3**			**X**		
Ku-Boboyi	*1.00*	*0.99*	*B*	*B*	**2**					
Tongazi	*7.00*	*7.23*	*B*	*B*	**3**		**X**	**X**		
Kandandhlovu	*1.53*	*1.60*	*B*	*B*	**3**		**X**	**X**		
Mpenjati	*23.61*	*23.55*	*B*	*A or BAS*	**5**		**X**	**X**		*Water quality, habitat destruction*
Umhlangankulu	*2.87*	*2.87*	*C*	*C*	**3**		**X**	**X**		
Kaba	*3.15*	*3.07*	*C*	*C*	**3**		**X**	**X**		
Mbizana	*36.30*	*35.52*	*B*	*B*	**3**			**X**	*<5%*	
Mvutshini	*1.66*	*1.63*	*B*	*B*	**3**		**X**	**X**		
Bilanhlolo	*5.02*	*4.98*	*C*	*C*	**3**		**X**	**X**		
Uvuzana	*1.05*	*1.05*	*C*	*C*	**3**		**X**	**X**		
Kongweni	*1.95*	*2.95*	*D*	*D*	**3**	**X**	**X**	**X**		
Vungu	*27.79*	*28.88*	*B*	*B*	**3**		**X**			
Mhlangeni	*9.29*	*9.56*	*C*	*C*	**3**		**X**	**X**		
Zotsha	*15.74*	*16.25*	*B*	*A/B or BAS*	**5**		**X**	**X**		*Water quality, habitat destruction*
Boboyi	*8.25*	*8.03*	*B*	*B*	**3**		**X**	**X**		

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Mbango	3.00	7.30	E	D	3	X	X	X		Flow modification, very poor water quality, severe habitat destruction
Umzimkulu	1452.49	1199.50	B	A/B or BAS	5				5-10%	Poor water quality, habitat destruction, medium-high fishing pressure
uMthente	12.07	11.14	C	C	3			X		
Mhlangamkulu	2.06	1.73	C	C	4	X		X		
Damba	4.56	3.85	C	A/B or BAS	5	X		X		Flow modification, habitat destruction
Koshwana	2.06	1.96	C	A/B or BAS	5	X	X	X		Flow modification, habitat destruction
Intshambili	6.48	4.86	C	A/B or BAS	5	X	X	X		Flow modification, poor water quality, some habitat destruction
Mzumbe	58.53	53.74	C	C	3		X	X	<5%	
Mhlabatshane	6.46	6.48	B	A/B or BAS	5			X		Significant flow modification, some habitat destruction
Mhlungwa	5.78	5.67	C	C	3		X	X		
Mfazazana	2.77	2.57	C	A/B or BAS	5		X	X		Flow modification, poor water quality, habitat destruction
Kwa-Makosi	3.23	3.03	B	A/B or BAS	5			X		Some habitat destruction
Mnamfu	3.08	2.88	C	C	3		X	X		
Mtwalume	57.60	42.78	C	C	3		X	X	<5%	
Mvuzi	1.65	1.55	C	C	3		X	X		
Fafa	46.45	37.64	C	C	4	X	X	X	<5%	
Mdesingane	2.02	2.02	C	C	3		X	X		

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Sezela	*3.92*	*3.67*	*C*	*C*	**3**		**X**	**X**		
Mkumbane	*3.79*	*3.54*	*C*	*C*	**3**		**X**	**X**		
uMuziwezinto	*23.17*	*20.09*	*C*	*C*	**3**	**X**	**X**	**X**		
Nkomba	*0.69*	*0.69*	*B*	*B*	**1**		**X**	**X**		
Mzimayi	*6.15*	*4.95*	*C*	*C*	**3**	**X**	**X**	**X**		
Mpambanyoni	*60.06*	*54.94*	*C*	*C*	**3**		**X**	**X**	*<5%*	
Mahlongwa	*13.76*	*13.18*	*C*	*A/B or BAS*	**5**		**X**	**X**		*Medium fishing pressure, poor water quality, habitat destruction*
Mahlongwane	*2.69*	*2.93*	*C*	*A/B or BAS*	**5**		**X**	**X**		*Poor water quality, significant habitat destruction*
uMkhomazi	*1077.74*	*926.05*	***C***	*B*	**5**	**X**	**X**	**X**	*5-10%*	*Significant flow modification, poor water quality, habitat destruction*
Ngane	*3.83*	*4.30*	*C*	*C*	**3**		**X**	**X**		
Umgababa	*10.56*	*9.58*	***C***	*A/B or BAS*	**5**	**X**		**X**		*Flow modification, poor water quality, habitat destruction*
Msimbazi	*10.04*	*10.34*	***B***	*A/B or BAS*	**5**		**X**	**X**		*Habitat destruction*
Lovu	*105.84*	*73.46*	***C***	*A/B or BAS*	**5**	**X**	**X**	**X**		*Significant flow modification, poor water quality, habitat destruction*
Little aManzimtoti	*2.84*	*6.62*	**E**	*D*	**3**	**X**	**X**	**X**		*Significant flow modification, poor water quality, habitat destruction*
aManzimtoti	*5.30*	*6.75*	*D*	*D*	**3**	**X**	**X**	**X**		
Mbokodweni	*31.52*	*53.54*	*E*	*D*	**3**	**X**		**X**		*Very significant flow modification, very poor water quality, severe habitat destruction (restoration of the existing mouth and lower reaches of the estuary required).*
Sipingo	*89.85*	*9.48*	*F*	*E*	**5**	**X**	**X**	**X**		*Very significant flow modification, very poor water quality,*

ESTUARY	nMAR*1	pMAR*2	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
										severe habitat destruction
Durban Bay	*36.33*	*63.44*	*E*	*D*	**5**	**X**	**X**	**X**		*High fishing pressure, significant flow reduction, poor water quality, severe habitat destruction (port development), trophic impacts*
uMngeni	*671.30*	*262.68*	***E***	*D*	**5**	**X**	**X**	**X**		*Significant flow modification, very poor water quality, severe habitat destruction*
Mhlanga	*13.34*	*22.33*	***D***	*B**	**5**	**X**	**X**	**X**		*Significant flow modification, poor water quality, habitat destruction*
uMdloti	*85.78*	*71.87*	*D*	*C**	**4**		**X**	**X**		*Flow modification, poor water quality, habitat destruction*
uThongathi	*70.77*	*71.16*	*D*	*D**	**4**		**X**	**X**		*Very poor water quality, severe habitat destruction*
Mhlali	*56.26*	*54.22*	*C*	*B*	**5**		**X**	**X**	*<5%*	*Poor water quality, habitat destruction*
Bob's Stream	*0.53*	*0.53*	*B*	*B*	**1**		**X**	**X**		
Seteni	*1.42*	*1.42*	*B*	*B*	**3**		**X**	**X**		
Mvoti	*420.00*	*314.00*	*D*	*D*	**5**		**X**	**X**	*<5%*	
Mdlotane	*6.04*	*5.85*	*B*	*A/B or BAS*	**5**		**X**			*Water quality, some habitat destruction*
Nonoti	*36.24*	*34.74*	*C*	*B*	**3**		**X**	**X**	*<5%*	*Poor water quality, some habitat destruction*
Zinkwasi	*14.49*	*14.04*	*B*	*A/B or BAS*	**5**		**X**	**X**		*Poor water quality, some habitat destruction*

**1 - nMAR: Natural MAR* **2 - pMAR: Present day MAR*

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ABBREVIATIONS

BAS	*Best Attainable State*
CD	*Chief Directorate*
CD: RDM	*Chief Directorate: Resource Directed Measures*
CPUE	*Catch-per-unit-effort*
CSIR	*Centre of Scientific and Industrial Research*
D:RQS	*Directorate: Resource Quality Services*
DEA: O&C	*Department of Environmental Affairs: Oceans and Coast*
DIN	*Dissolved Inorganic Nitrogen*
DIP	*Dissolved Inorganic Phosphate*
DO	*Dissolved Oxygen*
DRP	*Dissolved Reactive Phosphate*
DRS	*Dissolved Reactive Silicate*
DWA	*Department Water Affairs (Name change applicable after April 2009*
DWAF	*Department of Water Affairs and Forestry*
EC	*Ecological Category*
EcoSpecs	*Ecological Specifications*
EGSA	*Ecological Goods and Services Attributes*
EHI	*Estuarine Health Index*
EI	*Ecological Importance*
EIS	*Estuarine Importance Score*
ERC	*Ecological Reserve Category*
EWR	*Ecological Water Requirement*
H	*High*
IEI	*Integrated Environmental Importance*
IUA	*Integrated Unit of Analysis*
IWRM	*Integrated Water Resource Management*
L	*Low*
M	*Medium*
MAR	*Mean Annual Runoff*
MC	*Management Class*
MCM	*Million Cubic Metres*
MCM/a	*Million Cubic Metres per annum*
MSL	*Mean Sea Level*
NBA	*National Biodiversity Assessment*
NMMU	*Nelson Mandela Metropolitan University*
NWA	*National Water Act (1998)*
PES	*Present Ecological State*
ppt	*Parts per thousand*
PSP	*Professional Service Provider*
REC	*Recommended Ecological Category*
RQO	*Resource Quality Objectives*
RU	*Resource Unit*
RWQO	*Resource Water Quality Objective*
SA	*South Africa*
SCI	*Socio-Cultural Importance*
WARMS	*Water Authorisation and Registration System*

WMA	*Water Management Area*
WRCS	*Water Resource Classification System*
WRUI	*Water Resource Use Importance*
WRYM	*Water Resource Yield Model*

1 INTRODUCTION

1.1 BACKGROUND

There is an urgency to ensure that water resources in the Mvoti to UmzimkuluWater ManagementArea (WMA) are able to sustain their levels of use and be maintained in 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, 2011). 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 UmzimkuluWMA.

The objective of this task was to describe and document the status quo of the 64 estuaries occurring within the Mvoti to Umzimkulu Water Management Area (WMA). This requires that the status quo (Present Ecological Status), importance, and hotspots be identified for all the systems in the WMA. It also requires that the EWRs be addressed for the all the estuaries. Since these processes cannot be addressed at a detailed level for all the systems within the time frames of this study, using the above principles, a process of prioritization had to be followed to determine which of the 64 estuaries must be assessed at higher than desktop levels. The output of this study is therefore that a desktop level of information on EcoClassification is available for all estuaries; including hotspots identified and levels of EWR assessment determined for each estuary. The output of this task will serve as a strategic tool that will guide current and future monitoring requirements, and ultimately EWR determinations.

1.2 STUDY AREA OVERVIEW

The Mvoti to Umzimkulu WMA 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, 2011). The study area is shown in Figure 1.1.

The WMA extends along the KwaZulu-Natal coast from of Zinkwazi in the north to Port Edward in the south. It extends inland to the Drakensberg escarpment to the towns of Underberg and Greytown. 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, uMngeni, uMkhomazi, Umzimkulu and Mtamvuna (DWA, 2011).

Land cover in the catchment is dominated by grasslands and undeveloped rural land use. Urban land use in the WMA is concentrated along the coast from Umhlanga Rocks in the north to Port Edward in the south and the metropolitan areas of Durban and Pietermaritzburg. Agricultural (sugar cane farming) is predominant along the coast (Tongaat to Stanger) and intermittent in the interior. Forestry is practiced in the vicinity of Greytown to Howick, Richmond and the southeastern portion of the WMA. Indigenous forests and wetlands are sparsely distributed across the WMA (DWA, 2011).

Figure 1.1 The Mvoti to UmzimkuluWater Management Area (from DWA, 2011).

As is the case over the wider South Africa water resources in the Mvoti to Umzimkulu WMA are increasingly stressed due to an accelerated rate of development and changing weather patterns resulting in the scarcity of water (DWA, 2011). The importance of the water resources in the Mvoti to UmzimkuluWMA is best illustrated by the high level of water stress currently being experienced in the area due to the water use being substantially more that the long-term sustainable yields of the resources (DWA, 2010a).

1.3 ASSUMPTIONS AND LIMITATIONS FOR THIS STUDY

The following assumptions and limitations should be taken into account:

1. *The accuracy and confidence of an Estuarine Ecological Water Requirements study are strongly dependent on the quality of the hydrology information. The overall confidence in the hydrology data supplied to the estuarine study team is of a medium level (60-80), with a particular concern regarding the accuracy of the simulated base flows during the low flow periods into each estuary (Confidence = Low).*

2. *The degree to which the Mvoti to Umzimkulu WMAEstuary EWR study can address the objectives of the overall Mvoti to Umzimkulu WMA study is seriously constrained by the lack of long-term monitoring data (e.g. 5 to 10 years of continuous river inflow and water level data) available in the study area. Without supporting information, critical aspects such as river flow ranges that drive estuary mouth states and related water quality conditions cannot be resolved to any degree of confidence.*

1.4 REPORT STRUCTURE

Chapter 1: Introduction
This chapter provides the background and an overview of the study area.

Chapter 2: Method
Chapter 2 explains the approach taken in delineating the 64 estuaries of the Mvoti to Umzimkulu WMA. It also provides detail on the determination of the Present Ecological State, Estuary Importance, Recommended Ecological Category, Socio-Cultural Importance, Water Resource Use, and Priority estuaries or Hotspots.

Chapter 3: Baseline Description and Health Assessment
This section provides the detailed findings on the Present Ecological State of the estuaries in this WMA.

Chapter 4: The Recommended Ecological Category
This chapter highlights the national and regional conservation and biodiversity importance of the estuaries in the Mvoti to Umzimkulu WMA. The Recommended Ecological Category is then determined for the individual system based on its ecological importance.

Chapter 5: Socio-Cultural Importance
This section describes the Socio-Cultural Importance of the individual estuaries in the region based on their ritual use, aesthetic value, resource dependence, recreational use and historical/cultural value.

Chapter 6: Water Resource Use Importance
This chapter describes the Water Resource Use Importance of the individual estuaries in the region, by considering their current water balance of the catchment contributing to river flow, operational purposes, future development and water use, and river and dam water quality.

Chapter 7: Priority estuaries – Hotspots
Chapter 7 highlights the priority estuaries, also called Hotspots, for monitoring and EWR studies in the region, considering their PES, Ecological and Socio-Cultural Importance within the context of their Water Resource Use Importance.

Chapter 8: EWR Recommendations
This section summarises the remedial actions required to improve the condition of individual system as well the monitoring requirements to improve confidence in future studies.

2 METHOD

2.1 DESKTOP ESTUARY ASSESSMENT APPROACH

The desktop estuary assessment method is used as basis for the identification of hotspots and determination of different levels of estuary EWR assessment. Apart from the role this will play in this study, the results of the desktop study will also be useful for strategic planning, scoping exercises, and for determining the level of EWR assessment for licenses. The methodology consists of various methods and tools. The process used is described in Figure 2.2.

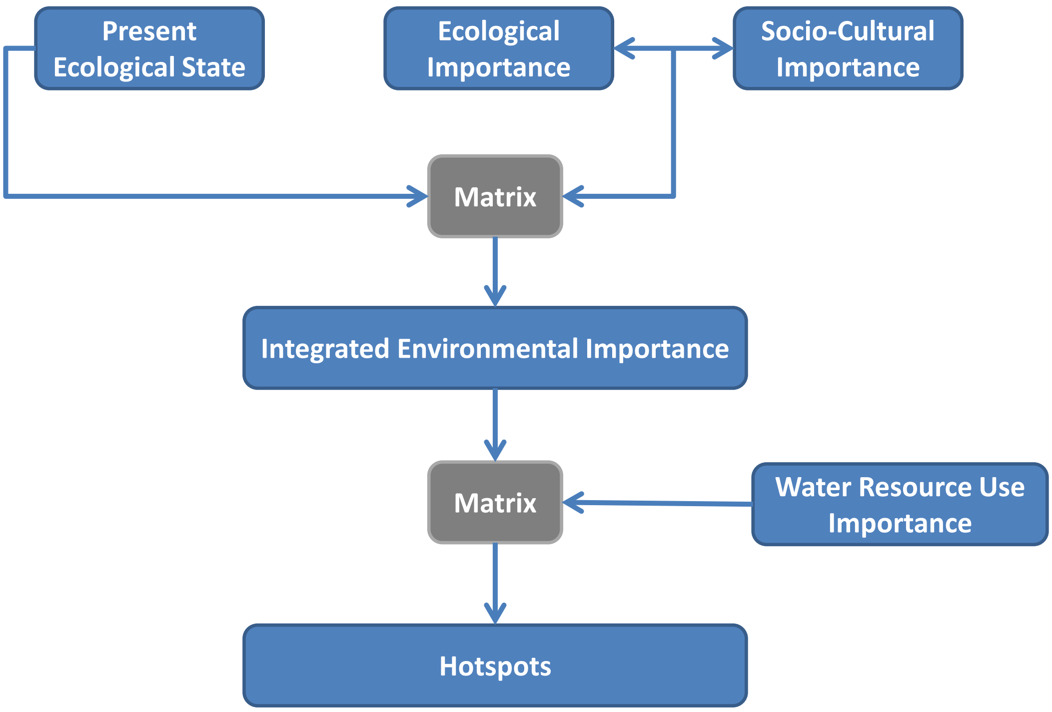

Figure 2.1 Summary of the process to identify estuary hotspots for monitoring and EWR assessments.

This study starts with the delineation of the 64 estuaries of the Mvoti to Umzimkulu WMA. This is followed by the assessment of the Present Ecological State of the individual estuaries in this WMA. This is then followed by the determination of the Recommended Ecological Category system based on their ecological importance.

In addition the Socio-Cultural Importance of the individual estuaries in the region is established based on their ritual use, aesthetic value, resource dependence, recreational use and historical/cultural value. The Integrated Environmental Importance is then evaluated based on the Ecological and Socio-Cultural importance of the individual system integrated with their PES. The PES forms part of the Integrated Environmental Importance as estuaries in good condition are important in their own right as they assist in achieving national biodiversity targets. The Water Resource Use Importance of the individual estuaries in the region is also established, considering current water balance of catchments contributing to river flows, operational purposes, future development and water use, and river and dam water quality.

In the final step the priority estuaries, also called Hotspots (important reservoirs of biodiversity threatened with destruction), is determined based on their Integrated Environmental Importance *within the context of the Water Resource Use Importance. The different tools and methods used explained in the following sections in this chapter.*

2.2 LOCATION AND DELINEATION OF MVOTI TO UMZIMKULU WMA ESTUARIES

Over longer time scales the total area occupied by the various estuarine habitat types tends to remain more or less constant, while the actual spatial location of the various estuarine habitats is highly likely to change between resetting events (e.g. larger floods). This relatively ephemeral nature of estuarine habitat presents an assessment and planning challenge. Water resource protection requires the delineation of the geographical boundaries of the resource. In order to do this it is important to define the space within which estuaries function to ensure their present and future health.

Mapping was undertaken of nearly 300 functional estuarine systems along the South African coastline as part of the NBA 2011. For each estuary the estuarine functional zone (estuarine ecosystem area) and open water areas were digitized using Spot 5 imagery (2008) and Google Earth. For the most part the images were relatively cloud free, but where cloudy conditions occurred on SPOT 5 images, Google images were used. The lateral boundaries included all the associated wetlands, intertidal mud and sand flats, beaches and foreshore environments that are affected by riverine or tidal flood events (Edgar, 2000).The 5 m topographical contour (obtained from Chief Directorate Surveys and Mapping) was used as the boundary to delineate the estuarine functional zone. Where the 5 m contour was not available in digital format, orthophotos (1:10 000) were scanned, georeferenced and the 5 m contour was digitized. From the estuarine functional zone delineation, spatial data such as area, length and perimeter (estuary coastline) and distance to the next system could be inferred.

The estuary mouth was taken as the downstream boundary of an estuary or, where the mouth was closed, the middle of the sand berm between the open water and the sea. The upstream boundary was determined as the limits of tidal variation or salinity penetration, whichever penetrates furthest up the system. This is in line with recent scientific studies and the administrative definition of a South African estuary (DWAF 2008).

Wherever possible the upstream boundary was derived from the literature, expert judgment or field observations. In a number of systems no data were available and the upper boundary was taken as the 5 m topographical contour (bearing in mind that the tidal range in South Africa is microtidal (< 2 m) and sand bars at closed estuary mouths can sometimes build up as high as + 4.5 m Mean Sea Level (MSL). The upper boundaries were also screened against other existing spatial delineations, e.g. the KwaZulu-Natal Estuaries database (Version 1.00.02) and the delineation developed for Durban estuaries (Forbes and Demetriades 2008) with preference given to data from the larger scale studies. Spatially, files were converted to GoogleEarth (KMZ formats) and reviewed during the desktop health for comment. Systems that need additional ground truthing were identified.

Appendix A (Table 10.1) provides the positions of the Mvoti to Umzimkulu WMA estuaries outlets (mouths). The lateral boundaries were taken as the 5 m contour above Mean Sea Level (MSL) along each bank.

2.3 PRESENT ECOLOGICAL STATE

The Mvoti to UmzimkuluWMA Estuarine Health Assessment was conducted as a desktop procedure during which a regional team of specialists, covering the full suite of disciplines, evaluated estuary health based on the general characteristics of the estuaries. The method used was a standardized approach developed for determining the ecological water requirements of South Africa's estuaries which has been applied to about 30 systems along the coast and applied in the National Biodiversity Assessment in 2009 (Van Niekerk and Turpie, 2012). All the specialists that contributed to the assessment were familiar with the Estuarine Health Index from previous DWA studies.

The health condition (also called the Present Ecological State (PES)) of an estuary is typically defined on the basis of current condition (i.e., the extent to which it differs from its reference or natural condition). Based on the above, estuary condition is described using six Ecological Categories (EC), ranging from natural (A) to critically modified (F) (Table 2.1). The fact that the physical conditions in estuarine systems are more dynamic than those of other aquatic ecosystems means that severe degradation of an estuary may involve a shift from a dynamic to a more stable, or unidirectional, system. This means that the loss of dynamic function per se is an important indication of declining estuarine health (DWAF 2008). Thus, in an estuarine health assessment, measures of these different states need to be sufficiently robust so that different practitioners/disciplines will arrive at the same categorisation.

Table 2.1 Ecological Categories (DWAF 2008).

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

The Estuarine Health Index was calculated through consideration of the following components (DWAF 2008):

A. Abiotic	B. Biotic
• *Hydrology (% change in MAR)* • *Hydrodynamics and mouth condition* • *Water chemistry (salinity and combined score for other variables)* • *Sediment processes*	• *Microalgae* • *Macrophytes* • *Invertebrates* • *Fish* • *Birds*

The assessment was undertaken by a multidisciplinary group of estuarine scientists in a workshop setting, based on their collective understanding of the likely impacts affecting each system. Expert knowledge and available information were all used to build a "picture" of the probable pristine state of each estuary and the changes under current conditions. The Estuarine Health Index is applied to all levels of ecological water requirement studies (comprehensive, intermediate or rapid), with only the level of information supporting the study and level of confidence varying. For each variable the conditions are estimated as a percentage (0 – 100%) of the pristine health. Scores are then weighted and aggregated so that the final score reflects the present health of the estuary as a percentage of the pristine state (Figure 2.1). Both abiotic and biotic variables are included as the relationships between the abiotic and biotic variables are often not well understood and because the biotic response to certain abiotic variables can be lagging.

For comparative reasons (with previous assessments) the individual health scores were aggregated as illustrated in Figure 2.2 and Table 2.2. In estuaries, unlike the terrestrial environment, degradation or loss of habitat seldom means a complete loss of system health or function. This can only happen if an estuary becomes completely degraded, e.g. changed into a parking lot or golf course. In most cases, degradation means loss of processes or loss of biological functionality, e.g. the estuarine space is filled with a different salinity condition or different species composition. This loss of functionally happens on a continuum, with estuaries which retain more than 90% of their natural processes and pattern being rated as Excellent and estuaries degraded to less of 40% of natural functionality rated as Poor.

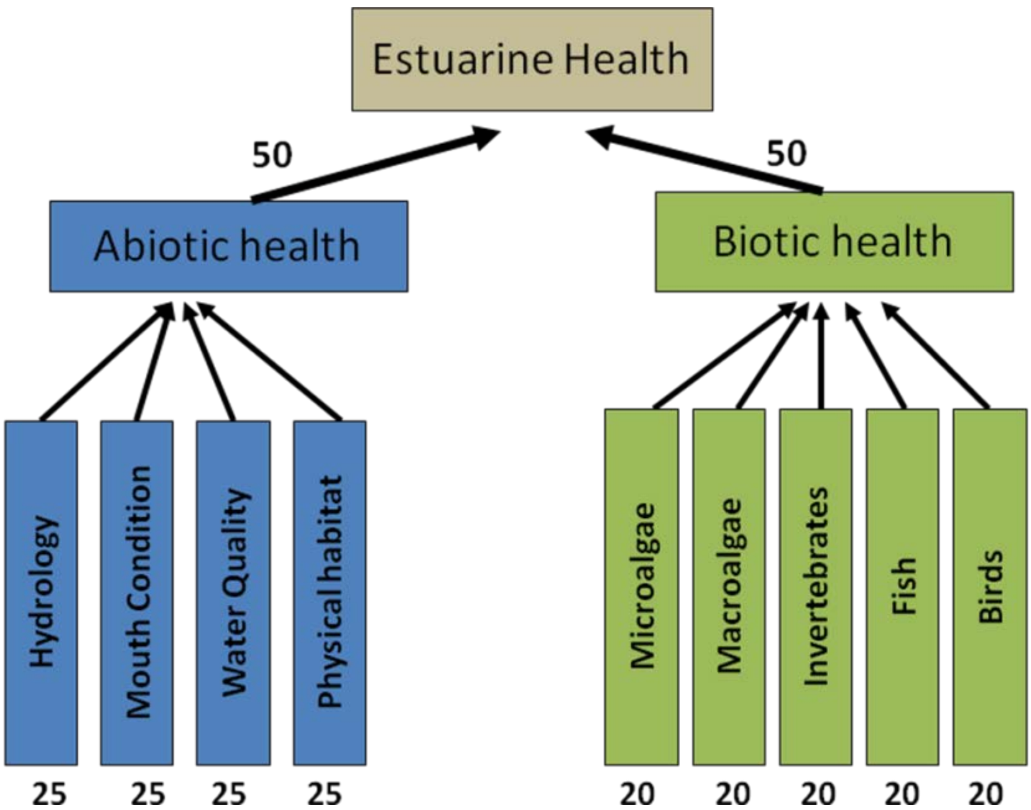

Figure 2.2 Components and weightings of the Estuarine Health Index (DWAF 2008).

Table 2.2 Schematic illustration of the relationship between loss of ecosystem condition and functionality.

Condition	≥91%	90-75	75 - 61	60 - 41	40-21	≤20
Category	A Natural	B Largely natural with few changes	C Moderately modified	D Largely modified	E Highly degraded	F Extremely degraded
State	Excellent	Good	Fair		Poor	
Functionality	Retain Process & Pattern (representation)		Loss of Process or Pattern		No Process & Pattern	

2.4 RECOMMENDED ECOLOGICAL CATEGORY

The Recommended Ecological Category (REC) represents the level of protection assigned to an estuary. The first step is to determine the 'minimum' EC, based on its PES. The relationship between Estuary Health Index (EHI) score, PES and minimum REC is given in Table 2.3.

Table 2.3 Relationship between the EHI, PES and minimum ERC

EHI score	PES	Description	Minimum EC
91 – 100	*A*	*Unmodified, natural*	*A*
76 – 90	*B*	*Largely natural with few modifications*	*B*
61 – 75	*C*	*Moderately modified*	*C*
41 – 60	*D*	*Largely modified*	*D*
21 – 40	*E*	*Highly degraded*	-
0 – 20	*F*	*Extremely degraded*	-

Thus PES sets the minimum REC. The degree to which the REC needs to be elevated above the PES depends on the level of **importance** *and level of* **protectionor desired** *protection of a particular estuary (Table 2.4).*

Table 2.4 Estuary protection status and importance, and the basis for assigning a recommended ecological reserve category (modified from DWA 2008).

Protection status and importance	REC	Policy basis
Protected area	*A or BAS**	*Protected and desired protected areas should be restored to and maintained in the best possible state of health*
Desired Protected Area		
Extremely important (Ranked as 1)	*PES + 1, min B*	*Highly important estuaries should be in an A or B category*
Very Important (Ranked as 2)	*PES + 1, min C*	*Important estuaries should be in an A, B or C category*
Of low to average importance (Ranked as 3-1)	*PES, min D*	*Estuaries to remain in a D category*

* *BAS = Best Attainable State*

2.5 INTEGRATED ENVIRONMENTAL IMPORTANCE

2.5.1 Ecological Importance and Sensitivity

The ecological importance of an estuary is an expression of its importance to the maintenance of biological diversity and ecological functioning on a regional, national or global scale. Ecological sensitivity (or resilience) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Resh et al., 1988; Milner, 1994). Both abiotic and biotic components of each estuary were taken into consideration in the assessment. These were then ranked based on their expected importance, condition and dependence on the estuaries.

2.5.2 Socio-Cultural Importance

The Socio-Cultural Importance (SCI) was generated by evaluating each estuary based on its ritual use, aesthetic value, resource dependence, recreational use, historical/cultural value. Scores were then adjudged to reflect the importance of each component relative to the other. In the model the following mechanism for arriving at the final score was adopted with a relative weighting for the importance within the context of the catchment. "Ritual Use" had 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.

2.5.3 Integrated Environmental Importance Assessment

As described above, the Ecological and Socio-Cultural importance were assessed separately and then integrated with the PES to determine the Integrated Environmental Importance. The PES forms part of the Integrated Environmental Importance because estuaries in good condition are important in their own right as they assist in achieving national biodiversity targets. An estuary that is in very good condition, but of low ecological, and/or SCI; might still be important from an ecological perspective, as it could be one of a limited number of that estuary ecosystem type that is in good condition.

The Integrated Environmental Importance also provides an indication of the restoration potential. Restoration potential refers to the probability of achieving rehabilitation of the estuary to an improved state. For example, if an estuary 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 was used to integrate it with the PES. A matrix (Table 2.5) to aid in consistently providing an integrated rating comparing EIS, SCI, and PES was designed during 2006 (Louw and Huggins, 2007) and modified for this study to automate the process and thereby produce more consistent answers.

Table 2.5 Matrix used to determine a combined EIS/SCI and PES value which provides an Integrated Environmental Importance value.

EI-ES&SCI (max)								
	Very high	5	3	3	4	5	5	
	High	3-3.99	3	3	3	5	5	
	Moderate	2-2.99	2	2	3	4	5	
	Low	1-1.99	1	1	2	4	4	
	Very low	0-0.99	1	1	2	3	4	
			E/F	D	C	B	A	Category
			PES					

2.6 WATER RESOURCE USE IMPORTANCE

The water resource use rating system guides the selection of estuaries for monitoring and EWR determinations. The study will use the assigned water resource use rating in conjunction with a rating of the ecological importance to select the location and define the Ecological Water Requirement determination method for each site.

The priority rating method consists of assigning a qualitative score to a river reach just above an estuary for four variables or factors that represent the status of the in-stream flow. The scores of the four variables are combined to determine an overall score in conjunction with the quality and confidence of the data on which the score is based. The scoring will represent the importance of the river reach in terms of the water resource use and guide the selection of the EWR determination method to be applied. The variables or factors included in the rating method aim to represent the status and function of the river reach.

In support of developing scoring values per river stretch, all available information and data per quaternary catchment related to water use, operations, development and quality considerations are summarized in a table. The following types of information are typically used to support the scoring (depending on the detail provided by the sources study) of quaternary catchment and river stretches:

Current water balance of catchment contributing to flow:

- *Date of present day use*
- *Area of SFR, irrigation and farm dams as percentage of quaternary area*
- *Estimated Natural MAR*
- *Estimated Present Day MAR*
- *Total Present Day Use (Surface Water)*
- *Total Present Day Use (Groundwater)*
- *Estimated Natural MAR Reduction to present MAR*

Operational Purposes:

- *Large dams*
- *Number of existing large upstream dams*
- *Major release made from dams to support d/s users and system*
- *Size of influence on natural flows*

Future development and water use:

- *Future development type*
- *Likelihood of happening*

- *Perceived impact*

River and Dam Water Quality

- *Major industry and towns*
- *Known and size of SW water quality problems*
- *Known and size of GW water quality problems*
- *Observed SW TDS*

2.7 PRIORITY ESTUARIES – HOTSPOTS

A biodiversity/ecological hotspot is a biogeographic region which is a significant reservoir of biodiversity which is threatened with destruction (Myers, et al, 2000). In the context used here, a hotspot represents an estuary with a high ecological importance which could be under threat due to its water resource use. The hotspots are therefore an indication of areas where monitoring and/or 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.

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, in this case an individual estuary, be nested within the IUAs (DWA, 2007b). The hotspot identification provides an indication of monitoring intensity and the level of EWR assessment required at each biophysical node. In essence, this is a filtering process where the detailed monitoring and assessment is prioritised at the hotspots.

The purpose of the identification of estuary hotspots for this study was the following:

- *To provide an indication where monitoring (especially long-term river inflow and water level recoding data needs to be collected) needs to be prioritised.*
- *To provide guidance to levels of EWR 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 steps used to identify the priority areas (hotspots) were:

- *Desktop EcoClassification which included the determination of the Present Ecological State (PES), the Ecological Importance, and the Socio-Cultural Importance (SCI).*
- *Determination of the Integrated Ecological Importance (IEI) by incorporating the PES, Ecological Importance, and the SCI.*
- *Determining the Water Resource Use Importance (WRUI).*
- *Identification of the estuaries which were priority hotspots based on of high IEI and/or WRUI.*
- *Provide recommendations for the locality of detailed monitoring and EWR studies.*

Hotspots (priority areas with overall importance) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. In the context used here, a hotspot represents an estuary with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use. 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 monitoring and EWR studies.*

A matrix was used to guide the consistent identification of hotspots (Table 2.6) (modified from Louw and Huggins, 2007). The Y-axis is based on the Integrated Environmental Importance value derived from the first matrix (Table 2.5). 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 more detailed investigations and monitoring and this specific Management Resource Unit would represent a hotspot.

Table 2.6 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								

2.8 DEFINITION OF CONFIDENCE LEVELS

The level of available historical data in combination with the level of effort expended during the assessment determines the level of confidence of the study. Three levels of study have been recognised in the past in terms of the effort expended during the assessment – rapid (low confidence), intermediate (medium confidence) and comprehensive (high confidence). In this study, effort lay somewhere between a low and medium confidence study, in that very limited historical field data were available that would allow for the correlation between river inflow, mouth state and water quality parameters. Therefore the confidence of the study is low. This is a situation that can only be remedied with some comprehensive and long-term data collection on the system. Criteria for the confidence limits attached to statements in this study are shown in Table 2.7.

Table 2.7 Confidence levels for an Estuarine EWR study (DWA 2008).

Confidence level	Situation	Expressed as percentage
Low	*If no data were available for the estuary or similar estuaries*	*< 40 certainty*
Medium	*If limited data were available for the estuary or other similar estuaries*	*40 – 80% certainty*
High	*If sufficient data were available for the estuary*	*> 80% certainty*

3 BASELINE DESCRIPTION AND HEALTH ASSESSMENT

3.1 PRESENT ECOLOGICAL STATE (PES)

The assessment of present ecological state clearly shows the footprint of urbanisation on the estuaries (Table 3.1). In most cases inflowing-hydrology is still in relatively good condition. Exceptions include urbanised systems where WWTWs have elevated base flows significantly. The hydrodynamics (Mouth State) and salinity distributions therefore show a similar pattern.

In contrast to the hydrology, the water quality in a large number of estuaries in this WMA has been modified significantly. This is largely attributed to diffuse agricultural runoff in rural areas (e.g. fertilizers, herbicides and pesticides) and contaminated stormwater runoff from urban development (e.g. nutrients and toxic substances). In some estuaries, water quality has been compromised by point source WWTW effluent being discharged into estuaries or into rivers near the head of estuaries. With the exception of the larger fast-flowing estuaries (e.g.the Mtamvuna, uMkhomazi, uMngeni and Umzimkulu) most systems along this stretch of coast are relatively small with a very high vulnerability to increased nutrient loading. It should also be noted that while the overall waterquality condition score for Durban Bay was relatively good this is largely as a result of tidal flushing of the lower reaches of this system. Important estuarine habitats (mangroves, mud and sand banks) in this Bay occur in the upper reaches however, and these are subject to reduced flushing and direct impacts of very poor water quality inflows from surround urban areas. In addition to the historic and ongoing physical alteration and destruction of habitat due to port development, water quality in these regions of the Bay significantly threatens ecological integrity.

Generally urbanisation has led to significant habitat modification. Road and rail infrastructure have to some extent impacted every system along this stretch of coast. Most estuaries have one or two large bridges across them. Bridge foundations and abutments, road and rail berms have led to infilling of systems and consequentialhabitat destruction, or development across floodplain and channel stabilisation has impacted natural flow patterns have resulted in localised scour and deposition. Durban Bay, now an operational port, also stands out as a highly transformed estuary. The size of this system and its remaining ecological function however, still render this Bay an important estuarine resource. Sugar cane farming along the banks of a large number of systems has led to infilling of floodplains and general constriction of tidal flows as well as large scale loss of marginal vegetation and natural estuarine buffers. Catchments of estuaries in Tribal Trust areas are also subjected to increased poor agricultural practise, overstocking and increased sediment loads contributing to sedimentation in estuaries.

Macrophytes, in most cases, also reflected the effect of urbanisation, with a significant number of systems showing signs of severe degradation of floodplain vegetation. The effect of nutrient enrichment was clearly evident in reed encroachment in a number of systems. In most cases there was also a significant loss of habitat due to the presence of bridge abutments and berms.

Increased stormwater and nutrient input from wastewater treatment has caused eutrophication. Emergent species thrive under these conditions and invasive aquatic macrophytes such as water hyacinth (Eicchornia crassipes) and water cabbage (Pistia stratiotes) outcompete indigenous plants. Disturbed floodplain areas and riparian zones have been invaded by Brazilian pepper tree (Schinusterebinthifolia) and Lantanacamara. In many areas, drains have been used to dry out aquatic habitats in order to cultivate the floodplain. Overall, this has resulted in woodier vegetation, encroachment by terrestrial vegetation and a loss of aquatic habitat. Reduction in freshwater *inflow to estuaries and an increase in the frequency and duration of closed mouth conditions is also a threat.*

Microalgae have responded positively to increased nutrient loading and concomitant increase in growth of reed habitat, but these effects were somewhat buffered by the fact that the systems were fast flowing in their open state.

Alteration and destruction of habitat has resulted in impacts to estuarine invertebrate communities in the systems in the study areas. These have arisen mostly due to development around (and in some case over) estuarine systems. Rail and road infrastructure, urban and sub-urban development has resulted in loss of reed banks and soft sediment habitat as well as volume of estuarine basins. Changes in hydrology are likely to have had impacts, especially to marine invertebrates, both though reduced connectivity (increased closure) and therefore reduced opportunity to recruit into estuaries, and through changes to the salinity regimes in some systems. The alien invasive snail Tarebia granifera has established in many systems and proliferates at the expense of indigenous gastropods. Although unstudied in South Africa, ecosystem impacts are highly likely to occur as a result of the proliferation of this alien species... Little is known of populations of several important invertebrates, such as thesandprawn Callichirus kraussi. Water quality impacts are likely to have played a role in invertebrates in many systems, and certainly to have in most estuaries in densely populated urban areas. Small TOCEs that are predominantly closed are especially prone to water quality impacts. Most of these systems exhibit some natural tendency towards depressed oxygen levels in deeper waters and this in exacerbated by the influence of increased nutrient inputs from surrounding land use and WWTWs.

Fish communities have responded to changes in hydrology in some systems, being sensitive to changes in mouth conditions. Most, if not all of the systems in the study area have experienced loss of estuarine habitat and loss of natural buffer on their perimeters and inflowing rivers. Critical habitat has been lost in some cases, which has resulted in marked reductions in fish diversity and nursery function. In this regard the loss of submerged aquatic vegetation, especially Zostera capensis (Sandlundlu, Umgababa, Sipingo, Durban Bay, and probably others) has undoubtedly played a significant role. In some systems, especially those in high density urban areas and those subjected to inflow from WWTWs, water quality is increasing becoming an issue. Fish kills have occurred in recent years in several estuaries in the eThekwini Municipal area (including Durban Bay) and in recent months north of Durban in the Mdlotane. These kills have been related to eutrophication and/or low oxygen events, probably triggered by waste water flows (due to infrastructure failure and/or overloading). In some cases trophic impacts are likely to have manifest with favoured prey items (e.g. sandprawn Callichirus kraussi) either lost or reduced in some systems due to habitat loss, modification, or water quality impacts.

Birds were very sensitive to human disturbance with most systems in urban areas showing suppressed numbers. This was further exasperated in some systems by a reduction in food availability and suitable habitat.

Table 3.1 Present ecological state of the estuaries.

IUA Code	Name	Hydrology	Hydrodynamics	Water Quality	Physical habitat	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Score	EHI SCORE
T40E-05869	*Mtamvuna*	B	A	A	B	B	B	B	C	C	B	B	B
T40F-05953	*Zolwane*	A	A	A	A	A	A	B	B	C	B	B	B
T40F-05923	*Sandlundlu*	A	A	B	C	B	B	C	D	E	D	D	C
T40F-05928	*Ku-Boboyi*	A	B	B	B	B	B	B	B	C	C	B	B
T40F-05879	*Tongazi*	A	A	B	B	B	B	C	D	C	C	C	B
T40F-05884	*Kandandhlovu*	A	B	C	C	B	B	C	D	C	C	C	B
T40F-05770	*Mpenjati*	A	A	B	D	B	B	C	D	D	B	C	B
T40F-05839	*Umhlangankulu*	A	A	D	D	C	C	D	E	D	C	D	C
T40F-05820	*Kaba*	A	A	C	C	B	B	C	C	D	C	C	C
T40F-05666	*Mbizana*	A	A	B	C	B	B	C	C	C	B	B	B
T40G-05773	*Mvutshini*	A	B	C	B	B	B	C	C	C	C	C	B
T40G-05722	*Bilanhlolo*	A	A	C	D	B	C	D	D	D	D	D	C
T40G-05768	*Uvuzana*	A	A	C	C	B	B	C	D	D	D	C	C
T40G-05739	*Kongweni*	E	E	D	D	D	E	E	D	D	D	D	D
T40G-05616	*Vungu*	B	A	C	B	B	C	B	C	C	C	C	B
T40G-05644	*Mhlangeni*	B	B	C	D	C	C	D	D	D	C	C	C
T40G-05577	**Zotsha***	B	C	C	B	B	B	C	C	B	B	B	B
T40G-05573	*Boboyi*	B	A	B	C	B	B	C	C	C	C	C	B
T40G-05611	*Mbango*	D	D	D	D	D	D	E	F	F	D	E	E
T52M-05547	*Umzimkulu*	B	B	C	C	B	B	B	C	B	B	B	B
U80A-05470	*uMthente*	B	B	B	D	B	B	D	C	D	C	C	C
U80A-05527	*Mhlangamkulu*	D	C	B	C	C	C	D	C	D	C	C	C
U80A-05461	*Damba*	D	D	B	D	C	C	C	C	D	C	C	C
U80A-05496	*Koshwana*	D	C	C	D	C	C	C	C	D	C	C	C
U80A-05456	*Intshambili*	D	C	C	C	C	C	C	C	C	C	C	C
U80C-05448	*Mzumbe*	B	B	C	D	C	C	E	D	D	E	D	C
U80D-05375	*Mhlabatshane*	A	A	B	C	B	B	D	C	C	C	C	B
U80D-05361	*Mhlungwa*	A	A	B	E	B	B	E	D	D	C	C	C
U80D-05374	*Mfazazana*	B	C	C	D	C	C	D	D	D	C	C	C
U80D-05345	*Kwa-Makosi*	B	B	B	C	B	B	C	C	C	C	C	B
U80D-05327	*Mnamfu*	C	C	C	C	C	C	C	D	D	C	C	C
U80F-05270	*Mtwalume*	B	C	C	C	C	C	C	D	D	D	C	C
U80G-05302	*Mvuzi*	B	C	C	D	C	C	C	C	C	C	C	C
U80G-05097	*Fafa*	C	B	C	D	C	C	D	D	D	D	C	C
U80H-05229	*Mdesingane*	A	A	C	D	B	C	E	E	E	D	D	C
U80H-05202	*Sezela*	B	B	C	D	C	C	C	D	D	D	C	C
U80H-05186	*Mkumbane*	B	B	C	C	B	C	D	D	D	D	D	C
U80H-05109	*uMuziwezinto*	C	B	C	D	C	C	D	D	D	D	D	C
U80H-05120	*Nkomba*	A	A	C	C	B	C	C	B	B	C	B	B
U80H-05120	*Mzimayi*	C	B	C	C	C	C	C	D	C	C	C	C
U80K-04952	*Mpambanyoni*	B	A	B	D	B	B	D	D	D	D	D	C
U80L-05020	*Mahlongwa*	B	A	B	D	B	B	D	C	D	D	C	C

IUA Code	Name	Hydrology	Hydrodynamics	Water Quality	Physical habitat	Habitat Score	Microalgae	Macrophytes	Invertebrates	Fish	Birds	Biological Score	EHI SCORE
U80L-05056	*Mahlongwane*	B	A	C	D	B	C	D	B	C	C	C	C
U10M-04746	*uMkhomazi*	C	A	C	D	C	C	D	C	D	D	C	C
U70E-05010	*Ngane*	B	B	C	D	C	C	D	D	D	D	D	C
U70E-04974	*Umgababa*	C	B	B	C	B	B	D	D	D	B	C	C
U70E-04942	*Msimbazi*	A	A	B	C	B	B	C	B	C	B	B	B
U70D-04905	*Lovu*	D	C	C	D	D	C	D	C	C	C	C	C
U70F-04893	**Little aManzimtoti***	D	F	E	B	D	F	D	F	F	D	E	E
U70F-04845	*aManzimtoti*	C	C	E	D	D	D	E	F	F	E	E	D
U60E-04792	**Mbokodweni***	C	E	E	D	D	D	E	F	E	F	F	E
U60E-04827	**Sipingo***	F	F	F	F	F	F	E	F	F	F	F	F
U60F-04684	*Durban Bay*	F	A	B	F	D	B	F	F	F	F	E	E
U20M-04543	**uMngeni***	D	B	E	E	D	D	F	F	F	E	E	E
U30B-04498	**Mhlanga***	D	E	D	D	D	D	C	E	E	D	D	D
U30B-04475	**uMdloti***	B	C	E	C	C	F	E	F	E	F	E	D
U30D-04315	**uThongathi***	A	A	F	D	C	C	E	E	E	F	E	D
U30E-04207	*Mhlali*	B	B	C	D	C	C	D	C	D	D	C	C
U30E-04256	*Bob's Stream*	A	A	C	D	B	B	C	B	B	C	B	B
U30E-04256	*Seteni*	A	A	B	D	B	B	C	B	B	C	B	B
U40J-03998	*Mvoti*	C	B	E	D	C	D	D	F	D	F	E	D
U50A-04141	*Mdlotane*	A	A	B	B	B	B	B	B	C	B	B	B
U50A-04021	*Nonoti*	B	A	D	C	B	C	D	D	F	D	D	C
U50A-04018	*Zinkwasi*	A	A	B	*C*	B	B	C	B	B	D	C	B

***Determined with an Ecological Water Requirement study**

****Mvoti based on historical EFR flow information**

4 THE RECOMMENDED ECOLOGICAL CATEGORY

4.1 CONSERVATION IMPORTANCE OF THE MVOTI TO UMZIMKULU WMA ESTUARIES

The National Biodiversity Assessment 2011 (NBA 2011) (Van Niekerk and Turpie, 2012; Turpie et al. 2012) developed a biodiversity plan for the estuaries of South Africa by prioritising and establishing which of them should be assigned partial or full Estuarine Protected Area (EPA) status. This biodiversity plan followed a systematic approach that took pattern, process and biodiversity persistence into account. While the plan has not explicitly taken social and economic costs and benefits into consideration, it used ecosystem health as a surrogate for the former to some extent. This is because estuaries where the opportunity costs of protection are likely to be high are also likely to be heavily-utilised systems that are in a lower state of health.

The plan indicates that, on a national scale 133 estuaries (61 require full protection and 72 require partial protection) including those already protected, would be required to meet biodiversity targets (Turpie et al.2012). Of these, 21 fall within Mvoti to Umzimkulu WMA, with a subset of six estuaries requiring full protection (see Table 4.1 for more detail).

Fullyprotected estuaries are taken to be full no-take areas. Partial protection might involve zonation that includes a no-take area, or it might address other pressures with other types of action. In both these cases, the management objective would be to protect 50% of the biodiversity features of the partially protected estuary. Fully protected and partially protected estuaries can be considered Estuarine Protected Areas, whereas all other estuaries should be designated Estuarine Management Areas. All estuaries require a Management Plan and these plans should be guided by the results of this assessment.

The national priority list provides recommendations regarding the extent of protection required for each estuary, the recommended extent of the estuary perimeter that should be free from development to an appropriate setback line, and the preliminary Recommended Ecological Category (or recommended future health class) as required under the National Water Act (Table 4.1)

Table 4.1 National priorities, the extent of protection required (Full = full no-take protection (modified from Turpie et al. 2012).

Estuary	NBA '11 PES	Recommended extent of protection	Recommended degree of undeveloped margin	NBA '11 REC
Mtamvuna	*B*	*Full*	*75%*	*A or BAS*
Mpenjati	*B*	*Partial*	*75%*	*A or BAS*
Zotsha	*B**	*Partial*	*50%*	*B**
Umzimkulu	*B**	*Partial*	*50%*	*B**
Damba	*C*	*Partial*	*50%*	*C*
Koshwana	*C*	*Partial*	*50%*	*C*
Intshambili	*B*	*Partial*	*50%*	*B*
Mhlabatshane	*B*	*Partial*	*50%*	*B*
Mfazazana	*C*	*Partial*	*50%*	*C*
Kwa-Makosi	*B*	*Partial*	*75%*	*B*
uMkhomazi	*C*	*Partial*	*25%*	*B*
Umgababa	*B*	*Full*	*50%*	*B*

Estuary	NBA '11 PES	Recommended extent of protection	Recommended degree of undeveloped margin	NBA '11 REC
Msimbazi	*B*	*Full*	*75%*	*B*
Lovu	*C*	*Partial*	*50%*	*C*
Durban Bay	*E*	*Partial*	*25%*	*B*
uMngeni	*E**	*Partial*	*25%*	*D**
Mhlanga	*D*	*Full*	*75%*	*B**
Mhlali	*C*	*Partial*	*50%*	*B*
Mvoti	*D*	*Full*	*75%*	*D*
Mdlotane	*B*	*Full*	*75%*	*A*
Zinkwasi	*C*	*Partial*	*50%*	*B*

**Current and recommended condition were determined by an ecological water requirement study, otherwise determined by the NBA 2011 study.*

4.2 ESTUARY ECOLOGICAL IMPORTANCE

4.2.1 National Importance rating

The Estuary Importance Score (EIS) for an estuary takes size (S), the rarity of the estuary type within its biographical zone (Z), habitat (H), biodiversity importance (B) of the estuary into account (Table 4.3) (DWA 2008). Biodiversity importance, in turn is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores ideally refer to the system in its natural condition. The scores have been determined for all South African estuaries, apart from functional importance, which is scored by the specialists during EWR workshops (DWA 2008).

To add resolution to the national estuary importance rating the EIS for the estuaries of Mvoti to Umzimkulu WMA *were rated on a 1 (0-20) to 5 (80-100) scale to provide an indication of their biodiversity importance in the region (Table 4.2 and Table 4.3) (DWA 2008).*

Table 4.2 Ecological Importance rating.

Importance score	Rating	Comment
0 - 20	*1*	*Little*
20.1 - 40	*2*	*Some*
40.1 - 60	*3*	*Important*
60.1 - 80	*4*	*Very important*
80.1 -100	*5*	*Extremely important*

Table 4.3 Estuary importance scores for the Mvoti to UmzimkuluWMA estuaries calculated on a national scale (DWAF 2008, Turpie and Clark 2007, Turpie et al. 2002).

Estuary	S	H	Z	B	I	National biodiversity Importance	Formal Protected Area	Planned PA	Conservation Importance
Mtamvuna	*80*	*50*	*10*	*83*	*66.3*	**4**	*Pondoland MPA*		**5**
Zolwane	*10*	*20*	*10*	*24.5*	*16.1*	**1**			**1**
Sandlundlu	*30*	*40*	*10*	*55.5*	*36.9*	**2**			**1**
Ku-boboyi	*10*	*20*	*10*	*37.5*	*19.4*	**1**			**1**
Tongazi	*10*	*70*	*10*	*63*	*38.3*	**2**			**1**
Kandandhlovu	*20*	*20*	*10*	*34.5*	*22.6*	**2**			**1**
Mpenjati	*40*	*50*	*10*	*73.5*	*47.9*	**3**	*Mpenjati NR*	*NBA '11 Partial*	**5**
Umhlangankulu	*40*	*80*	*10*	*49.5*	*49.4*	**3**			**1**
Kaba	*20*	*40*	*10*	*25*	*25.3*	**2**			**1**
Mbizana	*40*	*70*	*10*	*80*	*54.5*	**3**			**1**
Mvutshini	*10*	*20*	*10*	*10*	*12.5*	**1**			**1**
Bilanhlolo	*20*	*60*	*10*	*76.5*	*43.1*	**3**			**1**
Uvuzana	*10*	*20*	*10*	*23*	*15.8*	**1**			**1**
Kongweni	*10*	*40*	*10*	*48.5*	*27.1*	**2**			**1**
Vungu	*10*	*30*	*10*	*39*	*22.3*	**2**			**1**
Mhlangeni	*20*	*40*	*10*	*59*	*33.8*	**2**			**1**
Zotsha	*30*	*80*	*10*	*55.5*	*46.9*	**3**		*NBA '11 Partial*	**5**
Boboyi	*10*	*40*	*10*	*45.5*	*26.4*	**2**			**1**
Mbango	*10*	*60*	*10*	*31*	*27.8*	**2**			**1**
Umzimkulu	*80*	*100*	*30*	*76*	*79*	**4**		*NBA '11 Partial*	**5**
uMthente	*30*	*80*	*10*	*30.5*	*40.6*	**3**			**1**
Mhlangamkulu	*30*	*10*	*10*	*17*	*19.8*	**1**			**1**
Damba	*20*	*90*	*10*	*25*	*37.8*	**2**		*NBA '11 Partial*	**5**
Koshwana	*10*	*80*	*10*	*24.5*	*31.1*	**2**		*NBA '11 Partial*	**5**
Intshambili	*20*	*80*	*10*	*26*	*35.5*	**2**		*NBA '11 Partial*	**5**
Mzumbe	*50*	*50*	*10*	*53.5*	*46.9*	**3**			**1**
Mhlabatshane	*20*	*90*	*10*	*26.5*	*38.1*	**2**		*NBA '11 Partial*	**5**
Mhlungwa	*20*	*60*	*10*	*47.5*	*35.9*	**2**			**1**
Mfazazana	*20*	*80*	*10*	*57.5*	*43.4*	**3**		*NBA '11 Partial*	**5**
Kwa-Makosi	*20*	*90*	*10*	*39.5*	*41.4*	**3**		*NBA '11 Partial*	**5**
Mnamfu	*10*	*80*	*10*	*10*	*27.5*	**2**			**1**

Estuary	S	H	Z	B	I	National biodiversity Importance	Formal Protected Area	Planned PA	Conservation Importance
Mtwalume	*60*	*50*	*10*	*64*	*53.5*	**3**			**1**
Mvuzi	*10*	*50*	*10*	*29.5*	*24.9*	**2**			**1**
Fafa	*70*	*80*	*10*	*63*	*64.8*	**4**			**1**
Mdesingane	*10*	*30*	*10*	*29.5*	*19.9*	**1**			**1**
Sezela	*40*	*50*	*10*	*76.5*	*48.6*	**3**			**1**
Mkumbane	*10*	*40*	*10*	*50.5*	*27.6*	**2**			**1**
uMuziwezinto	*30*	*80*	*10*	*64*	*49*	**3**			**1**
Nkomba						**1**			**1**
Mzimayi	*10*	*40*	*10*	*24.5*	*21.1*	**2**			**1**
Mpambanyoni	*20*	*50*	*10*	*49*	*33.8*	**2**			**1**
Mahlongwa	*30*	*40*	*10*	*44*	*34*	**2**		*KZN*	**5**
Mahlongwana	*30*	*80*	*10*	*48*	*45*	**3**		*KZN*	**5**
uMkhomazi	*80*	*60*	*30*	*91.5*	*72.9*	**4**		*NBA '11 Partial*	**5**
Ngane	*10*	*40*	*10*	*67*	*31.8*	**2**			**1**
Umgababa	*50*	*60*	*10*	*63*	*51.8*	**3**		*NBA '11 Full*	**5**
Msimbazi	*50*	*50*	*10*	*84.5*	*54.6*	**3**		*NBA '11 Full*	**5**
Lovu	*40*	*80*	*10*	*78*	*56.5*	**3**		*NBA '11 Partial*	**5**
Little aManzimtoti	*10*	*80*	*10*	*37.5*	*34.4*	**2**			**1**
aManzimtoti	*30*	*70*	*10*	*84*	*51.5*	**3**			**1**
Mbokodweni	*30*	*40*	*10*	*72*	*41*	**3**			**1**
Sipingo	*30*	*100*	*10*	*63.5*	*53.9*	**3**			**1**
Durban Bay	*90*	*100*	*80*	*92.5*	*92.1*	**5**		*NBA '11 Partial*	**5**
uMngeni	*70*	*90*	*10*	*86.5*	*73.1*	**4**	*Beechwood NR*	*NBA '11 Partial*	**5**
Mhlanga	*80*	*70*	*10*	*79*	*70.3*	**4**	*EKZNW*	*NBA '11 Full*	**5**
uMdloti	*80*	*90*	*10*	*69*	*72.8*	**4**			**1**
uThongathi	*70*	*80*	*10*	*54.5*	*62.6*	**4**			**1**
Mhlali	*60*	*90*	*10*	*80*	*67.5*	**4**		*NBA '11 Partial*	**5**
Bob' Stream						**1**			**1**
Seteni	*10*	*80*	*10*	*37.5*	*34.4*	**2**			**1**
Mvoti	*60*	*30*	*70*	*80.5*	*58.6*	**3**		*NBA '11 Full*	**5**
Mdlotane	*60*	*90*	*10*	*65*	*63.8*	**4**		*NBA '11 Full*	**5**
Nonoti	*60*	*60*	*10*	*74.5*	*58.6*	**3**			**1**
Zinkwasi	*80*	*90*	*10*	*80*	*75.5*	**4**		*NBA '11 Partial*	**5**

4.3 RECOMMENDED ECOLOGICAL CATEGORY

The REC for each Mvoti to Umzimkulu WMAestuaryis listed in Table 4.4.

Table 4.4 The Recommended Ecological Category for the estuaries of Mvoti to Umzimkulu WMA.

Estuary	National Importance		Regional Importance			Overall importance	PES	REC
	Biodiversity	Conservation	Macrophytes	Fish	Birds			
Mtamvuna	*4*	*5*	*3*	*4*	*2*	*5*	**B**	**A or BAS**
Zolwane	*1*	*1*		*3*		*3*	**B**	**B**
Sandlundlu	*2*	*1*	*1*	*3*		*3*	**C**	**C**
Ku-boboyi	*1*	*1*		*2*		*2*	**B**	**B**
Tongazi	*2*	*1*		*3*		*3*	**B**	**B**
Kandandhlovu	*2*	*1*	*3*	*3*		*3*	**B**	**B**
Mpenjati	*3*	*5*	*1*	*3*	*1*	*5*	**B**	**A or BAS**
Umhlangankulu	*3*	*1*	*2*	*3*		*3*	**C**	**C**
Kaba	*2*	*1*	*1*	*3*		*3*	**C**	**C**
Mbizana	*3*	*1*		*3*	*2*	*3*	**B**	**B**
Mvutshini	*1*	*1*		*3*		*3*	**B**	**B**
Bilanhlolo	*3*	*1*	*2*	*3*		*3*	**C**	**C**
Uvuzana	*1*	*1*		*3*		*3*	**C**	**C**
Kongweni	*2*	*1*	*2*	*3*		*3*	**D**	**D**
Vungu	*2*	*1*		*3*		*3*	**B**	**B**
Mhlangeni	*2*	*1*	*1*	*3*		*3*	**C**	**C**
Zotsha	*3*	*5*		*3*		*5*	**B**	**A/B or BAS**
Boboyi	*2*	*1*		*3*		*3*	**B**	**B**
Mbango	*2*	*1*		*3*		*3*	**E**	**D**
Umzimkulu	*4*	*5*	*5*	*3*	*1*	*5*	**B**	**A/B or BAS**
uMthente	*3*	*1*		*3*		*3*	**C**	**C**
Mhlangamkulu	*1*	*1*	*4*	*3*		*4*	**C**	**C**
Damba	*2*	*5*	*3*	*3*		*5*	**C**	**A/B or BAS**
Koshwana	*2*	*5*		*3*		*5*	**C**	**A/B or BAS**
Intshambili	*2*	*5*	*1*	*3*	*1*	*5*	**C**	**A/B or BAS**
Mzumbe	*3*	*1*		*3*	*1*	*3*	**C**	**C**
Mhlabatshane	*2*	*5*	*3*	*3*		*5*	**B**	**A/B or BAS**
Mhlungwa	*2*	*1*	*3*	*3*		*3*	**C**	**C**
Mfazazana	*3*	*5*		*3*		*5*	**C**	**A/B or**

Estuary	**National Importance**		**Regional Importance**			**Overall impor-tance**	**PES**	**REC**
	Biodiversity	**Conservation**	**Macro-phytes**	**Fish**	**Birds**			
								BAS
Kwa-Makosi	*3*	*5*	*1*	*3*		*5*	**B**	**A/B or BAS**
Mnamfu	*2*	*1*		*3*		*3*	**C**	**C**
Mtwalume	*3*	*1*		*3*	*1*	*3*	**C**	**C**
Mvuzi	*2*	*1*		*3*		*3*	**C**	**C**
Fafa	*4*	*1*	*3*	*4*	*1*	*4*	**C**	**C**
Mdesingane	*1*	*1*	*2*	*3*		*3*	**C**	**C**
Sezela	*3*	*1*		*3*	*1*	*3*	**C**	**C**
Mkumbane	*2*	*1*		*3*		*3*	**C**	**C**
uMuziwezinto	*3*	*1*		*3*		*3*	**C**	**C**
Nkomba	*1*	*1*		*1*		*1*	**B**	**B**
Mzimayi	*2*	*1*		*3*		*3*	**C**	**C**
Mpambanyoni	*2*	*1*		*3*		*3*	**C**	**C**
Mahlongwa	*2*	*5*		*3*		*5*	**C**	**A/B or BAS**
Mahlongwana	*3*	*5*	*4*	*3*		*5*	**C**	**A/B or BAS**
uMkhomazi	*4*	*5*	*5*	*4*	*3*	*5*	**C**	**B**
Ngane	*2*	*1*		*3*		*3*	**C**	**C**
Umgababa	*3*	*5*	*4*	*4*		*5*	**C**	**A/B or BAS**
Msimbazi	*3*	*5*	*1*	*3*	*2*	*5*	**B**	**A/B or BAS**
Lovu	*3*	*5*		*3*	*1*	*5*	**C**	**A/B or BAS**
Little aManzimtoti	*2*	*1*		*3*		*3*	**E**	**D**
aManzimtoti	*3*	*1*		*3*	*1*	*3*	**D**	**D**
Mbokodweni	*3*	*1*		*3*		*3*	**E**	**D**
Sipingo	*3*	*1*	*5*	*3*	*1*	*5*	**F**	**E**
Durban Bay	*5*	*5*	*5*	*4*	*5*	*5*	**E**	**B**
uMngeni	*4*	*5*	*5*	*4*	*4*	*5*	**E**	**D**
Mhlanga	*4*	*5*	*1*	*4*	*2*	*5*	**D**	**B***
uMdloti	*4*	*1*	*3*	*4*	*2*	*4*	**D**	**C***
uThongathi	*4*	*1*		*3*	*2*	*4*	**D**	**D***
Mhlali	*4*	*5*	*2*	*4*	*3*	*5*	**C**	**B**
Bob' Stream	*1*	*1*		*1*		*1*	**B**	**B**
Seteni	*2*	*1*		*3*		*3*	**B**	**B**
Mvoti	*3*	*5*		*3*	*3*	*5*	**D**	**D**
Mdlotane	*4*	*5*	*5*	*4*	*1*	*5*	**B**	**A/B or BAS**

Estuary	National Importance		Regional Importance			Overall impor-tance	PES	REC
	Biodiversity	Conservation	Macro-phytes	Fish	Birds			
Nonoti	*3*	*1*	*3*	*3*		*3*	**C**	**B**
Zinkwasi	*4*	*5*	*5*	*3*	*2*	*5*	**B**	**A/B or BAS**

5 SOCIO-CULTURAL IMPORTANCE

The Socio-Cultural Importance (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 estuary takes place?" Typically this would be for ceremonial purposes or for spiritual/religious activities. An example would be areas 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 estuary 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 estuary and appreciate its aesthetic value and significance relates to the degree to which the estuary is of critical aesthetic importance to people.*

Resource Dependence: *This was scored between 0 - 5. This refers to the ecosystem services delivered by the estuary and peoples dependence on these components. This is usually a critical element of the SCI score and is designed to cater for estuary 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 estuary for resource importance and significance relates to the degree to which the estuary 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 estuary 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 estuary for recreational purposes and significance relates to the degree to which the estuary is of critical importance to people.*

Historical/Cultural Value: *This was scored between 0 - 5. The question that was asked was "Does the estuary have a strong cultural or historical value?" 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 estuary for its historical or cultural significance and significance relates to the degree to which the estuary 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 5.1 and Table 5.2 below.

Table 5.1 Socio-Cultural Importance 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.*

Table 5.2 Overall SCI scores for the Mvoti to Umzimkulu WMA estuaries.

Name	Ritual Use (0-5)	Aesthetic (0-5)	Resource Dependence (0-5)	Recreational Use (0-5)	Historical/ Cultural (0-5)	Ecosystem Services Score
Mtamvuna	*3*	*4*	*2*	*4*	*3*	**2.89**
Zolwane	*1*	*2*	*1*	*2*	*1*	**1.25**
Sandlundlu	*1*	*3*	*1*	*3*	*1*	**1.49**
Ku-Boboyi	*2*	*3*	*1*	*3*	*2*	**1.89**
Tongazi	*2*	*3*	*2*	*3*	*2*	**2.25**
Kandandhlovu	*2*	*3*	*2*	*3*	*2*	**2.25**
Mpenjati	*2*	*5*	*2*	*3*	*4*	**2.91**
Umhlangankulu	*2*	*2*	*2*	*2*	*2*	**2.00**
Kaba	*2*	*2*	*2*	*4*	*2*	**2.35**
Mbizana	*3*	*3*	*2*	*3*	*3*	**2.65**
Mvutshini	*2*	*2*	*2*	*2*	*2*	**2.00**
Bilanhlolo	*2*	*2*	*2*	*4*	*2*	**2.35**
Uvuzana	*1*	*2*	*1*	*2*	*1*	**1.25**
Kongweni	*3*	*4*	*3*	*5*	*3*	**3.42**
Vungu	*3*	*3*	*2*	*4*	*3*	**2.82**
Mhlangeni	*2*	*3*	*2*	*4*	*2*	**2.42**
Zotsha	*2*	*3*	*2*	*2*	*2*	**2.07**
Boboyi	*1*	*3*	*1*	*2*	*1*	**1.32**
Mbango	*1*	*1*	*1*	*1*	*1*	**1.00**
Umzimkulu	*2*	*3*	*3*	*5*	*2*	**2.95**
uMthente	*2*	*3*	*2*	*3*	*2*	**2.25**
Mhlangamkulu	*2*	*3*	*2*	*3*	*2*	**2.25**
Damba	*2*	*4*	*2*	*3*	*2*	**2.32**
Koshwana	*2*	*3*	*2*	*2*	*2*	**2.07**
Intshambili	*1*	*3*	*1*	*1*	*1*	**1.14**
Mzumbe	*3*	*2*	*2*	*3*	*2*	**2.32**
Mhlabatshane	*3*	*4*	*3*	*4*	*3*	**3.25**
Mhlungwa	*4*	*2*	*2*	*4*	*4*	**3.16**
Mfazazana	*4*	*2*	*2*	*4*	*4*	**3.16**
Kwa-Makosi	*4*	*2*	*2*	*4*	*4*	**3.16**

Name	Ritual Use (0-5)	Aesthetic (0-5)	Resource Dependence (0-5)	Recreational Use (0-5)	Historical/ Cultural (0-5)	Ecosystem Services Score
Mnamfu	*4*	*2*	*2*	*4*	*4*	**3.16**
Mtwalume	*2*	*4*	*2*	*3*	*2*	**2.32**
Mvuzi	*2*	*3*	*2*	*2*	*2*	**2.07**
Fafa	*2*	*4*	*2*	*3*	*2*	**2.32**
Mdesingane	*2*	*5*	*2*	*2*	*2*	**2.21**
Sezela	*2*	*3*	*2*	*2*	*2*	**2.07**
Mkumbane	*2*	*3*	*2*	*4*	*2*	**2.42**
uMuziwezinto	*2*	*3*	*2*	*2*	*2*	**2.07**
Nkomba	*3*	*3*	*2*	*3*	*3*	**2.65**
Mzimayi	*3*	*3*	*2*	*3*	*3*	**2.65**
Mpambanyoni	*2*	*2*	*3*	*5*	*2*	**2.88**
Mahlongwa	*2*	*4*	*2*	*3*	*2*	**2.32**
Mahlongwane	*2*	*3*	*2*	*2*	*2*	**2.07**
uMkhomazi	*3*	*3*	*2*	*4*	*3*	**2.82**
Ngane	*2*	*2*	*2*	*3*	*2*	**2.18**
Umgababa	*3*	*3*	*2*	*3*	*3*	**2.65**
Msimbazi	*3*	*3*	*3*	*2*	*3*	**2.82**
Lovu	*2*	*4*	*2*	*4*	*2*	**2.49**
Little aManzimtoti	*2*	*4*	*2*	*2*	*2*	**2.14**
aManzimtoti	*3*	*2*	*2*	*4*	*2*	**2.49**
Mbokodweni	*3*	*2*	*2*	*4*	*2*	**2.49**
Sipingo	*2*	*2*	*1*	*2*	*2*	**1.65**
Durban Bay	*2*	*2*	*2*	*5*	*3*	**2.79**
uMngeni	*4*	*4*	*3*	*5*	*4*	**3.82**
Mhlanga	*3*	*4*	*3*	*4*	*3*	**3.25**
uMdloti	*3*	*4*	*2*	*3*	*3*	**2.72**
uThongathi	*2*	*3*	*2*	*3*	*2*	**2.25**
Mhlali	*1*	*4*	*1*	*2*	*1*	**1.39**
Bob's Stream	*1*	*3*	*1*	*1*	*1*	**1.14**
Seteni	*1*	*3*	*1*	*1*	*1*	**1.14**
Mvoti	*1*	*3*	*1*	*2*	*1*	**1.32**
Mdlotane	*1*	*5*	*1*	*3*	*1*	**1.63**
Nonoti	*2*	*5*	*2*	*2*	*2*	**2.21**
Zinkwasi	*3*	*5*	*2*	*4*	*2*	**2.70**

A socio-economic goods and services assessment of the estuaries located in Mvoti to Umzimkulu WMA concluded that 14 of the 64 estuaries are deemed important. One estuary (Durban Bay) in particular was deemed to be very important due to the range of services provided. The 14 estuaries were ranked of moderate to high importance due to the following factors:

- **Recreational:** *Estuaries ranked of importance with respect to recreational use of estuaries generally provided for ease of access, recreational facilities, good water flow and quality and also supported a large local resident population.*
- **Ritual and Cultural:** *Estuaries ranked of importance with respect to ritual and cultural use generally provided for ease of access, good water flow and quality, good aesthetic value and also supported a large local resident population.*

- **Resource Use:** *Estuaries ranked of importance with respect to resource use/dependant generally supported (1) subsistence fishing, (2) natural material harvesting (reeds, grasses etc.) and sand mining.*
- **Aesthetic:** *Estuaries with intact natural vegetation and limited urban development on the banks generally showed high aesthetic values.*

6 WATER RESOURCE USE IMPORTANCE

The priority rating method consists of assigning a qualitative score to a river reach for four variables or factors that represent the status of the in-stream flow. The scores of the four variables are combined to determine an overall score in conjunction with the quality and confidence of the data on which the score is based. The scoring represents the importance of the river reach in terms of the water resource use. When the Water Resource Use Importance (WRUI) is integrated with the Integrated Environmental Importance, the resulting hotspots will guide the selection of the EWR determination method to be applied. Table 6.1presents the meaning of the WRUI score.

Table 6.1 Meaning of Water Resource Use Importance score.

Overall score	Descriptive evaluation
0	Very low
1	Low
2	Moderate
3	High
4	Very high

Note: (#) The final EWR determination method depends on a combination of the water resource use rating and the ecological importance.

Table 6.2 provides a summary of the WRUI applicable to the estuaries of the Mvoti to Umzimkulu WMA.

Table 6.2 WRUIscores for the estuaries of the Mvoti to Umzimkulu WMA.

Name	Use	Operational	Future development	Water Quality	WRUI
Mtamvuna	1	1	1	1	1
Zolwane	2	0	0	1	2
Sandlundlu	2	1	0	2	2
Ku-Boboyi	2	2	0	1	2
Tongazi	2	0	0	2	2
Kandandhlovu	3	2	0	1	3
Mpenjati	2	0	0	1	2
Umhlangankulu	2	1	0	2	2
Kaba	3	2	0	1	3
Mbizana	1	0	0	1	1
Mvutshini	2	2	0	1	2
Bilanhlolo	1	0	0	1	1
Uvuzana	2	0	0	1	2
Kongweni	2	2	0	2	2
Vungu	2	0	0	3	3
Mhlangeni	2	0	0	2	2
Zotsha	2	0	0	3	3
Boboyi	2	0	0	2	2
Mbango	2	1	0	3	3
Umzimkulu	2	0	0	2	2
uMthente	2	0	0	1	2
Mhlangamkulu	2	1	0	1	2
Damba	2	1	0	1	2

Name	Use	Operational	Future development	Water Quality	WRUI
Koshwana	*2*	*0*	*0*	*1*	*2*
Intshambili	*2*	*0*	*0*	*1*	*2*
Mzumbe	*1*	*0*	*0*	*1*	*1*
Mhlabatshane	*2*	*1*	*0*	*1*	*2*
Mhlungwa	*2*	*2*	*0*	*1*	*2*
Mfazazana	*2*	*0*	*0*	*1*	*2*
Kwa-Makosi	*2*	*0*	*0*	*1*	*2*
Mnamfu	*2*	*0*	*0*	*1*	*2*
Mtwalume	*2*	*0*	*0*	*1*	*2*
Mvuzi	*2*	*3*	*0*	*1*	*3*
Fafa	*2*	*1*	*0*	*1*	*2*
Mdesingane	*2*	*0*	*0*	*1*	*2*
Sezela	*3*	*3*	*0*	*1*	*3*
Mkumbane	*3*	*3*	*0*	*1*	*3*
uMuziwezinto	*3*	*3*	*0*	*3*	*3*
Nkomba	*2*	*0*	*0*	*1*	*2*
Mzimayi	*2*	*0*	*0*	*1*	*2*
Mpambanyoni	*2*	*1*	*0*	*1*	*2*
Mahlongwa	*2*	*0*	*0*	*1*	*2*
Mahlongwane	*2*	*0*	*0*	*2*	*2*
uMkhomazi	*2*	*0*	*4*	*1*	*4*
Ngane	*1*	*1*	*1*	*3*	*3*
Umgababa	*2*	*3*	*0*	*1*	*3*
Msimbazi	*1*	*0*	*0*	*1*	*1*
Lovu	*2*	*0*	*0*	*2*	*2*
Little aManzimtoti	*2*	*0*	*0*	*2*	*2*
aManzimtoti	*2*	*0*	*0*	*2*	*2*
Mbokodweni	*2*	*1*	*1*	*3*	*3*
Sipingo	*2*	*0*	*0*	*3*	*3*
Durban Bay	*3*	*4*	*0*	*4*	*4*
uMngeni	*4*	*4*	*3*	*4*	*4*
Mhlanga	*4*	*0*	*0*	*4*	*4*
uMdloti	*4*	*4*	*3*	*4*	*4*
uThongathi	*4*	*2*	*2*	*3*	*4*
Mhlali	*2*	*0*	*0*	*1*	*2*
Bob's Stream	*2*	*0*	*0*	*1*	*2*
Seteni	*2*	*0*	*0*	*1*	*2*
Mvoti	*3*	*0*	*4*	*1*	*4*
Mdlotane	*2*	*0*	*0*	*1*	*2*
Nonoti	*2*	*0*	*0*	*1*	*2*
Zinkwasi	*2*	*0*	*0*	*1*	*2*

7 PRIORITY ESTUARIES– HOTSPOTS

Hotspots (priority estuaries with overall importance) are identified by comparing (or overlaying) Integrated Environmental Importance with Water Resource Use Importance. In the context used here, the hotspot represents an estuary with a high Integrated Environmental Importance which could be under threat due to its importance for water resource use. 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 monitoring and EWR studies. Table 7.1 provides the detailed list for the estuaries of the WMA.

Table 7.1 Estuary hotspots in Mvoti to Umzimkulu WMA.

NAME	PES	Ecological Importance (rated 1- 5)	SCI (rated 0 - 5)	IEI (rated 1 - 5)	WRUI (rated 0-4)	Hotspot (rated 1- 4)
Mtamvuna	B	5	2.89	5	1	2
Zolwane	B	1	1.25	4	2	3
Sandlundlu	C	2	1.49	2	2	2
Ku-Boboyi	B	1	1.89	4	2	3
Tongazi	B	2	2.25	4	2	3
Kandandhlovu	B	2	2.25	4	3	4
Mpenjati	B	5	2.91	5	2	3
Umhlangankulu	C	3	2.00	3	2	2
Kaba	C	2	2.35	3	3	3
Mbizana	B	3	2.65	4	1	2
Mvutshini	B	1	2.00	4	2	3
Bilanhlolo	C	3	2.35	3	1	2
Uvuzana	C	1	1.25	2	2	2
Kongweni	D	2	3.42	2	2	2
Vungu	B	2	2.82	4	3	4
Mhlangeni	C	2	2.42	3	2	2
Zotsha	B	5	2.07	5	3	4
Boboyi	B	2	1.32	4	2	3
Mbango	E	2	1.00	1	3	2
Umzimkulu	B	5	2.95	5	2	3
uMthente	C	3	2.25	3	2	2
Mhlangamkulu	C	1	2.25	3	2	2
Damba	C	5	2.32	4	2	3
Koshwana	C	5	2.07	4	2	3
Intshambili	C	5	1.14	4	2	3
Mzumbe	C	3	2.32	3	1	2
Mhlabatshane	B	5	3.25	5	2	3
Mhlungwa	C	2	3.16	3	2	2
Mfazazana	C	5	3.16	4	2	3
Kwa-Makosi	B	5	3.16	5	2	3
Mnamfu	C	2	3.16	3	2	2
Mtwalume	C	3	2.32	3	2	2
Mvuzi	C	2	2.07	2	3	3
Fafa	C	4	2.32	3	2	2
Mdesingane	C	1	2.21	3	2	2

NAME	PES	Ecological Importance (rated 1- 5)	SCI (rated 0 - 5)	IEI (rated 1 - 5)	WRUI (rated 0-4)	Hotspot (rated 1- 4)
Sezela	C	*3*	*2.07*	*3*	*3*	*3*
Mkumbane	C	*2*	*2.42*	*3*	*3*	*3*
uMuziwezinto	C	*3*	*2.07*	*3*	*3*	*3*
Nkomba	B	*1*	*2.65*	*4*	*2*	*3*
Mzimayi	C	*2*	*2.65*	*3*	*2*	*2*
Mpambanyoni	C	*2*	*2.88*	*3*	*2*	*2*
Mahlongwa	C	*2*	*2.32*	*3*	*2*	*2*
Mahlongwane	C	*3*	*2.07*	*3*	*2*	*2*
uMkhomazi	C	*5*	*2.82*	*4*	*4*	*4*
Ngane	C	*2*	*2.18*	*3*	*3*	*3*
Umgababa	C	*5*	*2.65*	*4*	*3*	*4*
Msimbazi	B	*5*	*2.82*	*5*	*1*	*2*
Lovu	C	*5*	*2.49*	*4*	*2*	*3*
Little aManzimtoti	E	*2*	*2.14*	*2*	*2*	*2*
aManzimtoti	D	*3*	*2.49*	*2*	*2*	*2*
Mbokodweni	E	*3*	*2.49*	*2*	*3*	*3*
Sipingo	F	*3*	*1.65*	*5*	*3*	*4*
Durban Bay	E	*5*	*2.79*	*3*	*4*	*4*
uMngeni	E	*5*	*3.82*	*3*	*4*	*4*
Mhlanga	D	*5*	*3.25*	*3*	*4*	*4*
uMdloti	D	*4*	*2.72*	*3*	*4*	*4*
uThongathi	D	*4*	*2.25*	*3*	*4*	*4*
Mhlali	C	*5*	*1.39*	*4*	*3*	*4*
Bob's Stream	B	*1*	*1.14*	*4*	*2*	*3*
Seteni	B	*2*	*1.14*	*4*	*2*	*3*
Mvoti	D	*5*	*1.32*	*3*	*4*	*4*
Mdlotane	B	*5*	*1.63*	*5*	*2*	*3*
Nonoti	C	*3*	*2.21*	*3*	*2*	*2*
Zinkwasi	B	*5*	*2.70*	*4*	*2*	*3*

Following the process described above the thirteen estuaries emerge as hotspots (see Table 7.2).

Table 7.2 Mvoti to Umzimkulu WMA Estuary hotspots with a 4 rating.

NAME	PES	Ecological Importance (rated 1- 5)	SCI (rated 1- 5)	WRUI (rated 0-4)	EWR Status
Kandandhlovu	B	*2*	*2.25*	*3*	*Potential focus*
Vungu	B	*2*	*2.82*	*3*	*EWR done*
Zotsha	B	*5*	*2.07*	*3*	*EWR done*
uMkhomazi	C	*5*	*2.82*	*4*	*The focus of this study*
Umgababa	C	*5*	*2.65*	*3*	*Potential focus*
Sipingo	F	*3*	*1.65*	*3*	*Diversions of catchment for airport development*
Durban Bay	E	*5*	*2.79*	*4*	*Harbour, non-flow related Issues*
uMngeni	E	*5*	*3.82*	*4*	*EWR done*
Mhlanga	D	*5*	*3.25*	*4*	*EWR done*

NAME	PES	Ecological Importance (rated 1- 5)	SCI (rated 1- 5)	WRUI (rated 0-4)	EWR Status
uMdloti	D	*4*	*2.72*	*4*	*EWR done*
uThongathi	D	*4*	*2.25*	*4*	*EWR done*
Mhlali	C	*5*	*1.39*	*3*	*Potential focus*
Bob's Stream	B	*1*	*1.39*	*3*	*Artefact of hydrological modelling*
Mvoti	D	*5*	*1.32*	*4*	*The focus of this study*

Of these thirteen systems, six (the Vungu, Zotsha, uMngeni, Mhlanga, uMdloti and uThongathi estuaries) have been evaluated as part of previous EWR studies. Durban Bay and the Isipingo estuary are in a very poor condition as a result of major infrastructure developments (port and airport development respectively). It is recommended that remedial action be taken to improve their health status to a D Category preferably via the implementation of the Estuary Management Plans currently being developed under the National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008). They are not however seen as top-priority systems for EWR studies in the short term.

Existing and future water resource developments on the Mvoti and uMkhomazi estuaries are driving their selection as the focus areas forestuaryassessments. They are presently designated for Intermediate EWR level studies. However, there is some concern that the Mvoti Estuary may already be in an E Category due to water resource development, poor water quality and sand-mining. While this decline in health needs to be addressed it may be possible to identify the required actions in a rapid-level assessment and rather invest the resources (e.g. field investigations) available in the remaining hotspots identified.

Of the Mhlali, Umgababa and Kandandhlovu estuaries, the Mhlali and Umgababa are deemed the more ecologically significant. The recommendation, therefore, is that some of the resources of this study be directed towards those two systems, with the Umgababa the most likely study area for a Rapid EWR assessment.

Table 7.3 provides a summary of all the Mvoti to Umzimkulu WMA estuaries that have a hotspot rating of 3 and are deemed of high ecological or conservation importance (i.e. rating 5).

Table 7.3 Mvoti to UmzimkuluWMA Estuary hotspots with a 3 rating.

Estuary	PES	Ecological Importance (rated 1- 5)	SCI (rated 1- 5)	WRUI (rated 0-4)	EWR Status
Mpenjati	*B*	*5*	*2.91*	*2*	
Umzimkulu	*B*	*5*	*2.95*	*2*	*EWR done*
Damba	*C*	*5*	*2.32*	*2*	
Koshwana	*C*	*5*	*2.07*	*2*	
Intshambili	*C*	*5*	*1.14*	*2*	
Mhlabatshane	*B*	*5*	*3.25*	*2*	
Mfazazana	*C*	*5*	*3.16*	*2*	
Kwa-Makosi	*B*	*5*	*3.16*	*2*	
Mahlongwa	*C*	*5*	*2.32*	*2*	
Mahlongwane	*C*	*5*	*2.07*	*2*	
Lovu	*C*	*5*	*2.49*	*2*	
Mdlotane	*B*	*5*	*1.63*	*2*	
Zinkwasi	*B*	*5*	*2.70*	*2*	

Note:

The degree to which this Mvoti to Umzimkulu WMA flow requirement study can address the hotspots listed above is seriously hampered by the lack of long-term monitoring data (e.g. 5 to 10 years of continuous river inflow and water level data) in the study area. Without the supporting information, critical aspects such as river flow ranges that drive estuary mouth state and related water quality conditions cannot be resolved with some degree of confidence.

Critical data, i.e. continuous water level recorder data, for high confidence EWR assessments are only available for the following estuaries: uMkhomazi (U1T008), Mvoti (U4T011), uThongathi (U3T008), uMdloti (U3T009), and Mlanga (U3T010). Flow data are only available for the first four estuaries.Therefore, while all estuaries in the catchment are deemed ecologically and socially significant, and sensitive to water resources development, not all of them are under the same degree of pressure. The relevant government departments are therefore strongly urged to invest in the long-term monitoring programmes required to undertake higherlevel confidence EWR studies on the identified systems.

8 EWR RECOMMENDATIONS

8.1 EWR RECOMMENDATIONS

Of the 64 estuaries occurring in the WMA, 30% (19 estuaries) had significant flow related pressures on them, while 78% (50 estuaries) were under significant water quality pressure (Table 8.1). More than 90% (58 estuaries) had undergone significant habitat destruction. All of the estuaries could benefit from some remedial actions and more proactive management of the main vectors of change.

In some of the systems, additional water resource development would be possible, as long as the baseflow (low flow regime) is maintained, e.g. the inflowing river can be targeted for off-channel development or runoff river abstraction. The majority of the catchments in the region are small and linked to temporarily open/closed estuaries that require a high percentage of the natural runoff to maintain their required condition. Any increase or decrease in runoff to this type of system rapidly leads to changes in mouth state and related ecological degradation.

It should also be noted that the majority of theseestuary mouths close from time to time and are therefore very sensitive to nutrient loading from the catchment or direct surrounding environment. The assessment of nutrient dischargesfrom WWTWs into an estuary should consider the impact of this on the receiving environment; in this case an estuary, rather than relying on adherence to permitted discharge levels. In the case of estuaries it appears that either general or special standards are applied to the waste water streams and the impact of the associated nutrients and any organic material on the estuary appears not to be considered. The small estuaries of the Mvoti to Umzimkulu WMA, during closure periods, will retain and accumulate nutrients with consequent impacts on water quality and on the microalgae and macrophytes, with cascading ripple effects on all other trophic levels.

Therefore neither general nor special standards are sufficient to prevent a deterioration in overall estuarine health in intermittently open estuaries and the application of a receiving water quality evaluation is advocated when assessing the impacts of discharges on these systems. It is recommended that consideration should be given to the advisability of using intermittently open estuaries as conduits for waste water.

Table 8.1 Estuaries EWR and recommendations

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Mtamvuna	*275.19*	*239.49*	*B*	*A or BAS*	5				*5-10%*	*Flow modification, water quality, some habitat destruction*
Zolwane	*2.19*	*2.31*	*B*	*B*	3					
Sandlundlu	*5.07*	*5.00*	*C*	*C*	3			X		
Ku-Boboyi	*1.00*	*0.99*	*B*	*B*	2					
Tongazi	*7.00*	*7.23*	*B*	*B*	3		X	X		
Kandandhlovu	*1.53*	*1.60*	*B*	*B*	3		X	X		
Mpenjati	*23.61*	*23.55*	*B*	*A or BAS*	5		X	X		*Water quality, habitat destruction*
Umhlangankulu	*2.87*	*2.87*	*C*	*C*	3		X	X		
Kaba	*3.15*	*3.07*	*C*	*C*	3		X	X		
Mbizana	*36.30*	*35.52*	*B*	*B*	3			X	*<5%*	
Mvutshini	*1.66*	*1.63*	*B*	*B*	3		X	X		
Bilanhlolo	*5.02*	*4.98*	*C*	*C*	3		X	X		
Uvuzana	*1.05*	*1.05*	*C*	*C*	3		X	X		
Kongweni	*1.95*	*2.95*	*D*	*D*	3	X	X	X		
Vungu	*27.79*	*28.88*	*B*	*B*	3		X			
Mhlangeni	*9.29*	*9.56*	*C*	*C*	3		X	X		
Zotsha	*15.74*	*16.25*	*B*	*A/B or BAS*	5		X	X		*Water quality, habitat destruction*
Boboyi	*8.25*	*8.03*	*B*	*B*	3		X	X		
Mbango	*3.00*	*7.30*	*E*	*D*	3	X	X	X		*Flow modification, very poor water quality, severe habitat destruction*

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Umzimkulu	*1452.49*	*1199.50*	*B*	*A/B or BAS*	**5**				5-10%	*Poor water quality, habitat destruction, medium-high fishing pressure*
uMthente	*12.07*	*11.14*	*C*	*C*	**3**			**X**		
Mhlangamkulu	*2.06*	*1.73*	*C*	*C*	**4**	**X**		**X**		
Damba	*4.56*	*3.85*	*C*	*A/B or BAS*	**5**	**X**		**X**		*Flow modification, habitat destruction*
Koshwana	*2.06*	*1.96*	*C*	*A/B or BAS*	**5**	**X**	**X**	**X**		*Flow modification, habitat destruction*
Intshambili	*6.48*	*4.86*	*C*	*A/B or BAS*	**5**	**X**	**X**	**X**		*Flow modification, poor water quality, some habitat destruction*
Mzumbe	*58.53*	*53.74*	*C*	*C*	**3**		**X**	**X**	*<5%*	
Mhlabatshane	*6.46*	*6.48*	*B*	*A/B or BAS*	**5**			**X**		*Significant flow modification, some habitat destruction*
Mhlungwa	*5.78*	*5.67*	*C*	*C*	**3**		**X**	**X**		
Mfazazana	*2.77*	*2.57*	*C*	*A/B or BAS*	**5**		**X**	**X**		*Flow modification, poor water quality, habitat destruction*
Kwa-Makosi	*3.23*	*3.03*	*B*	*A/B or BAS*	**5**			**X**		*Some habitat destruction*
Mnamfu	*3.08*	*2.88*	*C*	*C*	**3**		**X**	**X**		
Mtwalume	*57.60*	*42.78*	*C*	*C*	**3**		**X**	**X**	*<5%*	
Mvuzi	*1.65*	*1.55*	*C*	*C*	**3**		**X**	**X**		
Fafa	*46.45*	*37.64*	*C*	*C*	**4**	**X**	**X**	**X**	*<5%*	
Mdesingane	*2.02*	*2.02*	*C*	*C*	**3**		**X**	**X**		
Sezela	*3.92*	*3.67*	*C*	*C*	**3**		**X**	**X**		
Mkumbane	*3.79*	*3.54*	*C*	*C*	**3**		**X**	**X**		
uMuziwezinto	*23.17*	*20.09*	*C*	*C*	**3**	**X**	**X**	**X**		

ESTUARY	nMAR[*1]	pMAR[*2]	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
Nkomba	*0.69*	*0.69*	*B*	*B*	**1**		**X**	**X**		
Mzimayi	*6.15*	*4.95*	*C*	*C*	**3**	**X**	**X**	**X**		
Mpambanyoni	*60.06*	*54.94*	*C*	*C*	**3**		**X**	**X**	*<5%*	
Mahlongwa	*13.76*	*13.18*	*C*	*A/B or BAS*	**5**		**X**	**X**		*Medium fishing pressure, poor water quality, habitat destruction*
Mahlongwane	*2.69*	*2.93*	*C*	*A/B or BAS*	**5**		**X**	**X**		*Poor water quality, significant habitat destruction*
uMkhomazi	*1077.74*	*926.05*	**C**	*B*	**5**	**X**	**X**	**X**	*5-10%*	*Significant flow reduction, poor water quality, habitat destruction*
Ngane	*3.83*	*4.30*	*C*	*C*	**3**		**X**	**X**		
Umgababa	*10.56*	*9.58*	**C**	*A/B or BAS*	**5**	**X**		**X**		*Flow modification, poor water quality, habitat destruction*
Msimbazi	*10.04*	*10.34*	**B**	*A/B or BAS*	**5**		**X**	**X**		*Habitat destruction*
Lovu	*105.84*	*73.46*	**C**	*A/B or BAS*	**5**	**X**	**X**	**X**		*Significant flow reduction, poor water quality, habitat destruction*
Little aManzimtoti	*2.84*	*6.62*	**E**	*D*	**3**	**X**	**X**	**X**		*Significant flow increase, poor water quality, habitat destruction*
aManzimtoti	*5.30*	*6.75*	*D*	*D*	**3**	**X**	**X**	**X**		*Poor water quality, habitat destruction*
Mbokodweni	*31.52*	*53.54*	*E*	*D*	**3**	**X**		**X**		*Very significant flow modification, very poor water quality, severe habitat destruction (restoration of the existing mouth and lower reaches of the estuary required).*
Sipingo	*89.85*	*9.48*	*F*	*E*	**5**	**X**	**X**	**X**		*Very significant flow modification, very poor water quality, severe habitat destruction*
Durban Bay	*36.33*	*63.44*	*E*	*D*	**5**	**X**	**X**	**X**		*High fishing pressure, significant flow modification, poor water quality, severe habitat destruction (port development), reduced food availability*
uMngeni	*671.30*	*262.68*	**E**	*D*	**5**	**X**	**X**	**X**		*Significant flow modification, very poor water quality, severe habitat destruction*
Mhlanga	*13.34*	*22.33*	**D**	*B**	**5**	**X**	**X**	**X**		*Significant flow modification, poor water quality, habitat*

ESTUARY	nMAR*1	pMAR*2	PES	REC	ECOLOGICAL & CONSERVATION IMPORTANCE	FLOW	WATER QUALITY	NON-FLOW	POTENTIAL FOR WATER RESOURCE DEVELOPMENT	ASPECTS THAT NEEDS TARGETING FOR RESTORATION/REHABILITATION
										destruction
uMdloti	*85.78*	*71.87*	*D*	*C**	**4**		**X**	**X**		*Flow modification, poor water quality, habitat destruction*
uThongathi	*70.77*	*71.16*	*D*	*D**	**4**		**X**	**X**		*Very poor water quality, severe habitat destruction*
Mhlali	*56.26*	*54.22*	*C*	*B*	**5**		**X**	**X**	*<5%*	*Poor water quality, habitat destruction*
Bob's Stream	*0.53*	*0.53*	*B*	*B*	**1**		**X**	**X**		
Seteni	*1.42*	*1.42*	*B*	*B*	**3**		**X**	**X**		
Mvoti	*420.00*	*314.00*	*D*	*D*	**5**		**X**	**X**	*<5%*	*Poor water quality, habitat destruction*
Mdlotane	*6.04*	*5.85*	*B*	*A/B or BAS*	**5**		**X**			*Water quality, some habitat destruction*
Nonoti	*36.24*	*34.74*	*C*	*B*	**3**		**X**	**X**	*<5%*	*Poor water quality, some habitat destruction*
Zinkwasi	*14.49*	*14.04*	*B*	*A/B or BAS*	**5**		**X**	**X**		*Habitat destruction*

**1 - nMAR: Natural MAR* **2 - pMAR: Present day MAR*

8.2 ESTUARY LONG-TERM MONITORING REQUIREMENTS IN SUPPORT OF HIGHER LEVEL EWR STUDIES

Recommended minimum monitoring requirements to ascertain impacts of changes in freshwater flow to the estuary and any improvement or reductions therein are listed in Table 8.2.

Table 8.2 Recommended minimum requirements for long-term monitoring.

Component	Monitoring action	Temporal scale (frequency and when)	Spatial scale (no. stations)
Hydrodynamics	*Record water levels*	*Continuous*	*At the mouth*
	Measure freshwater inflow into the estuary	*Continuous*	*Near head of estuary*
	Aerial/Satellite photographs of estuary (spring low tide)	*Every 3 years*	*Entire estuary*
Sediment dynamics	*Bathymetric surveys: Series of cross-section profiles and a longitudinal profile collected at fixed 200-500 m intervals, but in more detail in the mouth (every 100m). The vertical accuracy should be about 5 cm.*	*Every 3 years*	*Entire estuary*
	Set sediment grab samples (at cross section profiles) for analysis of particle size distribution (PSD) and origin (i.e. using microscopic observations)	*Every 3 years* *(with invert sampling)*	*Entire estuary*
Water quality	*Water quality (e.g. system variables (e.g. pH, oxygen, turbidity), nutrients and toxic substances) measurements on river water entering at the head of the estuary*	*Monthly continuous*	*Close proximity to head of estuary*
	Longitudinal salinity and temperature profiles (in situ) collected over a spring and neap tide during high and low tide at: • *end of low flow season (i.e. period of maximum seawater intrusion)* • *peak of high flow season (i.e. period of maximum flushing by river water)*	*Seasonally every year*	*Entire estuary (3-10 stations)*
	Water quality measurements (i.e. system variables, and nutrients) taken along the length of the estuary (surface and bottom samples)	*Seasonal surveys, every 3 years or when significant change in water inflows or quality expected*	*Entire estuary (3-10 stations)*
	Measurements of organic content and toxic substances (e.g. trace metals and hydrocarbons) in sediments along length of the estuary, where considered an issue.	*Every 3- 5 years*	*Focus on sheltered, depositional areas*
	Water quality (e.g. system variables, nutrients and toxic substances)measurements on near-shore seawater	*Use available literature*	*Seawater adjacent to estuary mouth at salinity 35*

Component	Monitoring action	Temporal scale (frequency and when)	Spatial scale (no. stations)
Macrophytes	*Ground-truthed maps to document changes in macrophyte habitats over time;* *Record number of macrophyte habitats, identification and total number of macrophyte species, number of rare or endangered species or those with limited populations documented during a field visit;* *Document area covered by sensitive habitats i.e. mangroves and submerged macrophytes. Note extent of macroalgal blooms, floating aquatic macrophytes and area occupied by invasive vegetation*	*Summer survey every 3 years*	*Entire estuary*
Macrophytes	*Ground-truthed maps;* *Record number of plant community types, identification and total number of macrophyte species, number of rare or endangered species or those with limited populations documented during a field visit;* *Record percentage plant cover, salinity, water level, sediment moisture content and turbidity on a series of permanent transects along an elevation gradient;* *Take measurements of depth to water table and ground water salinity in supratidal marsh areas*	*Summer survey every 3 years*	*Entire estuary*
Invertebrates	*Record species and abundance of zooplankton, based on samples collected across the estuary at each of a series of stations along the estuary;* *Record benthic invertebrate species and abundance, based on subtidal and intertidal grab samples at a series of stations up the estuary, and counts of hole densities;* *Measures of sediment characteristics at each station*	*Summer and winter survey every 3 years*	*Entire estuary* *(3-10 stations)*
Fish	*Record species and abundance of fish, based on seine net and gill net sampling.*	*Summer and winter survey every 3 years*	*Entire estuary* *(3-10 stations)*
Birds	*Undertake counts of all water associated birds, identified to species level.*	*Annual winter (Jul/Aug) and summer (Jan/Feb) surveys*	*Entire estuary*

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10 APPENDIX A. LOCATION OF THE ESTUARIES OF THE MVOTI TO UMZIMKULU WMA

Appendix A (Table 10.1) provides the positions of the Mvoti to Umzimkulu WMA estuaries outlets (mouths). The lateral boundaries were taken as the 5 m contour above Mean Sea Level (MSL) along each bank.

Table 10.1 The mouth positions of the Mvoti to Umzimkulu WMA estuaries

IUA Code	NAME	X-Coordinate	Y-Coordinate
T40E-05869	*Mtamvuna*	*30^0 11' 37.2984"*	*31^0 5' 4.27200"*
T40F-05953	*Zolwane*	*30^0 12' 17.5427"*	*31^0 4' 31.5876"*
T40F-05923	*Sandlundlu*	*30^0 13' 44.6087"*	*31^0 2' 33.4319"*
T40F-05928	*Ku-Boboyi*	*30^0 14' 8.16359"*	*31^0 2' 4.77599"*
T40F-05879	*Tongazi*	*30^0 15' 24.5915"*	*31^0 0' 41.1732"*
T40F-05884	*Kandandhlovu*	*30^0 16' 9.45480"*	*30^0 59' 50.625"*
T40F-05770	*Mpenjati*	*30^0 17' 2.78160"*	*30^0 58' 25.348"*
T40F-05839	*Umhlangankulu*	*30^0 18' 11.0699"*	*30^0 56' 43.490"*
T40F-05820	*Kaba*	*30^0 18' 32.3604"*	*30^0 56' 9.4776"*
T40F-05666	*Mbizana*	*30^0 20' 5.22239"*	*30^0 54' 31.103"*
T40G-05773	*Mvutshini*	*30^0 20' 49.6895"*	*30^0 53' 38.684"*
T40G-05722	*Bilanhlolo*	*30^0 20' 56.1479"*	*30^0 53' 24.687"*
T40G-05768	*Uvuzana*	*30^0 21' 32.2415"*	*30^0 52' 42.254"*
T40G-05739	*Kongweni*	*30^0 22' 21.8495"*	*30^0 51' 41.288"*
T40G-05616	*Vungu*	*30^0 23' 43.1303"*	*30^0 50' 11.345"*
T40G-05644	*Mhlangeni*	*30^0 24' 20.1168"*	*30^0 49' 12.810"*
T40G-05577	*Zotsha*	*30^0 25' 25.1687"*	*30^0 47' 22.322"*
T40G-05573	*Boboyi*	*30^0 26' 21.2531"*	*30^0 46' 14.509"*
T40G-05611	*Mbango*	*30^0 26' 51.6084"*	*30^0 45' 27.745"*
T52M-05547	*Umzimkulu*	*30^0 27' 29.8800"*	*30^0 44' 23.398"*
U80A-05470	*uMthente*	*30^0 28' 54.1019"*	*30^0 42' 34.534"*
U80A-05527	*Mhlangamkulu*	*30^0 29' 54.0420"*	*30^0 41' 17.394"*
U80A-05461	*Damba*	*30^0 30' 37.5335"*	*30^0 40' 20.863"*
U80A-05496	*Koshwana*	*30^0 31' 2.27280"*	*30^0 39' 37.137"*
U80A-05456	*Intshambili*	*30^0 32' 11.5223"*	*30^0 38' 13.938"*
U80C-05448	*Mzumbe*	*30^0 32' 52.0116"*	*30^0 36' 50.133"*
U80D-05375	*Mhlabatshane*	*30^0 34' 17.0363"*	*30^0 35' 4.1208"*
U80D-05361	*Mhlungwa*	*30^0 34' 59.6459"*	*30^0 33' 38.926"*
U80D-05374	*Mfazazana*	*30^0 36' 25.4339"*	*30^0 31' 54.534"*
U80D-05345	*Kwa-Makosi*	*30^0 36' 36.8496"*	*30^0 31' 33.085"*
U80D-05327	*Mnamfu*	*30^0 37' 28.9991"*	*30^0 30' 30.272"*
U80F-05270	*Mtwalume*	*30^0 38' 8.16000"*	*30^0 29' 6.6300"*
U80G-05302	*Mvuzi*	*30^0 38' 51.4104"*	*30^0 28' 11.276"*
U80G-05097	*Fafa*	*30^0 39' 13.0068"*	*30^0 27' 24.073"*
U80H-05229	*Mdesingane*	*30^0 40' 17.7275"*	*30^0 25' 33.772"*
U80H-05202	*Sezela*	*30^0 40' 39.8747"*	*30^0 24' 54.046"*
U80H-05186	*Mkumbane*	*30^0 40' 58.2060"*	*30^0 24' 20.185"*
U80H-05109	*uMuziwezinto*	*30^0 42' 32.9219"*	*30^0 22' 3.5075"*

IUA Code	NAME	X-Coordinate	Y-Coordinate
U80H-05120	Nkomba	30^{0} 43' 13.3608"	30^{0} 21' 10.357"
U80H-05120	Mzimayi	30^{0} 43' 38.3448"	30^{0} 20' 47.292"
U80K-04952	Mpambanyoni	30^{0} 45' 33.4655"	30^{0} 16' 49.432"
U80L-05020	Mahlongwa	30^{0} 45' 50.1336"	30^{0} 16' 8.8968"
U80L-05056	Mahlongwane	30^{0} 47' 37.4424"	30^{0} 13' 30.478"
U10M-04746	uMkhomazi	30^{0} 48' 13.9248"	30^{0} 12' 9.3203"
U70E-05010	Ngane	30^{0} 49' 1.67159"	30^{0} 10' 43.824"
U70E-04974	Umgababa	30^{0} 49' 50.6171"	30^{0} 9' 20.4120"
U70E-04942	Msimbazi	30^{0} 50' 51.5724"	30^{0} 7' 46.2863"
U70D-04905	Lovu	30^{0} 51' 27.2700"	30^{0} 6' 19.5552"
U70F-04893	Little aManzimtoti	30^{0} 52' 23.7395"	30^{0} 4' 40.9152"
U70F-04845	aManzimtoti	30^{0} 53' 4.71480"	30^{0} 3' 30.8159"
U60E-04792	Mbokodweni	30^{0} 56' 12.4367"	30^{0} 0' 34.9524"
U60E-04827	Sipingo	30^{0} 57' 4.53959"	29^{0} 59' 45.229"
U60F-04684	Durban Bay	31^{0} 3.' 45.0288"	29^{0} 51' 58.085"
U20M-04543	uMngeni	31^{0} 2.' 33.4031"	29^{0} 48' 30.585"
U30B-04498	Mhlanga	31^{0} 6.' 5.30279"	29^{0} 42' 10.832"
U30B-04475	uMdloti	31^{0} 7.' 44.9328"	29^{0} 39' 2.1348"
U30D-04315	uThongathi	31^{0} 11' 5.58600"	29^{0} 34' 24.275"
U30E-04207	Mhlali	31^{0} 16' 41.4119"	29^{0} 27' 36.575"
U30E-04207	Bob's Stream	31^{0} 17' 41.0496"	29^{0} 26' 16.717"
U30E-04256	Seteni	31^{0} 18' 10.4544"	29^{0} 25' 45.667"
U40J-03998	Mvoti	31^{0} 20' 5.47439"	29^{0} 23' 30.775"
U50A-04141	Mdlotane	31^{0} 22' 25.7844"	29^{0} 21' 8.6507"
U50A-04021	Nonoti	31^{0} 24' 25.4880"	29^{0} 19' 7.8852"
U50A-04018	Zinkwasi	31^{0} 26' 36.5207"	29^{0} 16' 53.724"

11 APPENDIX B. DETAILED METHOD AND SCORES FOR INDIVIDUAL ESTUARY COMPONENTS

Appendix B provides the detailed methods and scores for the abiotic and biotic componentsof the Mvoti to Umzimkulu WMA estuaries.

11.1 HYDROLOGY

11.1.1 Hydrological modelling approach

The hydrology in this catchment was modelled using three different models:

- *Water Resources Yield Model*
- *WRSM2000*
- *Water Resources Modelling Platform*

Where existing models were setup and calibrated the data was sourced otherwise the assessment relied on the outputs from Water Research Commission WRC K5/2187: The vulnerability of South Africa's estuaries to future water resource development based on their resilience to provide and assessment of modification in flows to the estuaries of Mvoti to Umzimkulu WMA.

11.1.2 The water resources yield model

The Water Resources Yield Model, developed and maintained by the Department of Water Affairs, has been set up for many of the major basins in South Africa. The intention is therefore to use these model setups wherever they are available, i.e. where they have modelled the whole catchment down to the estuary. The only missing component with existing Water Resources Yield Model setups is that these models do not have a function to produce cumulative natural flow time series. This can be overcome by developing an application to mine the hydrological data and compute this separately.

While the above list of models only accounts for 8 out of the 280 estuaries, it covers more than half of the catchment areas to be modeled by including the Orange catchment.

11.1.3 WRSM2000

As part of the WR 2005 project to update the hydrology for the whole of South Africa, the WRSM2000 model setups were updated for the whole of the country. These could be used to generate natural hydrology and, with some effort, also present hydrology. One of the problems to be overcome is that WRSM2000 model setup have historic water use data and not present day water use data. Hence any WRSM2000 model run using the existing setup would not produce stationery records. In order to produce a stationery record, all the water use time series would need to be changed to present day time series.
WRSM200 is however a source of national water use data. Most important, it contains estimated irrigated areas in each quaternary catchment. This was used to estimate irrigation use at quaternary scale.

11.1.4 The Water Resources Modelling Platform

The Water Resources Modelling Platform (WReMP), developed largely by IWR Water Resources with input from the Institute of Water Research and the University of Pretoria, is similar to WRYM in that it is a time series simulation model. It can therefore produce the reference and present day time series required of this Estuaries project. The main motivation for the development of WReMP was to develop a Windows based water resources model. At the time of it development WRYM was a dos based model and many practitioners still use WRYM in Dos mode.

The advantage of WReMP over WRYM for this particular application of modeling a large number of the estuaries in Mvoti to Umzimkulu WMA, is that this model has been structured to interface with databases referenced to South Africa's quaternary catchments. It is therefore relatively simple to set up models simply by indicating the quaternary catchments included in the setup and the relationship between these setups. In addition to the above, there are numerous existing WReMP setups which can be used to model reference and present day hydrology.

11.1.5 Summary of the changes in the hydrological components that drive condition in the Mvoti to Umzimkulu WMA estuaries.

Table 11.1 provides a summary of the hydrological characteristics the rivers that flow into the Mvoti to Umzimkulu WMA estuaries. It lists the catchment area (km^2), natural MAR (MCM/a), present MAR (MCM/a), the percentage change in MAR, and percentage change in the baseflows (the 25 percentile was use as indicative of baseflows). As no flood hydrology was available, change in MAR was taken as indicative of modifications to the flood regime. The overall hydrology score was calculated as:

Hydrology score = (% MAR remaining x 0.4) + (% Baseflows remaining x 0.6)

Table 11.1 Assessment of the hydrology of the Mvoti to Umzimkulu WMA estuaries.

Estuary	Catchment area (km^2)	Natural MAR (MCM/a)	Present MAR (MCM/a)	% MAR change	% baseflow change	MAR score	Baseflow Score	Hydrology Score
Mtamvuma	1 586.0	275.2	239.5	-13.0	20.0	87	80	B
Zolwane	8.3	2.2	2.3	5.8	0.0	94	100	A
Sandhlunlu	19.2	5.1	5.0	-1.5	-8.8	98	91	A
Kuboyoyi	3.8	1.0	1.0	-0.6	0.0	99	100	A
Tongazi	26.4	7.0	7.2	3.4	4.3	97	96	A
Kandanhlovu	5.8	1.5	1.6	4.4	0.0	96	100	A
Mpenjati	89.6	23.6	23.5	-0.3	-2.6	100	97	A
Umhlangankulu	10.9	2.9	2.9	0.2	-10.5	100	89	A
Kaba	12.1	3.1	3.1	-2.3	-5.0	98	95	A
Mbizana	137.9	36.3	35.5	-2.1	-8.4	98	92	A
Mvuthsini	6.6	1.7	1.6	-1.4	12.5	99	88	A
Bilanhlolo	19.8	5.0	5.0	-0.9	-6.1	99	94	A
Umvazana	4.2	1.0	1.0	0.0	0.0	100	100	A
Kongweni	7.9	1.9	3.0	51.6	91.7	48	8	E

Estuary	Catchment area (km^2)	Natural MAR (MCM/a)	Present MAR (MCM/a)	% MAR change	% baseflow change	MAR score	Baseflow Score	Hydrology Score
Vungu	110.0	27.8	28.9	3.9	15.7	96	84	B
Mhlangeni	37.2	9.3	9.6	2.9	-35.0	97	65	B
Zotsha	62.5	15.7	16.2	3.2	0.0	97	100	B
Boboyi	32.1	8.2	8.0	-2.6	22.6	97	77	B
Mbango	11.8	3.0	7.3	143.7	552.6	-44	0	D
Umzimkulu	6 678.0	1 452.5	1 175.1	-19.1	-37.6	81	62	B
Mtentwini	64.6	12.1	11.1	-7.7	-35.0	92	65	B
Mhlangamkulo	11.2	2.1	1.7	-16.1	-73.3	84	27	D
Domba	24.4	4.6	3.9	-15.6	-75.7	84	24	D
Koshwani	11.2	2.1	2.0	-5.0	-75.7	95	24	D
Inhshambili	34.4	6.5	4.9	-24.9	-82.7	75	17	D
Mzumbe	536.2	58.5	53.7	-8.2	-20.6	92	79	B
Mhlabatshane	33.9	6.5	6.5	0.3	-3.8	100	96	A
Mhlungwa	29.7	5.8	5.7	-1.9	-10.2	98	90	A
Mfazazana	14.2	2.8	2.6	-7.2	-36.4	93	64	B
KwaMakozi	16.6	3.2	3.0	-6.3	-23.1	94	77	B
Mnamfu	15.8	3.1	2.9	-6.3	-75.7	94	24	C
Mtwalume	563.0	57.6	42.8	-25.7	-73.9	74	26	B
Mvuzi	8.6	1.6	1.5	-6.1	-13.3	94	87	B
Fafa	242.5	46.4	37.6	-19.0	-40.6	81	59	C
Mdesingane	11.8	2.0	2.0	0.0	-10.5	100	89	A
Sezela	22.5	3.9	3.7	-6.4	-23.5	94	76	B
Mkumbane	21.7	3.8	3.5	-6.6	-20.6	93	79	B
uMuziwezinto	134.4	23.2	20.1	-13.3	-51.0	87	49	C
Nkomba	4.0	0.7	0.7	0.0	-10.5	100	89	A
Mzimayi	35.3	6.1	4.9	-19.5	-35.7	80	64	C
Mpambanyoni	539.8	60.1	54.9	-8.5	-15.6	91	84	B
aMahlongwa	87.5	13.8	13.2	-4.3	-14.6	96	85	B
Mahlangwana	17.3	2.7	2.9	9.1	17.4	91	83	B
uMkhomazi	4 398.0	1 077.7	926.1	-14.1	-52.1	86	48	C
Ngane	12.6	3.8	4.3	12.2	26.8	88	73	B
Umgababa	35.2	10.6	9.6	-9.3	-36.2	91	64	C
Msimbazi	32.9	10.0	10.3	3.0	2.8	97	97	A
Lovu	951.0	105.8	73.5	-30.6	-62.1	69	38	D
Little aManzimtoti	17.0	2.8	6.6	132.5	188.5	-33	-88	D
aManzimtoti	32.0	5.3	6.7	27.4	40.0	73	60	C
Mmbokotwini	243.0	31.5	53.5	69.8	133.7	30	-34	C
Sipingo*	11.2**	89.85	9.48	90	95	10	5	F
Durban Bay	229.0	36.3	63.4	74.6	90	25	10	F
uMngeni	4 416.0	671.3	262.7	-60.9	-34.0	39	66	D
Mhlanga	84.4	13.3	22.3	67.5	105.0	33	-5	D
uMdloti	486.0	85.8	71.9	-16.2	-33.0	84	67	B

Estuary	Catchment area (km^2)	Natural MAR (MCM/a)	Present MAR (MCM/a)	% MAR change	% baseflow change	MAR score	Baseflow Score	Hydrology Score
uThongathi	408.0	70.8	71.2	0.6	5.0	**99**	**95**	**A**
Mhlali	247.0	56.3	54.2	-3.6	-24.6	**96**	**75**	**B**
Bobstream	2.3	0.5	0.5	0.0	0.0	**100**	**100**	**A**
Seteni	6.2	1.4	1.4	0.0	0.0	**100**	**100**	**A**
Mvoti**	2 751.0	420.0	314.0	-25.2	25.0	**75**	**75**	**C**
Mdlotane	29.8	6.0	5.8	-3.2	0.0	**97**	**100**	**A**
Nonoti	177.0	36.2	34.7	-4.1	-15.3	**96**	**85**	**B**
Zinkwazi	71.4	14.5	14.0	-3.2	0.0	**97**	**100**	**A**

**Sipingo catchment area used to be 45 km^2*
***Mvoti Estuary hydrology was not modelled as part of the desktop assessment and is based on the results of the historical EFR Study. To be updated as part of this study.*

11.2 HYDRODYNAMICS

Estuary mouth state (used as proxy for hydrodynamics) was evaluated based on percentage change in MAR, percentage change in baseflows, the degree of connectivity to the marine environment, and the average depth of the estuary. Table 11.2 provides a summary of the changes in mouth state of the Mvoti to Umzimkulu WMA estuary health assessment.

Table 11.2 An assessment of the hydrodynamics (mouth state) of the Mvoti to Umzimkulu WMA estuaries.

Name	% Mouth Open	Depth	Hydrodynamics	Artificial Breaching
Mtamvuna	95	3	**A**	?
Zolwane	81	2	**A**	Y
Sandlundlu	60	2	**A**	Y
Ku-Boboyi	53	1	**B**	
Tongazi	91	2	**A**	
Kandandhlovu	54	1	**B**	
Mpenjati	71	2	**A**	Y
Umhlangankulu	33	2	**A**	Y
Kaba	27	1	**A**	
Mbizana	54	1	**A**	?
Mvutshini	42	1	**B**	Y
Bilanhlolo	47	1	**A**	Y
Uvuzana	32	1	**A**	Y
Kongweni	49	2	**E**	Y
Vungu	96	15	**A**	
Mhlangeni	55	1	**B**	Y
Zotsha	76	2	**C**	Y

Name	% Mouth Open	Depth	Hydrodynamics	Artificial Breaching
Boboyi	*94*	*1*	**A**	
Mbango	*86*	*2*	**D**	
Umzimkulu	*97*	*3*	**B**	*Y*
uMthente	*40*	*2*	**B**	
Mhlangamkulu	*19*	*2*	**C**	
Damba	*28*	*1*	**D**	*Y*
Koshwana	*26*	*1*	**C**	
Intshambili	*42*	*1*	**C**	
Mzumbe	*74*	*1*	**B**	
Mhlabatshane	*50*	*2*	**A**	
Mhlungwa	*29*	*1*	**A**	
Mfazazana	*24*	*1*	**C**	
Kwa-Makosi	*37*	*1*	**B**	
Mnamfu	*42*	*1*	**C**	
Mtwalume	*71*	*1*	**C**	
Mvuzi	*23*	*2*	**C**	
Fafa	*45*	*1*	**B**	*Y*
Mdesingane	*58*	*1*	**A**	
Sezela	*19*	*2*	**B**	*Y*
Mkumbane	*8*	*2*	**B**	
uMuziwezinto	*15*	*2*	**B**	*?*
Nkomba	*10*	*1*	**A**	
Mzimayi	*20*	*1*	**B**	
Mpambanyoni	*78*	*1*	**A**	*?*
Mahlongwa	*22*	*1*	**A**	*Y*
Mahlongwane	*13*	*2*	**A**	*?*
uMkhomazi	*99*	*2*	**A**	*Y*
Ngane	*54*	*1*	**B**	*?*
Umgababa	*46*	*1*	**B**	*Y*
Msimbazi	*36*	*1*	**A**	
Lovu	*77*	*1*	**C**	*Y*
Little aManzimtoti	*72*	*1*	**F**	*Y, water quality*
aManzimtoti	*44*	*1*	**C**	*Y*
Mbokodweni	*86*	*2*	**E**	*Y, water quality*
Sipingo	*5*	*2*	**F**	
Durban Bay	*100*	*2*	**A**	
uMngeni	*95*	*2*	**B**	*Y*
Mhlanga	*48*	*2*	**E**	*Y*
uMdloti	*40*	*1*	**C**	*Y*
uThongathi	*84*	*2*	**A**	*Y*
Mhlali	*48*	*1*	**B**	*Y*
Bob's Stream	*20*	*1*	**A**	
Seteni	*35*	*1*	**A**	
Mvoti	*99*	*1*	**B**	*Y*
Mdlotane	*14*	*2*	**A**	
Nonoti	*18*	*2*	**A**	*Y*

Name	% Mouth Open	Depth	Hydrodynamics	Artificial Breaching
Zinkwasi	28	1	A	Y

11.3 PHYSICAL HABITATS

Table 11.3 provides a summary of the changes in the physical habitat of the Mvoti to Umzimkulu WMA estuaries.

Table 11.3 Assessment of the Physical habitat of the Mvoti to Umzimkulu WMA estuaries.

Name	Physical Habitat Condition	Mining	Bridges	Mouth	Breaching
Zinkwasi	C	Sand (1)			
Nonoti	C	Sand (1)			
Mdlotane	B				
Mvoti	D	Sand (5)			
Seteni	D				
Bob's Stream	D				
Mhlali	D	Sand (4)	Wier?		
uThongathi	D	Sand (2)	Bridge (S)		
uMdloti	C	Sand (3)	Bridge (s)		
Mhlanga	D		Bridge (S)		Y
uMngeni	E	Sand (2)	Bridge (S)	Mouth stabilised	Y
Durban Bay	F			Port	
Sipingo	F			Culverts	
Mbokodweni	D	Sand (8)	Bridge (S)	Mouth stabilised	Y, water quality
aManzimtoti	D	Sand (1)	Bridge (S)		Y
Little aManzimtoti	B		Bridge (S)		Y, water quality
Lovu	D	Sand (7)	Bridge (S)		Y
Msimbazi	C		Bridge (S)		
Umgababa	C		Bridge (S)		Y
Ngane	D		Bridge (S)		?
uMkhomazi	D	Sand (6)	Bridge (S)		Y
Mahlongwane	D		Bridge (S)		?
Mahlongwa	D	Sand (2)	Bridge (S)		Y
Mpambanyoni	D	Sand (1)	Bridge (S)		?
Mzimayi	C		Bridge (S)		
Nkomba	C		Bridge (S)		
uMuziwezinto	D		Bridge (S)		?
Mkumbane	C		Bridge (S)		
Sezela	D		Bridge (S)		Y
Mdesingane	D		Bridge (S)		
Fafa	D	Sand (2)	Bridge (S)		Y
Mvuzi	D		Bridge(s)		
Mtwalume	C	Sand (2)	Bridge(s)		
Mnamfu	C		Bridge(s)		
Kwa-Makosi	C		Bridge(s)		
Mfazazana	D		Bridge(s)		

Name	Physical Habitat Condition	Mining	Bridges	Mouth	Breaching
Mhlungwa	E		Bridge(s)		
Mhlabatshane	C		Bridge(s)		
Mzumbe	D	Sand (2)	Bridge(s)		
Intshambili	C		Bridge(s)		
Koshwana	D		Bridge(s)		
Damba	D		Bridge(s)		Y
Mhlangamkulu	C		Bridge(s)		
uMthente	D		Bridge(s)		
Umzimkulu	C	Sand (5)	Bridge(s)		Y
Mbango	D		Bridge(s)		
Boboyi	C		Bridge(s)		
Zotsha	B	Sand (2)	Bridge(s)		Y
Mhlangeni	D		Bridge(s)	Sandbag	Y
Vungu	B		Bridge(s)		
Kongweni	D		Bridge(s)		Y
Uvuzana	C		Bridge(s)		Y
Bilanhlolo	D		Bridge(s)		Y
Mvutshini	B		Bridge(s)		Y
Mbizana	C	Sand (1)	Bridge(s)		?
Kaba	C		Bridge(s)		
Umhlangankulu	D		Bridge(s)		Y
Mpenjati	D	Sand (2)	Bridge(s)		Y
Kandandhlovu	C		Bridge(s)		
Tongazi	B		Bridge(s)		
Ku-Boboyi	B		Bridge(s)		
Sandlundlu	C	Sand?	Bridge(s)	Mouth Stabilised	Y
Zolwane	A				Y
Mtamvuna	B		Bridge(s)		?

11.4 WATER QUALITY

11.4.1 Salinity

Salinity was evaluated based on estuary volume, relative depth, mouth state and percentage change in average monthly flow (Table 11.4). A volumetric relationship was used provide a guideline for scoring, but moderated with expert opinion.

$Volume_{inflow}/Volume_{estuary}$

If ratio >30 assumed estuary is nearly fresh (5 PSU);

If ratio between 30 - 5 assumed estuary is brackish (>2m deep=15 PSU /<2m deep=10 PSU);

If ratio >5 assumed estuary is saline (30 PSU > 50% open / 20 PSU < 50% open).

Table 11.4 An assessment of the salinity changes of the Mvoti to Umzimkulu WMA estuaries

Name	% Mouth Open	Depth	Salinity
Mtamvuna	95	3	A

Name	% Mouth Open	Depth	Salinity
Zolwane	*81*	*2*	**A**
Sandlundlu	*60*	*2*	**A**
Ku-Boboyi	*53*	*1*	**A**
Tongazi	*91*	*2*	**A**
Kandandhlovu	*54*	*1*	**B**
Mpenjati	*71*	*2*	**A**
Umhlangankulu	*33*	*2*	**B**
Kaba	*27*	*1*	**A**
Mbizana	*54*	*1*	**A**
Mvutshini	*42*	*1*	**B**
Bilanhlolo	*47*	*1*	**A**
Uvuzana	*32*	*1*	**A**
Kongweni	*49*	*2*	**D**
Vungu	*96*	*15*	**A**
Mhlangeni	*55*	*1*	**B**
Zotsha	*76*	*2*	**D**
Boboyi	*94*	*1*	**A**
Mbango	*86*	*2*	**D**
Umzimkulu	*97*	*3*	**B**
uMthente	*40*	*2*	**B**
Mhlangamkulu	*19*	*2*	**B**
Damba	*28*	*1*	**B**
Koshwana	*26*	*1*	**B**
Intshambili	*42*	*1*	**B**
Mzumbe	*74*	*1*	**B**
Mhlabatshane	*50*	*2*	**A**
Mhlungwa	*29*	*1*	**A**
Mfazazana	*24*	*1*	**B**
Kwa-Makosi	*37*	*1*	**B**
Mnamfu	*42*	*1*	**B**
Mtwalume	*71*	*1*	**B**
Mvuzi	*23*	*2*	**C**
Fafa	*45*	*1*	**B**
Mdesingane	*58*	*1*	**A**
Sezela	*19*	*2*	**B**
Mkumbane	*8*	*2*	**B**
uMuziwezinto	*15*	*2*	**B**
Nkomba	*10?*	*1*	**A**
Mzimayi	*20*	*1*	**B**
Mpambanyoni	*78*	*1*	**A**
Mahlongwa	*22*	*1*	**A**
Mahlongwane	*13*	*2*	**A**
uMkhomazi	*99*	*2*	**B**
Ngane	*54*	*1*	**B**
Umgababa	*46*	*1*	**B**
Msimbazi	*36*	*1*	**A**
Lovu	*77*	*1*	**C**

Name	% Mouth Open	Depth	Salinity
Little aManzimtoti	*72*	*1*	F
aManzimtoti	*44*	*1*	C
Mbokodweni	*86*	*2*	F
Sipingo	*5?*	*2*	F
Durban Bay	*100*	*2*	A
uMngeni	*95*	*2*	F
Mhlanga	*48*	*2*	E
uMdloti	*40*	*1*	F
uThongathi	*84*	*2*	F
Mhlali	*48*	*1*	B
Bob's Stream	*20?*	*1*	A
Seteni	*35*	*1*	A
Mvoti	*99*	*1*	B
Mdlotane	*14*	*2*	A
Nonoti	*18*	*2*	B
Zinkwasi	*28*	*1*	A

11.4.2 Other water quality parameters

Water quality information on the estuaries of WMA11 is very limited. In order to estimate the present status of water quality in these estuaries water quality conditions were estimated from various sources draining into each estuary (Figure 11.1). Three sources were considered, namely:

- **River inflow** *into the estuary*
- **Effluents from wastewater treatment plants** *(WWTW) discharged directly into estuaries.*
- **Urban stormwater runoff** *entering along the banks of the estuary*

For a specific estuary, the daily volume for river inflow were estimated from Present Mean Annual Runoff (MAR), e.g. MAR/365 = Estimated daily volume.

Daily effluent volumes from WWTW were obtained from the responsible authorities and are summarised in Table 11.5.

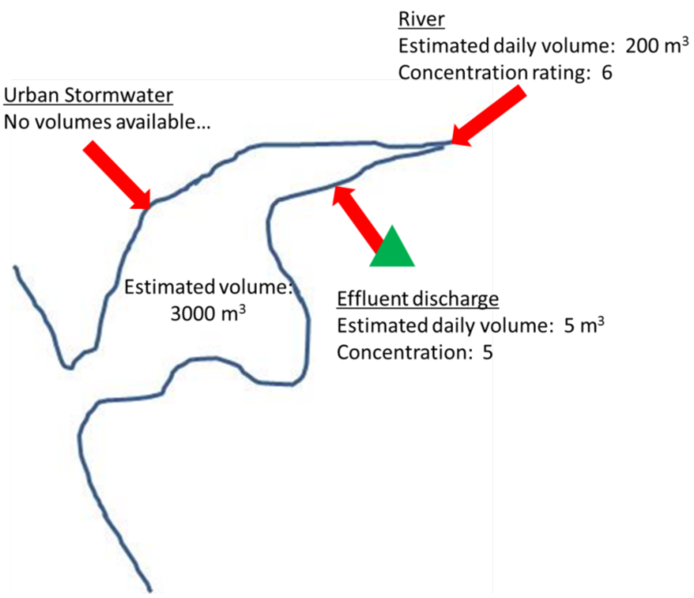

Figure 10.1 Schematic illustration of the approach adopted for water quality condition.

Table 11.5 Daily WWTW volumes discharged into the estuaries.

Estuary	WWTW	Daily Volume (M^3)	Position of discharge
Mvutshini	*Ramsgate*	*1 300*	*Just upstream into river*
Kongweni	*Margate*	*4 998*	*Estuary*
Vungu	*Uvongo*	*1 500*	*Estuary*
Koshwana			*WWTW in middle reach next to estuary?*
uMkhomazi	*Umkomaas*	*1 000*	*Estuary*
Little aManzimtoti	*Kingsburgh*	*5 000*	*Just upstream in river*
Mbokodweni	*Isipingo*	*16 000*	*Estuary*
	aManzimtoti	*24 000*	*Estuary*
Durban Bay	*Umbilo*	*16 000*	*Estuary*
	Umhlatuzana	*10 000*	*Estuary*
uMngeni	*Kwa-Mashu*	*67 000*	*Just upstream into river*
	Northern	*54 000*	*Just upstream into river*
	New Germany	*1 000*	*Just upstream into river*
	Phoenix	*>8 000*	*Via Mhlangane River into river*
uThongathi	*Tongaat*	*7 000*	*Just upstream into river*
	Frasers	*5 000*	*Just upstream into river*
Mvoti	*Stanger-Kwadukuza*	*4 000*	*Estuary*

It was not possible to obtain reasonable estimated of daily volumes for urban stormwater runoff directly into the estuary.

For the purposes of this study present water quality (WQ) of sources were rated as a “Modification from Reference” as follows:

1 = no difference
2 = some modification
3 = moderate modification
4 = large modification
5 = high modification
6 = severe modification

In the case of WWTW effluent a rating of **6** *(severe modification) was allocated as a default. This was based on the assumption that even if WWTW is treated to General or Special Standards (according to the General Authorisation Regulations of 2004 under the National Water Act), dissolved inorganic nitrogen (DIN) concentrations in effluent will still be relatively high. For example general and special standards for DIN is 21 000 μg/ℓ and 3 500 μg/ℓ, respectively (Estuaries typically range between 50-150 μg/ℓ). Similarly General and Special standard concentrations for DIP are 10 000 μg/ℓ and 1000 μg/ℓ, respectively (estuaries typically range between 10-20 μg/ℓ). The water quality ratings for river inflow were estimated from the PES allocated to the river water quality allocated as part of the river component of this study. The water quality rating for stormwater was based on expert judgement and visual observations from Google Earth.*

Using the above information, the influence of various sources on the water quality of an estuary was estimated as follows:

1. Allocate a **water quality rating** *(1 to 6) to each source entering into the estuary (e.g. river, effluent and/or urban stormwater)*

2. In the case of river inflow and WWTW effluent calculate a **volume fraction** *as a ratio of the Estuary:*

$Vol_{estuary}/Volume_{inflow}$ (e.g. ratio >1, input has high influence on estuary water quality; ratio <0.25 input has low influence on estuary water quality)

3. For river and WWTW effluent **estimate effect on estuary water quality** *of specific source as follows:*

		WQ rating of Inflow					
		1	2	3	4	5	6
Volume fraction: Estuary volume/Daily inflow volume	> 1	1	2	3	4	5	6
	1-0.75	1	2	3	4	5	6
	0.75-0.5	1	1	2	3	4	5
	0.5-0.25	1	1	1	2	3	4
	<0.25	1	1	1	1	2	3

4. *In the case of stormwater, use the water quality rating and visual observation of area and extent of urban development along banks of the estuary to* **estimate effect on estuary water quality**
5. *Use the* **maximum "estimated effect on estuary water quality" of either river inflow, WWTW effluent or urban stormwater** *as the* **preliminary water quality condition** *in estuary.*
6. *Modify the preliminary water quality conditions in the estuary based on* **% open/closed mouth** *as follows:*

		Preliminary Estuary WQ condition					
		1	2	3	4	5	6
Percentage mouth open	>70%	1	2	3	4	5	6
	70-40%	2	3	4	5	5	6
	40-0%	3	4	5	5	5	6

The present day water quality condition estimated for estuaries in the Mvoti to Umzimkuluare presented in Table 11.6.

The final scoring from A to F represents the following:

A = no difference;
B = some modification;

C = moderate modification;
D = large modification;
E = high modification; and
F = severe modification.

Table 11.6. Assessment of the water quality of the Mvoti to Umzimkulu WMA estuaries.

Name	Overall estuary WQ condition	% Mouth open	Prelim estuary WQ condition	Estimated effect on estuary WQ		
				WWTW	Urban stormwater/ agricultural return flows along banks	River inflow
Mtamvuna	A	95	1			1
Zolwane	A	81	1			1
Sandlundlu	B	60	1			1
Ku-Boboyi	B	53	1			1
Tongazi	C	91	3		3	3
Kandandhlovu	C	54	2		2	1
Mpenjati	C	71	3	3	3	1
Umhlangankulu	E	33	3		3	1
Kaba	D	27	2			2
Mbizana	B	54	1			1
Mvutshini	C	42	2			2
Bilanhlolo	D	40	2		2	1
Uvuzana	D	32	2		2	1
Kongweni	D	49	3	3	3	1
Vungu	D	96	4	3		4
Mhlangeni	C	55	2			2
Zotsha	D	70	3		3	2
Boboyi	C	94	3		3	3
Mbango	E	86	5	5	4	3
Umzimkulu	B	97	2			2
uMthente	B	41	1			1
Mhlangamkulu	C	19	1			1
Damba	C	28	1			1
Koshwana	C	26	1			1
Intshambili	C	42	2			2
Mzumbe	C	70	2			2
Mhlabatshane	B	50	1			1
Mhlungwa	C	29	1			1
Mfazazana	C	24	1			1
Kwa-Makosi	B	41	1			1
Mnamfu	C	40	1			1
Mtwalume	C	70	2			2
Mvuzi	C	23	1			1
Fafa	C	40	1			1
Mdesingane	D	40	2			2
Sezela	D	19	2		2	1
Mkumbane	D	8	2			2
uMuziwezinto	D	50	3			3
Nkomba	D	10	2			2
Mzimayi	D	20	2			2
Mpambanyoni	C	78	3		3	2

Name	Overall estuary WQ condition	% Mouth open	Prelim estuary WQ condition	Estimated effect on estuary WQ		
				WWTW	Urban stormwater/ agricultural return flows along banks	River inflow
Mahlongwa	C	22	1			1
Mahlongwane	D	13	2		2	1
uMkhomazi	C	99	3	3		2
Ngane	D	54	3		3	3
Umgababa	B	46	1			1
Msimbazi	E	36	3		3	1
Lovu	C	70	2			2
Little aManzimtoti	E	70	4		4	3
aManzimtoti	E	40	3		3	1
Mbokodweni	E	86	5	4	3	5
Sipingo	E	5	3		3	1
Durban Bay	C	100	3	3	3	1
uMngeni	F	95	6			6
Mhlanga	D	48	3		2	3
uMdloti	F	40	4			4
uThongathi	F	84	6			6
Mhlali	D	40	2			2
Bob's Stream	D	10	2			2
Seteni	C	41	2			2
Mvoti	F	99	6	3		6
Mdlotane	C	14	1			1
Nonoti	E	18	1		1	1
Zinkwasi	C	28	1			1

11.5 MACROPHYTES

11.5.1 Macrophyte groups

Nine different habitat types are recognised for estuaries (Table 11.7). These include the microalgal habitats e.g. open water surface areas and intertidal sand and mudflats as the area covered by each habitat is used to calculate the overall botanical importance of an estuary. The most common macrophyte habitats in Mvoti to Umzimkulu WMA are reeds and sedges due to the freshwater nature of these small systems. Submerged macrophytes, plants that are rooted in the substrate with their leaves in the water column, are uncommon in KwaZulu-Natal's small estuaries. They cannot withstand silt deposition and are sensitive to light reduction which reduces photosynthesis and primary production. Sediment resuspension due to flooding causes temporary smothering of these plants. Human impacts such as dredging can cause the same effect. Lagoon swamp forest occurs in many of KZN's estuaries where they are found as isolated patches in the upper reaches of permanently open estuaries or are dominant in the smaller, fresher temporarily open/closed estuaries such as uMdloti. In permanently open estuaries they can also occur at sites where freshwater seeps from adjacent coastal dunes. Unfortunately much of the area of swamp forest has been lost to development, agriculture and forestry. Salt marsh and mangroves are also restricted in distribution and abundance as they occur in saline habitats which are uncommon because of the high rainfall and freshwater conditions of the many small estuaries.

Table 11.7 Macrophyte habitats and functional groups recorded in the Mvoti to Umzimkulu WMA estuaries (spp. examples in italics).

Habitat type	Species
Open surface water areas	*Proxy as available habitat for phytoplankton.*
Intertidal sand and mudflats	*Indicates available habitat for intertidal and sub-tidal benthic microalgae.*
Submerged macrophyte beds	*Zostera capensis, Ruppia cirrhosa, Potamogeton pectinatus (now known as Stuckenia pectinata)*
Macroalgae	*Ulva spp., Enteromorpha spp.*
Intertidal salt marsh	*Sarcocornia tegetaria, Triglochin spp.*
Supratidal salt marsh	*Sarcocornia pillansii, Sporobolus virginicus.*
Reeds and sedges	*Phragmites australis, Schoenoplectus scirpoides, Juncus kraussii*
Mangroves	*Avicennia marina, Rhizophora mucronata, Bruguiera gymnorrhiza.*
Swamp forest	*Barringtonia racemosa, Hibiscus tiliaceus*

11.5.2 Baseline description: Species diversity, richness and rarity

Historically estuaries along the KwaZulu-Natal coastline supported restricted macrophyte communities as they are often perched with steep channels and narrow riparian areas. Permanently open estuaries within this WMA support fringes of mangrove and swamp forest habitats. Development and utilisation for wood has led to the loss of mangroves from a number of the systems. In general the temporarily open/closed estuaries do not support salt marsh and mangrove habitats as they require tidal inundation and saline conditions. All habitats are dependent on flooding (both tidal and riverine) and suitable salinity. Any changes in these drivers will reduce the species richness, growth, cover, distribution and community composition. Anthropogenic activity, particularly the N2 bridges, cultivation of sugarcane in the floodplain; and input from Wastewater Treatment Works (WWTW) have impacted these estuaries. Loss of riparian habitat and proliferation of alien vegetation is problematic.

11.5.3 Factors affecting the abundance of different macrophytes groups

The effect of abiotic characteristics and processes, as well as other biotic components on macrophyte habitats is described in Table 11.8.

Table 11.8 Effect of abiotic characteristics and processes, as well as other biotic components on macrophyte habitats.

Process	Macrophytes
Mouth condition (provide temporal implications where applicable)	*Open mouth conditions favour the establishment and growth of mangroves, which only occur in permanently open systems. Sand and mudflats may increase in area under open mouth condition due to a decrease in water area. Closed mouth conditions and a rise in water level for prolonged droughts can result in macrophyte die back.*
Retention times of water masses	*During closed mouth conditions (i.e. long retention time) it is likely that nutrient levels in the estuaries would increase providing optimal conditions for reed expansion.*
Flow velocities (e.g.	*Submerged macrophytes and macroalgae are washed out of estuaries under high*

Process	Macrophytes
tidal velocities or river inflow velocities)	*flow conditions.*
Total volume and/or estimated volume of different salinity ranges	*Different macrophytes are distributed along a salinity gradient.*
Floods	*Major flood scour the estuaries removing reeds and fringing communities thus increasing open water habitats. These are important for resetting estuaries and preventing reed expansion.*
Salinity	*Reeds, sedges, swamp forest are indicative of low salinity conditions (<15 ppt) whereas salt marsh and mangroves prefer high salinity conditions (>25 ppt).*
Turbidity	*High turbidity can result from catchment disturbance and sediment runoff. This reduces the light available to submerged macrophytes and causes die-back.*
Dissolved oxygen	*Eutrophication caused by increased nutrient input depletes oxygen. Prolonged anoxic conditions reduce the growth of mangroves.*
Nutrients	*Increased nutrients input from agricultural runoff and treated effluent from WWTW will enable proliferation of reeds and sedges as well as nuisance aquatic macrophytes which are mostly alien species such as Azolla and Eicchornia (water hyacinth).*
Sediment characteristics (including sedimentation)	*Extensive sediment transport occurs during flooding. Development of the N2 resulted in the infilling of open water and riparian areas. Poor agricultural practices have caused erosion.*
Other biotic components	*Alien invasive species are problematic in both the riparian fringes- Syringa (Melia azederach) and Brazilian pepper tree (Schinus terebinthifolia); and open water- water hyacinth (Eichhornia crassipes) and Nile cabbage (Pistia stratiotes).*

11.5.4 Summary of the macrophytes condition in Mvoti to Umzimkulu WMA

Available literature was summarised to identify the change in macrophyte habitats (Table 11.9). An estimate was made of the percentage change in habitat from natural. This was done using available literature, aerial photographs and Google imagery. The percentage change was assigned to five main pressures; loss of habitat as a result of disturbance which could be development or agriculture, eutrophication, loss of habitat due to invasion by alien plants, loss of mangroves, sedimentation and reed expansion.

Table 11.9 A summary of the macrophyte conditions of the Mvoti to Umzimkulu WMA estuaries based on available information. The following historical assessments are summarised below: Begg (1978) condition (G=Good, F=Fair, D=Degraded, HD=Highly disturbed);Forbes & Demetriades (2009) Pressure (H=High, M=Medium, L=Low); Harrison (2000) Aesthetic score (G=Good, M=Moderate, P=Poor).

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
Mtamvuna		*G*		*M*	*10*		*5*	*5*		**B**	*Loss of mangrove area 1 ha, low density development in lower reaches, Lantana and Casuarina invasions in campsite on northern bank (Cooper et al. 1993). Day (1950) thin mossy algal carpet possibly Chara.*
Zolwane		*G*			*15*		*5*			**B**	*Conservation potential (Begg) few Casuarina trees (Cooper et al. 1993), 2013 Google : some impact from an upstream bridge, little estuarine habitat.*
Sandlundlu		*F*		*G*	*25*		*5*			**C**	*Entire floodplain utilised, campsite, small bridge crosses upper reaches, exotics present (Cooper et al. 1993). Submerged Ruppia or Zostera growing on the floor of the lagoon (in the 70s) (Begg 1968).*
Ku-Boboyi		*D*			*10*	*5*	*5*			**B**	*Near pristine, campsite has Lantana, grassing of shoreline (Cooper et al. 1993). No longer serves estuarine function (Begg 1968). KZN mapping (2013) reeds & sedges, coastal forest. 2013 Google : Possibly some runoff and pollution from surrounding development.*
Tongazi				*G*	*25*	*5*				**C**	*Pristine condition (Cooper et al. 1993). 2013 Google : some storm water and sewage input, upstream disturbance, therefore some change in macrophytes as a result possibly macroalgal blooms although only swamp forest recorded in botanical database.*
Kandandhlovu		*F*		*G*	*30*					**C**	*Loss of mangroves, Ward and Steinke (1982) recorded 0.5 ha Bruguiera gymnnorhiza. Undeveloped reeds in lower reaches and riverine forest in upper reaches, residential development in surrounds (Cooper et al. 1993). 2013 Google : upstream transformation, sedimentation and expansion of reeds, the estuary is now possibly fresher.*
Mpenjati				*M*	*25*	*5*				**C**	*45 % of floodplain used for recreational activities, 10 % sand mining, 2 bridges, moderate to dense residential development, Lantana and Chromolaena, filamentous algae observed during sampling (Cooper et al. 1993). Blooms of filamentous algae e.g. Chaetomorpha (Begg 1984).2013 Google : wastewater & stormwater inputs could increase macroalgal blooms*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											and reed and sedge expansion.
Umhlangankulu				*M*	*50*					**D**	*Residential and recreational activities within the floodplain (Cooper et al. 1993). 2013 two bridges, KZN mapping: swamp forest, botanical database includes swamp forest and reeds & sedges. Rajkaran in 2006 found no mangroves, Ward & Steinke (1982) recorded 0.5 ha of mangroves.*
Kaba				*G*	*20*		*10*			**C**	*Near natural, fairly dense residential development, some exotic vegetation, some reinforcement of the banks (Cooper et al. 1993) Chaetomorpha (filamentous algae) blooms recorded (Begg 1978), he also recorded reed encroachment due to shallowing. 2013 Potamogeton (pondweed) present in botanical database.*
Mbizana		*D*		*G*	*20*		*10*			**C**	*Almost entirely natural, abundant residential developments, low bridge, exotic vegetation (Cooper et al. 1993). 2013 Google : bridge would have influenced habitat, reeds & sedges and swamp forest present, there may have been some reed encroachment as a result of sedimentation and shallowing.*
Mvutshini				*G*	*20*	*10*				**C**	*Mainly natural, bridge, moderate residential development (Cooper et al. 1993). 2013 Google : no large macrophyte habitats, some reeds. Deterioration in water quality may result in macroalgal blooms.*
Bilanhlolo				*M*	*35*	*20*				**D**	*Loss of mangroves 0.5 ha Bruguiera gymnnorhiza (Rajkaran et al. 2009). Residential development in floodplain, sewage pipes (Cooper et al. 1993) Blooms of Chaetomorpha (Begg 1978). 2013 Google images: Possible loss of intertidal habitat and development in floodplain. Possible algal blooms due to wastewater input. KZN Wildlife mapped Hibiscus tiliaceus (swamp forest), coastal forest, reed swamps present.*
Uvuzana		*F*		*M*	*20*		*10*			**C**	*Mainly natural, bridge, dense residential development, pine trees (Cooper et al. 1993). 2013 Google : 4.5 ha of reeds, possible expansion due to sedimentation and bridge.*
Kongweni		*HD*		*P*	*40*	*15*		*5*		**E**	*Loss of mangroves, 0.5 ha Bruguiera gymnnorhiza (Rajkaran et al. 2009). Dense residential development, 60 % of shoreline unnatural (Cooper et al. 1993). 2013 Google : swamp forest, reeds & sedges, possible eutrophication, mouth manipulation.*
Vungu				*G*	*10*	*5*	*5*			**B**	*Mostly natural, multi-unit developments in the area, waterfall at head of estuary (Cooper et al. 1993). 2013 Google : steep sided with cliffs and only*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											some reeds present.
Mhlangeni				*M*	*20*	*10*			*10*	**D**	*Majorly impacted by freeway bridge and holiday flats on south bank. Dense residential development, algal bloom during sampling and covered with filamentous algae (Cooper et al. 1993). 2013 Google : 8 ha of reeds & sedges, possible expansion due to eutrophication and reduction in base flow.*
Zotsha	*25*			*M*						**C**	*Barringtonia on north bank and surrounds mainly agricultural grasslands. 70 % of floodplain used for residential and recreational activities, 30 % shoreline grassed, 3 bridges, invasive vegetation, few houses (Cooper et al. 1993)*
Boboyi		*F*		*G*	*20*	*0*		*0*	*10*	**C**	*Near pristine state, 50 % sugarcane surrounds the estuary, 2 bridges but no impacts (Cooper et al. 1993). Extensive reed swamp (Begg 1984). 2013 Google : some loss of habitat and disturbance due to bridges.*
Mbango		*F*		*P*	*50*	*10*				**E**	*30 % of floodplain occupied by a garage. 2 low bridges (Cooper et al. 1993). 2013 google : disturbance due to bridges, development, disturbed floodplain and infilling, reeds, sedges and swamp forest present. Eutrophication due to past sewage spills but there has been a recent improvement.*
Umzimkulu	*80*	*D*		*M*						**B**	*No natural floodplain- divided by recreational and industrial use, mouth stabilised on one side, south bank impacted by railway yards and factories, moderate turbidity and invasive aliens present (Cooper et al. 1993). Small salt marsh near the old ferry site (Juncus and Salicornia) and a carpet of green 'Vaucheria like' algae on the intertidal mud flats (Begg 1984).*
uMthente		*D*		*M*	*50*	*5*			*5*	**D**	*Caravan park, 3 bridges, 15 % of natural shoreline replaced with solid structure and artificially grassed, moderately dense residential developments (Cooper et al. 1993). Weir, fishing, sugarcane encroachment, macroalgal blooms (Chaetomorpha) periodically. 2013 Google shows development disturbance within the 5 m contour line. Base flow reduction and surrounding disturbance may have led to some reed encroachment.*
Mhlangamkulu		*F*		*G*	*45*	*5*		*5*	*5*	**D**	*Loss of mangroves, 0.5 ha. Riverine forest communities worth preserving. Near natural, difficult to access, 2 bridges, severe invasion, little residential developments. Saw-weed and Lamprothamnium papulosum. Traces of pondweed found, and periodic blooms of Chaetomorpha (Begg 1978).*
Damba				*M*	*20*				*10*	**C**	*Campsite, 2 bridges, holiday houses, severe algal blooms and thick mat of filamentous algae during sampling (Cooper et al. 1993). Important for swamp*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											forest fringe according to Begg (1978). 2013 Google : Reduction in base flow possibly some reed expansion.
Koshwana				*M*	*25*				*10*	**C**	*Reed covered floodplain, near-natural conditions, railway bridge and old bridge pilings, moderate turbidity and holiday houses, access limited (Cooper et al. 1993). Sewage works above lagoon (Begg 1978). 2013 Google : Reduced base flow may have led to reed encroachment.*
Intshambili		*G*		*G*	*25*				*5*	**C**	*Undeveloped, dense Barringtonia swamp in southern channel, 2 bridges both with embankments, ski-boat launch site, little residential development (Cooper et al. 1993). 2013 Google: Possibly some reed encroachment due to reduced base flow, agricultural disturbance in the floodplain including infilling.*
Mzumbe		*HD*			*50*				*10*	**E**	*50 % of floodplain under sugarcane and 10 % maize cultivation, 2 bridges with embankments (Cooper et al. 1993). 2013 Google : Disturbance due to roads and bridges, agriculture in the floodplain, disturbance upstream as a result of sand mining, currently 5 ha of reeds & sedges.*
Mhlabatshane		*F*		*M*	*30*		*10*			**D**	*3 bridges, invasive vegetation, few houses (Cooper et al. 1993). Blooms of Chaetomorpha recorded by Begg (1978). 2013 Google : Disturbance due to development in lower reaches as well as development in the floodplain. Important swamp forest habitat.*
Mhlungwa				*G*	*50*				*10*	**E**	*Nearly pristine, 2 bridges (Cooper et al. 1993). Lower reaches have records of pondweed and Lamprothamium papulosum (Begg 198). 2013 Google images: Lower reaches altered, disturbance in the floodplain, major disturbance from infilling from N2 and since Begg's time. Also sugarcane in floodplain.*
Mfazazana		*F*		*M*	*40*				*10*	**D**	*Botanically “unimportant” (Begg 1978). Near natural, 3 low bridges, mouth stabilised on both sides. 2013 Google : Some disturbance in the floodplain and surrounding areas.*
Kwa-Makosi		*F*		*M*	*30*					**C**	*Botanically “unimportant” (Begg 1978) undeveloped, 3 low bridges, mouth stabilised on both sides (Cooper et al. 1993). 2013 Google bridge near lower reaches, N2 upstream has resulted in infilling. Currently has 3.5 ha reeds and sedges and 7 ha swamp forest.*
Mnamfu		*F*		*M*	*30*					**C**	*Botanically “unimportant (Begg 1978)” 4 low bridges, stabilised on both sides (Cooper et al. 1993). 2013 Google images: loss of habitat in the upper reaches, some decrease in base flow but no evidence of reed encroachment.*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
Mtwalume				*M*	*20*		*10*			**C**	*Agriculture in floodplain, 3 bridges all with embankments, invasive alien species, minor residential development (Cooper et al. 1993). Proposed dam (Begg 1978). 2013 Google images: only reeds and sedges 4 ha present, some change in habitat as a result of bridges and other developments.*
Mvuzi				*M*	*30*				*5*	**C**	*Near pristine, floodplain covered with reeds and grasses, 2 bridges, invasive species and a few houses (Cooper et al. 1993). 2013 Google images: Road near mouth would have caused some changes, little sedimentation and reed encroachment, severe disturbance in the upper reaches.*
Fafa		*G*		*G*	*20*				*20*	**D**	*Campsite, 1 bridge, mouth manipulated by weir, invasive species (Cooper et al. 1993). References to Potamogeton at the upper end of the estuary in the 1950s. Study in 1971 indicated 37 species of algae (Begg 1978). Potamogeton crispus and Lamprothamnium papulosum found in 1982. Google images 2013: Disturbance upstream from N2 and sand mining. Disturbances possibly caused some shallowing and reed encroachment. Reeds absent in earlier aerial photographs 1960s, 1980s.*
Mdesingane		*F*		*G*	*35*	*5*			*20*	**E**	*Conservation potential (Begg 1984). Weir, low bridge, moderate water turbidity and a car park (Cooper et al. 1993). 2013 Google images: Small estuary destroyed by weir, roads & bridge, subsequent reed growth, approximately 6 ha of reeds and sedges. Bulrush (Typha) also present, possible nutrient enrichment.*
Sezela		*HD*		*M*	*25*	*5*				**C**	*Sugar mill on north bank. Severe algal blooms during sampling (Cooper et al. 1993). Small dam to supply township (Begg 1978). 2013 Google images: habitat loss on north bank, extensive reed areas, some loss due to development.*
Mkumbane				*M*	*45*				*5*	**D**	*Largely undeveloped, invasive vegetation (Cooper et al. 1993). 2013 Google images: disturbance in the floodplain due to agriculture, possibly some eutrophication and reed expansion.*
uMuziwezinto		*G*			*40*					**D**	*Conservation potential (Begg 1978). Undeveloped but most of floodplain under bananas and sugarcane. 3 bridges, 20 % banks stabilised with fill (Cooper et al. 1993). 2013 Google images: Loss of habitat due to development, upstream disturbance due to N2.*
Nkomba					*30*					**C**	*2013 Google images: some upstream development leading to change in*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											habitat, Casuarina trees present (Begg 1984).
Mzimayi				*M*	*20*				*10*	**C**	*Nearly pristine. 10% of bank composed of solid fill, 2 bridges, invasive species (Cooper et al. 1993). 2013 Google images: Some reed encroachment*
Mpambanyoni		*HD*		*M*	*40*					**D**	*Agricultural development in the floodplain. 4 Bridges, Surprising not well developed for running through Scottburgh. Dams and virtually no vegetation (Begg 1978). 2013 Google images: floodplain disturbance.*
Mahlongwa		*G*		*M*	*35*			*5*		**D**	*Loss of mangroves, 0.5 ha (Rajkaran et al. 2009). Floodplain mostly undeveloped. 3 bridges (Cooper et al. 1993) stunted Ruppia spiralis occurred on one occasion in winter with a bloom of Chaetomorpha (Begg 1984). 2013 Google images: bridges, floodplain development led to habitat loss.*
Mahlongwane			*M*	*M*	*40*					**D**	*25 % of the floodplain utilised for agriculture and 10 % stabilised with solid fill. 3 bridges with the mouth stabilised by the railway bridge. Access to the estuary is difficult hence good condition. (Cooper et al. 1993) Extensive beds of saw-weed (Najas marina). 2013 Google images: loss of habitat due to developments.*
uMkhomazi		*HD*	*M*	*M*	*30*		*5*	*5*		**D**	*Loss of mangroves (Begg 1978), industrial and agricultural landuse in the floodplains, 10 % of the banks stabilised. Exotic vegetation a moderately severe problem (Cooper et al. 1993). 2013 Google images: Loss of mangroves approximately 7 ha, habitat loss due to development, disturbance and alien vegetation in floodplain .*
Ngane		*F*	*M*	*G*	*35*			*5*		**D**	*Loss of mangroves, 0.4 ha. Mainly undeveloped, bridges, exotic vegetation and high turbidity (Cooper et al. 1993). 2013 Google images: upstream disturbance and habitat loss. Possible sedimentation and macrophyte growth as a result of N2, 1976 aerial shows undisturbed, larger water surface area. Black mangrove (Bruguiera gymnorrhiza) was observed in the estuary during a site visit in July 2013*
Umgababa		*G*	*M*		*40*					**D**	*Loss of mangroves, 0.5 ha (Rajkaran et al. 2009). Floodplain mostly undeveloped. 4 bridges (Cooper et al. 1993). 2013 loss of habitat due to disturbance, upstream N2 impacts. Submerged Zostera beds, Ruppia maritima in the upper reaches, saw-weed (Najas marina) in the middle reaches, Alternanthera sessilis near the mouth, blooms of Chaetomorpha. Stilaphora flananganii and Lamprothamnium papulosum algae blooms (Begg*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											1984). Large floodplain areas of rush Juncus kraussii indicative of brackish conditions.
Msimbazi		*G*	*M*	*G*	*25*			*5*	*5*	**C**	*Loss of mangroves, 0.5 ha (Rajkaran et al. 2009). Floodplain mostly undeveloped. 4 bridges (Cooper et al. 1993) Blooms of filamentous algae (Chaetomorpha sp.) (Begg 1978). 2013 Google images: Floodplain developments and changes in channels in response to N2 and infilling.*
Lovu		*F*	*L*	*M*	*30*			*5*	*5*	**D**	*Loss of mangroves, 2 ha. Agricultural and residential developments within floodplain, 4 bridges (Cooper et al. 1993). 2013 Google images: loss of habitat due to floodplain disturbance, possibly some reed encroachment*
Little aManzimtoti	*30*	*HD*	*H*	*M*	*30*		*10*			**D**	*Loss of mangroves, 0.5 ha (Rajkaran et al. 2009). Development in floodplain, 4 bridges, alien invasives (Lantana and Chromolaena) (Cooper et al. 1993).*
aManzimtoti		*D*	*M*	*P*	*40*	*20*	*10*			**E**	*Commercial development covers entire floodplain. 5 low bridges and presence of Pistia. Development surrounds the estuary (Cooper et al. 1993). 2013 Google images: Loss of habitat as well as eutrophication.*
Mbokodweni	*58*	*HD*	*H*	*P*	*50*	*10*	*10*			**E**	*Alien invasive aquatics recorded Eicchornia, Pistia. Lowest appearance score. Golf course and industrial uses of floodplain, stabilised mouth, residential and industrial area running through Prospecton Industrial Area (Cooper et al. 1993). 2013 Google images: Complete loss of habitat due to golf course and other development.*
Sipingo			*H*	*P*	*45*	*20*		*5*		**E**	*Second worst score in the study! Formal residential and commercial activities (Prospecton Industrial works with a canalised sewage works located upstream) in the floodplain. 50 % of banks stabilised. Litter, invasive species, persistent sewage smell (Cooper et al. 1993). Remnants of salt marsh communities Sarcocornia natalensis when visited in 1979 as well as blooms of Chaetomorpha (Begg 1984). Hiralal (2001) 1948 herbarium specimen of Zostera for Sipingo. 2013 Google images: extreme loss of habitat and some macrophyte changes due to eutrophication.*
Durban Bay			*H*		*70*			*20*		**F**	*Zostera capensis beds disappeared with the decimation of the mangroves. Reclamation and dredging (Begg 1978). 2013 Google images: major loss of mangroves and submerged macrophytes, riparian and floodplain habitat.*
uMngeni	*65*		*H*	*M*						**F**	*Golf course in floodplain, 4 bridges, mouth stabilised, surrounded by developments (Cooper et al. 1993).*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
Mhlanga		*G*	*H*	*G*	*25*		*10*			**C**	*Loss of mangroves 0.5 ha (Rajkaran et al. 2009), reed swamp conversion now secondary grasslands. Bridge and embankment near the coast, exotic vegetation (Cooper et al. 1993). Freshwater Potamogetan pectinatus downstream of the bridge (Begg 1978).*
uMdloti	*20*	*P*	*H*	*M*	*65*		*10*			**E**	*2 Bridges, residential development (Cooper et al. 1993). Alien invasive aquatics recorded Azolla, Eicchornia, Pistia (Begg 1978). Dam present.*
uThongathi	*60*	*HD*	*H*							**E**	*Sugarcane encroachment, bridge near mouth, invasive species including water hyacinth (Cooper et al. 1993).*
Mhlali				*G*	*40*					**D**	*Sugarcane encroachment & weir across lagoon (Begg 1978). Near pristine condition (Cooper et al. 1993). Mild bloom of Chaetomorpha during 1981 during a period when the mouth was open (Begg 1978). 2013 Google images: extensive transformation in floodplain mainly due to agriculture.*
Bob's Stream					*30*					**C**	*2013 Google images: Some habitat transformation.*
Seteni					*30*		*10*			**C**	*Near pristine health, Invasive plants (Cooper et al. 1993). Essentially undisturbed but sugarcane encroaching and severe siltation (Begg 1978).*
Mvoti		*D*		*M*	*30*	*10*	*10*			**D**	*Prolific bird life. 3 bridges, severe algal blooms and invasive vegetation (Cooper et al. 1993). 2013 Google images: major impacts from agriculture, invasives and disturbed riparian zones.*
Mdlotane		*G*		*G*	*20*					**B**	*Potential for conservation, Potamogeton occurs in the lower reaches. (Begg 1978). Exotic vegetation (Cooper et al. 1993). 2013 Google images: swamp forest important, disturbance from surrounding development, recent fish kill possible eutrophication.*
Nonoti					*30*	*30*				**D**	*Sugarcane encroachment, proposed dam, artificially breached (Begg 1978). Exotic vegetation (Cooper et al. 1993). Partially covered with water hyacinth as well as extensive beds of Potamogeton pectinatus, which is a sign of health in the system (Begg 1978). 2013 Google images: sugarcane to edge of estuary, some habitat loss and signs of eutrophication, water grass encroachment Echinocloa? as well as water hyacinth*
Zinkwasi		*P*		*M*	*20*				*15*	**C**	*Sugar cane encroachment, caravan park at mouth and exotic vegetation (Cooper et al. 1993). Sandbar artificially breached, reeds encroaching into water course, 7 ha decrease in open water in the lagoon. Decrease in riverine vegetation, The charophyte Lamprothamnium papulosum= Chara*

Name	EWR Studies	Begg	Forbes & Demetriades	Harrison	Loss of habitat	Eutrophication	Invasive	Loss of mangroves	Sedimentation & reed expansion	Macrophytes	Comments
											macropogon, was found in the system (Begg 1978). 2013 Google images: possibly some reed encroachment, some agricultural development, some invasive grass.

11.6 MICROALGAE

11.6.1 Microalgae groups

The microalgae groups are described in Table: 11.10.

Table 11.10 Microphyte habitats and functional groups recorded in the Mvoti to Umzimkulu WMA estuaries (spp. examples in italics).

Group		Description
Phytoplankton	*Cyanophytes*	*These microalgae are often very abundant in eutrophic water*
	Dino-flagellates	*Not usually very abundant. This group are usually counted with the flagellates. Where this group become dominant it usually indicates a problem that requires investigation.*
	Chlorophytes	*Photosynthetic microalgae that occur in both fresh and marine water.*
	Diatoms	*There are 333 species occurring throughout RSA estuaries. Higher biomass in eutrophic water. Alternate in abundance with flagellates. In good quality water they can be the dominant microalgal type present.*
	Flagellates	*Heterotrophic. Very abundant in water that has lots of organic matter, i.e. eutrophic water.*
Microphyto-benthos (MPB)	*Often has a greater abundance in still eutrophic water where the cells have time to settle to the sediment. In flowing water the cells are more frequent in the water column. Eutrophic water results in elevated MPB biomass.*	

11.6.2 Description of factors influencing microalgae

The effect of abiotic characteristics and processes, as well as other biotic components on microalgae is summarised in Table 11.11.

Table 11.11 Effect of abiotic characteristics and processes, as well as other biotic components on microalgae.

Process	Microalgae
Mouth condition (provide temporal implications where applicable)	*Mouth condition is very important because when open to the sea there is a good exchange of seawater to the estuary and there is an obvious flow of freshwater to the sea. Unless the freshwater is very eutrophic this is the best situation for a healthy microalgal population*
Retention times of water masses	*As the water retention increases the quality of the water for microalgae declines and much of the biomass can become benthic. This is not adverse as long as the duration (weeks) is not prolonged.*
Flow velocities (e.g. tidal velocities or river inflow velocities)	*Flooding is irrelevant because the estuary is reset. The outcome of this is good when the frequency is "normal". Natural velocities are best because those velocities define what is normal for the ecology.*
Total volume and/or estimated volume of different salinity ranges	*In estuaries, a good range of salinity from seawater to freshwater is good as it indicates both an open mouth and freshwater inflow. With salinity ranging from seawater to near fresh is best. A well-mixed estuary indicates a closed mouth. The longer it is closed the more likely that problems will occur.*
Floods	*Strong floods every 3-5 years resets the estuary and is best for microalgae*
Salinity	*Microalgae can tolerate salinity ranging from 0-35psu*
Turbidity	*High turbidity indicates low light penetration which will lower the score for microalgae*
Dissolved oxygen	*Microalgae under good conditions produce oxygen. When oxygen is low it can indicate that there is low microalgal activity.*
Nutrients	*Microalgal condition is best when nutrient content is low.*
Sediment characteristics (including sedimentation)	*Microalgae can tolerate all sediments. Active sedimentation usually goes with turbidity.*

Process	Microalgae
Other biotic components	*No known effects in RSA of problems with other biota.*

11.6.3 Summary of the microalgae condition in Mvoti to Umzimkulu WMA

Microalgae were evaluated on the basis of the change in four driving components namely: (Hydrology% x 0.25) + (Hydrodynamics% x 0.25) + (Water Quality% (nutrients) x 0.4) + (Macrophytes x 0.10). Table 3.10 provides a summary of the microalgae component condition. Table 11.12 provide a summary of the microalgae component scores.

Table 11.12 Summary of the microalgae component condition.

Name	Microalgae Condition	Comment
Mtamvuna	B	
Zolwane	A	
Sandlundlu	B	
Ku-Boboyi	B	
Tongazi	B	
Kandandhlovu	B	
Mpenjati	B	
Umhlangankulu	C	*Poor water quality and habitat degradation*
Kaba	B	
Mbizana	B	
Mvutshini	B	
Bilanhlolo	C	*Poor water quality, macrophyte cover changes*
Uvuzana	B	
Kongweni	E	*Flow modification, poor water quality, macrophyte cover changes*
Vungu	C	*Poor water quality*
Mhlangeni	C	*Poor water quality, macrophyte cover changes*
Zotsha	B	
Boboyi	B	
Mbango	D	*Flow modification, poor water quality, macrophyte cover changes*
Umzimkulu	B	
uMthente	B	
Mhlangamkulu	C	*Flow modification, macrophyte cover changes*
Damba	C	*Flow modification, macrophyte cover changes*
Koshwana	C	*Flow modification, poor water quality, macrophyte cover changes*
Intshambili	C	*Flow modification, poor water quality, macrophyte cover changes*
Mzumbe	C	*Poor water quality, significant macrophyte cover changes*
Mhlabatshane	B	
Mhlungwa	B	
Mfazazana	C	*Poor water quality, macrophyte cover changes*
Kwa-Makosi	B	
Mnamfu	C	*Flow modification, poor water quality, macrophyte cover*

Name	Microalgae Condition	Comment
		changes
Mtwalume	C	*Poor water quality, macrophyte cover changes*
Mvuzi	C	*Poor water quality, macrophyte cover changes*
Fafa	C	*Flow modification, poor water quality, macrophyte cover changes*
Mdesingane	C	*Poor water quality, significant macrophyte cover changes*
Sezela	C	*Poor water quality, macrophyte cover changes*
Mkumbane	C	*Poor water quality, macrophyte cover changes*
uMuziwezinto	C	*Flow modification, poor water quality, macrophyte cover changes*
Nkomba	C	*Poor water quality, macrophyte cover changes*
Mzimayi	C	*Flow modification, poor water quality, macrophyte cover changes*
Mpambanyoni	B	
Mahlongwa	B	
Mahlongwane	C	*Poor water quality, macrophyte cover changes*
uMkhomazi	C	*Flow modification, poor water quality, macrophyte cover changes*
Ngane	C	*Poor water quality, macrophyte cover changes*
Umgababa	B	
Msimbazi	B	
Lovu	C	*Significant flow modification, poor water quality, macrophyte cover changes*
Little aManzimtoti	F	*Significant flow modification, very poor water quality, macrophyte cover changes*
aManzimtoti	D	*Flow modification, very poor water quality, macrophyte cover changes*
Mbokodweni	D	*Flow modification, macrophyte cover changes*
Sipingo	F	*Severe Flow modification, poor water quality, macrophyte cover changes*
Durban Bay	B	
uMngeni	D	*Flow modification, poor water quality, macrophyte cover changes*
Mhlanga	D	*Flow modification, poor water quality, macrophyte cover changes*
uMdloti	F	*Poor water quality, macrophyte cover changes*
uThongathi	C	*Very poor water quality, severe macrophyte cover changes*
Mhlali	C	*Poor water quality, macrophyte cover changes*
Bob's Stream	B	
Seteni	B	
Mvoti	D	*Flow modification, very poor water quality, macrophyte cover changes*
Mdlotane	B	
Nonoti	C	
Zinkwasi	B	*Poor water quality, some macrophyte cover changes*

11.7 ESTUARINE INVERTEBRATE FAUNA

11.7.1 Invertebrate groups

The major invertebrates groups are described in Table11.13. They consist of a wider variety of taxonomic groups, but are broadly made up of segmented worms (polychaetes, and to a lesser extent oligocheates), molluscs (gastropods and bivalves), small benthic crustaceans (amphipods and isopods), small planktonic crustaceans (copepods) and large crustaceans (prawns and crabs). These groups all contain taxa that are either of marine origin, or complete their life cycles in estuaries. Few freshwater groups exist (selected carid prawns being notable exceptions). During prolonged mouth closure in TOCEs and in the upper (freshwater) reaches of open systems insect larvae do occur. In KwaZulu-Natal systems it is rarely the case that these occur abundantly, and if they do this insect assemblage is often dominated by chironomid larvae indicative of poor water quality (hypoxia).

Table 11.13 Classification of the main South African estuarine invertebrate fauna and the parameters influencing their abundance and distribution. POM = particulate organic matter, MPB = Microphytobenthos

#	Description	Influencing factors
1	*Polychaetes - estuarine resident (e.g. Ceratoneries keiskama, Dendronereis arborifera, Desdemona ornata)*	*Med to fine sediments; detritus; salinity, other edible invertebrates or POM in the case of D. ornata)*
2	*Polychaetes - marine (e.g. Nephtys sphaerocirrata, Ancistrosyllis parva)*	*Med to coarse sediments; detritus; open mouth; saline water, other edible invertebrates*
3	*Amphipods (e.g. Grandiderella spp., Corophium spp.)*	*Finer sand/mud; granulometry suitable for tube building; detritus; POM; reduced salinity*
4	*Isopods (e.g. Eurydice longicornis, Cirolana spp.)*	*Coarse sediments; higher salinity; dead matter*
5	*Gastropods - marine dominated species (detritivores, scavengers & predators e.g. Nassarius kraussianus)*	*Detritus; open mouth; MPB; higher salinity*
6	*Gastropods - resident sediment living grazers, detritivores (e.g. Melanoides tuberculata increasingly being replaced by the invasive Tarebia granifera)*	*Shelter; submerged macrophytes; MPB; detritus*
7	*Bivalves - estuarine resident (eg Brachidontes virgiliae)*	*Med-fine sediments; submerged macrophytes; POM*
8	*Bivalves - marine (e.g. Dosinia/Tellina/Eumarcia)*	*Med-coarse sediments; open mouth; POM*
9	*Crabs - resident estuarine (e.g. Paratylodiplax blephariskios)*	*Muddy sediments, often co-occur with Penaeid prawns*
10	*Crabs - marine (e.g. Varuna litterata)*	*Mouth condition, migrate from marine spawning grounds to freshatwer habiats, and back to see to spawn*
11	*Crabs - marine (e.g. Hymenosoma)*	*Open mouth; saline*
12	*Penaeid prawns - marine (e.g. Metapenaeus monoceros)*	*Med-fine sediments, muddy for some Penaeid species; detritus; predominantly open mouth and high salinity*
13	*Carid prawns - freshwater (e.g. Macrobracium spp.)*	*Submerged and emergent macrophytes; detritus; closed phase in TOCEs or upper reaches of open systems in lower salinity*
14	*Insect larvae*	*Submerged and emergent macrophytes, low salinities*
15	*Mudprawns (e.g. Upogebia)*	*Fine sand/mud; open mouth; POM*
15	*Sandprawns (e.g. Calianassa)*	*Sand; not extended fresh water (>17ppt to breed); POM*
16	*Zooplankton - marine*	*Phytoplankton; open mouth*
17	*Zooplankton – estuarine resident*	*Phytoplankton*

11.7.2 Baseline description

A wide range of invertebrate taxa use estuaries in KwaZulu-Natal and are a critical component of the food chain, converting detritus and POM to productivity for higher tropic levels, including fishes, birds and man. Despite this wide range, abundance is typically contributed by relatively few species, especially in TOCEs. Two copepods genera (Acartia and Pseudodiaptomus) are dominant, contributing by far the major proportion of both abundance and biomass to the zooplankton assemblage. Smaller benthic invertebrates are dominated by polychaetes, often Desdemona ornata, Dendronereis arborifera and Ceratoneries keiskama. Oligocheates are sometimes abundant, but often only in the freshwater reaches of systems when organic content of sediments is particularly high. Amphipods (most often Grandiderella spp. and Corophium spp) are more abundant than isopods. Larger crustaceans comprise both crabs and prawns. These groups are generally more abundant in systems that are either permanently or predominantly open.

11.7.3 Factors affecting the invertebrate fauna

The main factors affecting the abundance of the different invertebrate groups found in the Mvoti to Umzimkulu WMA estuaries are summarised in Table 11.14.

Table 11.14 Effect of abiotic characteristics and processes, as well as other biotic components on invertebrate groupings

Factor	Affected categories
Mouth condition (provide temporal implications where applicable)	*Mouth closure often benefits the subtidal macrozoobenthos, since it increases benthic microalgae and therefore food availability. This typically leads to higher abundance of select species. Reduced connectivity with the sea however also leads to a loss of marine species, or species with a preference for high salinity waters.*
Retention times of water masses	*Increased retention times of the water mass would benefit the planktonic assemblage (holoplankton and meroplankton), since loss of larvae through tidal entrainment out of the estuary would be reduced. Increased retention time also allows for increased phytoplankton producing which benefits zooplankton and some benthic species.*
Flow velocities (e.g. tidal velocities or river inflow velocities)	*As tidal velocities increase, loss of the zooplanktonic forms increases, particularly copepods. Under high flow conditions, entire populations may be lost. Since zooplankton is a key component in the estuarine food web, the ripple effect would impact higher trophic levels directly. Recover time are however quite quick. Similarly, the benthic assemblage can be flushed from systems under high flow conditions. Recovery times for this assemblage are likely to be slower.*
Total volume and/or estimated volume of different salinity ranges	*The presence of different salinity zones (0-10, 10-30 and 30-35 approx.) ensures different habitats for organisms. These different zones also lead to increased species richness in the estuary. From a biomass perspective, the larger the 10-30 zone (volume), the higher the biomass of invertebrates present.*
Floods	*Floods scour accumulated sediments from the estuary, particularly in the lower reaches. Tidal exchange is enhanced and this leads to a resetting of the balance between the three major salinity zones. Because tidal exchange is more dynamic under open mouth conditions, coarser sediments (sand) in the lower estuary particularly are resorted and fine material scoured from these lower reaches near the mouth.*
Salinity	*The persistence of a full salinity gradient along the length of the estuary is an important characteristic and ensures a range of habitats available to organisms and hence a greater diversity of biota.*
Turbidity	*Although naturally turbid, benthic organisms may be smothered under excessive loads of fine material in the water column.*
Dissolved oxygen	*Plays a major role in influencing the benthic assemblage. However, if values fall below approx. 50% of surface saturation, organisms become stressed. Sessile organisms particularly are affected. Below these levels the community is characterised by fewer, more tolerant species.*

Factor	Affected categories
Subtidal and intertidal habitat	*The availability of both these tidal areas for inveterbrates is an important characteristic of the estuary, increasing species richness and biomass within these zones.*
Sediment characteristics (including sedimentation)	*A range of sediment types (particularly sand and mud) provides habitat for those organisms that require specific sediment characteristics. These include species that are tube builders, such as the amphipods Corophium spp. Sediment is probably the single most important environmental variable that structures benthic communities in TOCEs and is important, with salinity, in permanently open systems as well.*
Phytoplankton and Benthic micro-algae biomass	*High phytoplankton biomass leads to increased biomass of invertebrates in the estuary as it is the most important food component in the seston.*
Zooplankton biomass	*Zooplankton biomass is influence by a combination of high phytoplankton biomass and often salinity character tics of an estuary.*
Aquatic macrophyte cover	*Macrophyte cover is important for the sub- and intertidal invertebrate community as it provides protective habitat and detritus for consumption by the community. The presence, type and abundance of submerged aquatic vegetation is an important factor in the invertebrate productivity and biodiversity in estuaries. It also provides important substrate for microphytobenthos.*
Fish biomass	*A high fish biomass leads to high levels of predation on invertebrates.*

11.7.4 Summary of the estuarine invertebrate condition in Mvoti to Umzimkulu WMA

Table 11.15 provide a summary of the microalgae component scores.

Table 11.15 Summary of the invertebrate component condition.

Name	Invertebrate Condition	Comments
Mtamvuna	**C**	
Zolwane	**B**	
Sandlundlu	**D**	*Habitat destruction, reduced food availability*
Ku-Boboyi	**B**	
Tongazi	**D**	*Poor water quality, habitat destruction, reduced food availability*
Kandandhlovu	**D**	*Poor water quality, habitat destruction, reduced food availability*
Mpenjati	**D**	*Water quality, habitat destruction, reduced food availability*
Umhlangankulu	**E**	*Very poor water quality, habitat destruction, reduced food availability*
Kaba	**C**	
Mbizana	**C**	
Mvutshini	**C**	
Bilanhlolo	**D**	*Water quality, habitat destruction, reduced food availability*
Uvuzana	**D**	*Water quality, habitat destruction, reduced food availability*
Kongweni	**D**	*Flow modification, water quality, severe habitat destruction, reduced food availability*
Vungu	**C**	
Mhlangeni	**D**	*Water quality, habitat destruction, reduced food availability*
Zotsha	**C**	
Boboyi	**C**	
Mbango	**F**	*Flow modification, very poor water quality, severe habitat destruction, reduced food availability*
Umzimkulu	**C**	
uMthente	**C**	
Mhlangamkulu	**C**	
Damba	**C**	

Name	Invertebrate Condition	Comments
Koshwana	C	
Intshambili	C	
Mzumbe	D	*Water quality, habitat destruction (macrophytes), reduced food availability*
Mhlabatshane	C	
Mhlungwa	D	*Water quality, severe habitat destruction, reduced food availability*
Mfazazana	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Kwa-Makosi	C	
Mnamfu	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Mtwalume	D	*Poor water quality, habitat destruction, reduced food availability*
Mvuzi	C	
Fafa	D	*Poor water quality, severe habitat destruction (macrophytes), reduced food availability*
Mdesingane	E	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Sezela	D	*Poor water quality, habitat destruction, reduced food availability*
Mkumbane	D	*Poor water quality, habitat destruction, reduced food availability*
uMuziwezinto	D	*Poor water quality, habitat destruction, reduced food availability*
Nkomba	B	
Mzimayi	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Mpambanyoni	D	*Poor water quality, habitat destruction, reduced food availability*
Mahlongwa	C	
Mahlongwane	B	
uMkhomazi	C	
Ngane	D	*Poor water quality, habitat destruction, reduced food availability*
Umgababa	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Msimbazi	B	
Lovu	C	
Little aManzimtoti	F	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*
aManzimtoti	F	*Significant flow increase, very poor water quality, severe habitat destruction, reduced food availability*
Mbokodweni	F	*Significant flow increase, very poor water quality, extreme habitat destruction, reduced food availability*
Sipingo	F	*Very significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*
Durban Bay	F	*Significant flow reduction, poor water quality, severe habitat destruction (port development), reduced food availability*
uMngeni	F	*Significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*
Mhlanga	E	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*
uMdloti	F	*Flow increase, poor water quality, habitat destruction, reduced food availability*
uThongathi	E	*Very poor water quality, severe habitat destruction, reduced food availability*
Mhlali	C	

Name	Invertebrate Condition	Comments
Bob's Stream	B	
Seteni	B	
Mvoti	F	*Flow reduction, very poor water quality, habitat destruction (sand mining), reduced food availability*
Mdlotane	B	
Nonoti	D	*Poor water quality, invasive floating and fringing macrophytes*
Zinkwasi	B	*Habitat destruction, reduced food availability*

11.8 FISH

11.8.1 Fish groups

The major invertebrates groups are described in Table 11.16.

Table 11.16 Classification of South African fish fauna according to their dependence on estuaries (Whitfield 1994)

Category	Description
I *Ia* *Ib*	*Truly estuarine species, which breed in southern African estuaries; subdivided as follows:* *Resident species which have not been recorded breeding in the freshwater or marine environment* *Resident species which have marine or freshwater breeding populations*
II *IIa* *IIb* *IIc*	*Euryhaline marine species which usually breed at sea with the juveniles showing varying degrees of dependence on southern African estuaries; subdivided as follows:* *a. Juveniles dependant of estuaries as nursery areas* *b. Juveniles occur mainly in estuaries, but are also found at sea* *c. Juveniles occur in estuaries but are more abundant at sea*
III	*Marine species which occur in estuaries in small numbers but are not dependant on these systems*
IV	*Euryhaline freshwater species that can penetrate estuaries depending on salinity tolerance. Includes some species which may breed in both freshwater and estuarine systems.*
V	*Obligate catadromous species which use estuaries as transit routes between the marine and freshwater environments. Includes the following subcategories:* *a. Obligate catadromous species* *b. Facultative catadromous species*

11.8.2 Baseline description

Whitfield (1998) lists a total of 142 species of fishes associated with southern African estuaries. Of these the brunt (131, 92%) have either cosmopolitan or subtropical distributions and therefore could occur in the estuaries under consideration in this study. However several of these species (e.g. Liza richardsonii) have distributional ranges centred in the warm temperate biogeographical zone, and their presence in KwaZulu-Natal estuaries is limited in terms of both frequency and abundance. The main families in terms of abundance in these systems are often small bodied Ambassidae (Ambassis spp.) and Clupeidae (Gilchristella aestuaria). Important in terms of biomass are Mugilidae (various species, but probably predominated by Myxus capensis, Valamugil cunnesius, Liza dumerilii, Liza macrolepis and Mugil cephalus), and, in freshwater dominated systems Cichlidae (Oreochromis mossambicus). The latter are all detritivores and their dominance *in terms of fish biomass is reflecting of the importance of detritus to the food base in KwaZulu-Natal estuaries.*

11.8.3 Factors affecting the fish community

The effect of abiotic characteristics and processes, as well as other biotic components on fish is summarised in Table 11.17.

Table 11.17 Summary of fish responses to abiotic processes and biotic components.

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV. Freshwater species
Mouth condition	*Resident species proliferate under closed mouth conditions*		*Abundance and richness of marine migrant communities declines with prolonged mouth closure.*			*Increase in abundance if low salinity.*
Retention times of water masses	*Food (zooplankton) abundance for all groups increases with increased retention times. Prolonged mouth closure also favours resident and freshwater species over marine migrants.*					
Flow velocities (e.g. tidal velocities or river inflow velocities)	*Resident species move upstream when flow velocities increase. During spates these species may be washed out of systems (see below), but can return as flood waters recede, presumably led be tidal fronts.*	*Migrant species exploit tidal currents when migrating into the estuary or when feeding and following the tidal 'front' up the estuary.*				*Freshwater species can get washed into the estuary if a strong river current is present.*
Total volume and/or estimated volume of different salinity ranges	*Increased volume translates to an increase in available habitat for all species, especially those that spend most of their time in the water column (as opposed to benthic species, for example). Brackish water habitat favours resident and estuary-associated marine migrants while marine water is preferred by marine species. High water levels that inundate supratidal areas are positive for juvenile marine fish and small estuarine species. During the closed phase of TOCEs high littoral habits are flooded providing habitat refuge and feeding opportunity to all fishes, including young juveniles using these systems are nursery areas.*					
Floods	*The larvae of resident species are washed into the sea at the onset of floods. Adults of small bodied species may also be affected.*	*Juvenile marine and catadromous species use floodwaters entering the sea as a cue for locating and migrating into estuaries, whereas adults and sub-adults exit during floods. Major river flooding associated with high sediment loads can cause gill clogging for fishes in the estuary.*				*High flow velocities may flush some individuals downstream into the estuary, and even out to sea, where mortalities can occur because of osmo-regulatory shock.*
Salinity	*Resident and estuary-associated marine species are generally tolerant of salinities in the range 1-35 PSU.*				*Tend to inhabit waters close to*	*Highly variable and most*

Factor	Ia. Estuarine residents (breed only in estuaries)	Ib. Estuarine residents (breed in estuaries and the sea)	IIa. Estuary dependent marine species	IIb and c. Estuary associated species	III. Marine migrants	IV. Freshwater species
	Tolerance of salinities higher than 35 PSU is more limited.				*35 PSU. Become stressed at salinities under 20 PSU.*	*prefer salinity < 10 PSU.*
Turbidity	*Tolerant of a wide range of turbidities.*		*Little discernible response to turbidity.*	*Turbidity preferences vary among species*	*Generally prefer low turbidity*	*Tolerant of a wide range of turbidities.*
Dissolved oxygen	*Most resident and estuary-associated marine species become stressed when oxygen drops below 4 mg.l^{-1}.*				*Little tolerance to low oxygen levels/hypoxia.*	*Some indigenous species tolerant of low oxygen.*
Subtidal, intertidal and supratidal habitat	*All the fish are confined to the subtidal at low tide but forage in the intertidal during high tide. Intertidal reaches are nonetheless extremely important foraging areas for most fish species. Shallow marginal areas tend to be warmer than deeper channel areas and have better oxygenated waters, and are therfore favourable for metabolic processes. Juveniles and small adults also use shallow water as a predation refuge.*					*Freshwater species seldom occur in tidal reaches of estuaries*
Other abiotic components	*Low temperatures can increase the risk of mass mortalities at very low salinities.*					
Sediment characteristics (including sedimentation)	*Individual species preferences are highly variable and related to preferred food sources as well as water quality characteristics over different sediments (e.g. more turbid waters over muddier sediments)*					
Phytoplankton biomass	*High phytoplankton production contributes to turbidity in estuaries and probably favours those species with higher turbidity preferences.*					
Benthic micro-algae biomass	*Detritivores, especially mullet, benefit from high microphytobenthos biomass.*					
Zooplankton biomass	*Filter and particulate feeders benefit from increased zooplankton biomass. Many fish species are able to switch between filter and targeted feeding modes to take advantage of dominant zooplanktonic food sources.*					
Aquatic macrophyte cover	*Juveniles of most fish species find refuge in littoral macrophyte beds during the daytime but move into open water during the night as oxygen levels drop in the littoral zone.*					
Benthic invertebrate biomass	*Many estuary-associated fish species feed on benthic invertebrates and will thus benefit from increases in benthic invertebrate biomass.*					
Fish biomass	*No major piscivorous species in these categories. Most of the fish biomass consists of planktivores and small zoobenthivores.*		*Fish biomass dominated by estuary-associated marine species that utilize different food chains, e.g. groovy mullet Liza dumerilii is a detritivore, spotted grunter Pomadasys commersonnii a zoobenthivore and dusky kob Argyrosomus japonicas a piscivore. The piscivores benefit from the high biomass of estuarine resident and small marine migrants in the estuary.*			*Oreochromis mossambicus can dominate biomass in TOCEs during prolonged mouth closed phases.*

11.8.4 Summary of the fish condition in Mvoti to Umzimkulu WMA

Table 11.18 provide a summary of the fish component condition.

Table 11.18 Summary of the Fish component condition in the estuaries of Mvoti to Umzimkulu WMA.

Name	Fish Condition	Comments
Mtamvuna	C	
Zolwane	B	
Sandlundlu	D	*Habitat destruction, reduced food availability*
Ku-Boboyi	B	
Tongazi	D	*Poor water quality, habitat destruction, reduced food availability*
Kandandhlovu	D	*Poor water quality, habitat destruction, reduced food availability*
Mpenjati	D	*Water quality, habitat destruction, reduced food availability*
Umhlangankulu	E	*Very poor water quality, habitat destruction, reduced food availability*
Kaba	C	
Mbizana	C	
Mvutshini	C	
Bilanhlolo	D	*Water quality, habitat destruction, reduced food availability*
Uvuzana	D	*Water quality, habitat destruction, reduced food availability*
Kongweni	D	*Flow modification, water quality, severe habitat destruction, reduced food availability*
Vungu	C	
Mhlangeni	D	*Water quality, habitat destruction, reduced food availability*
Zotsha	C	
Boboyi	C	
Mbango	F	*Flow modification, very poor water quality, severe habitat destruction, reduced food availability*
Umzimkulu	C	
uMthente	C	
Mhlangamkulu	C	
Damba	C	
Koshwana	C	
Intshambili	C	
Mzumbe	D	*Water quality, habitat destruction (macrophytes), reduced food availability*
Mhlabatshane	C	
Mhlungwa	D	*Water quality, severe habitat destruction, reduced food availability*
Mfazazana	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Kwa-Makosi	C	
Mnamfu	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Mtwalume	D	*Poor water quality, habitat destruction, reduced food availability*
Mvuzi	C	
Fafa	D	*Poor water quality, severe habitat destruction (macrophytes), reduced food availability*
Mdesingane	E	*Flow reduction, poor water quality, habitat destruction, reduced food availability*

Name	Fish Condition	Comments
Sezela	D	*Poor water quality, habitat destruction, reduced food availability*
Mkumbane	D	*Poor water quality, habitat destruction, reduced food availability*
uMuziwezinto	D	*Poor water quality, habitat destruction, reduced food availability*
Nkomba	B	
Mzimayi	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Mpambanyoni	D	*Poor water quality, habitat destruction, reduced food availability*
Mahlongwa	C	
Mahlongwane	B	
uMkhomazi	C	
Ngane	D	*Poor water quality, habitat destruction, reduced food availability*
Umgababa	D	*Flow reduction, poor water quality, habitat destruction, reduced food availability*
Msimbazi	B	
Lovu	C	
Little aManzimtoti	F	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*
aManzimtoti	F	*Significant flow increase, very poor water quality, severe habitat destruction, reduced food availability*
Mbokodweni	F	*Significant flow increase, very poor water quality, extreme habitat destruction, reduced food availability*
Sipingo	F	*Very significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*
Durban Bay	F	*Significant flow reduction, poor water quality, severe habitat destruction (port development), reduced food availability*
uMngeni	F	*Significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*
Mhlanga	E	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*
uMdloti	F	*Flow increase, poor water quality, habitat destruction, reduced food availability*
uThongathi	E	*Very poor water quality, severe habitat destruction, reduced food availability*
Mhlali	C	
Bob's Stream	B	
Seteni	B	
Mvoti	F	*Flow reduction, very poor water quality, habitat destruction (sand mining), reduced food availability*
Mdlotane	B	
Nonoti	F	*Poor water quality, habitat destruction, reduced food availability, floating and fringing alien vegetation*
Zinkwasi	B	*Habitat destruction, reduced food availability*

11.9 BIRDS

11.9.1 Bird groups

For the purposes of this study, the birds found on the estuary have been grouped into nine groups (Table 10.19). Waders, gulls and terns dominate the avifauna at present, with waterfowl also being common.

Table 11.19 Major bird groups found in the Mvoti to Umzimkulu WMA estuaries, and their defining features (Modified from Van Niekerk *et al* 2013).

Bird groups	Defining features, typical/dominant species
Piscivorous cormorants	*The estuary supports a few species of pursuit swimming piscivores which catch their prey by following it under water and therefore prefer deeper water habitat. These include Reed Cormorant, Cape Cormorant, White-breasted Cormorant and African Darter.*
Piscivorous wading birds	*This group comprises the egrets, herons, ibises and spoonbill. Loosely termed piscivores, their diet varies in plasticity, with fish usually dominating, but often also includes other vertebrates, such as frogs, and invertebrates. The ibises were included in this group, though their diet mainly comprises invertebrates and is fairly plastic. They tend to be tolerant of a wide range of salinities. Wading piscivores prefer shallow water up to a certain species dependant wading depth.*
Herbivorous waterfowl	*This group is dominated by species that tend to occur in lower salinity or freshwater habitats and are associated with the presence of aquatic plants such as Potamageton and Phragmites. The group includes some of the ducks, and all the rallids (e.g. Redknobbed Coot, African Purple Swamphen). Some herbivorous waterfowl such as Egyptian Goose probably feed in terrestrial areas away from the estuary and floodplain as well as in the estuary.*
Omnivorous waterfowl	*This group comprises ducks which eat a mixture of plant material and invertebrate food such as small crustaceans - Yellow-billed Duck, Cape Teal, Red-billed Teal and Cape Shoveller. Although varying in tolerance, these species are fairly tolerant of more saline conditions.*
Benthivorous waders	*This group includes all the waders (e.g. Greenshank, Curlew Sandpiper). They are the smallest species on the estuary, and feed on benthic macroinvertebrates in exposed and shallow intertidal areas. Invertebrate-feeding waders forage mainly on exposed sandbanks, mudflats and in the inter-tidal zone. A few resident species occur such as White-fronted Plover and Black-winged Stilt. Many species of Palaearctic migrants have been recorded on the estuary, often in fairly high numbers.*
Piscivorous gulls & terns	*This group comprises the rest of the Charadriiformes, and includes all the gull and tern species using the estuary. These species are primarily piscivorous, but also take invertebrates. Most are euryhaline, but certain tern species on the estuary tend to be associated with low salinity environments. Gulls and terns can be very abundant and use the estuary primarily for roosting*
Piscivorous kingfishers	*Three species of kingfishers occur on the estuary in low numbers. They breed and perch on the river banks and prefer areas of open water with overhanging vegetation.*
Piscivorous birds of prey	*This group includes African Fish Eagle and Osprey. The African Fish Eagle is not confined to a diet of fish, also taking other vertebrates and invertebrates.*
Other birds of prey	*The Marsh Harrier has been recorded on the estuary in the past, and feeds on small vertebrates such as mice and frogs.*

11.9.2 Baseline description

A total of 100 birds species occur along the coast line of Mvoti to Umzimkulu WMA, with the majority of these birds found on the estuaries and wetlands in the region (Ryan et al. 1986). The most abundant wader species are curlew sandpipers, little stints and ruffs. Non-waders are mostly greater flamingos and common/Artic terns. Palaeartic migrants account for more than 80% of all waders. Only 16 of the 100 species surveyed had populations amounting to more than 1% of the total number of birds counted (Ryan et al. 1986). The large numbers of marine tern and cattle egrets counted used estuaries and coastal wetlands primarily as roosting sites. For example, at times major tern roosts were found at the mouth of the Mhlali, Mvoti, Lovu, uMngeni, and Durban Bay.

There is great variability in bird numbers and species richness between systems along this coastline. Much of this variability in bird numbers can be explained in terms of estuary size. The correlation between bird numbers and estuary shore length is highly significant (Ryan et al. 1986). Siegried (1981) attributed the depauperate avifauna in many Natal estuaries and lagoons to their small size, lack of inter tidal flats and their disturbed state.

All Mvoti to Umzimkulu WMA estuaries are affected by direct human disturbance to some extent. Direct disturbance by recreation activities is high in many systems, especially in estuaries situated near resorts. This disrupts feeding and causes birds to move elsewhere.

While, direct human disturbance of estuaries strongly affects both the composition and abundance of the avifauna, is often seen as reversible. In contrast, estuary ecosystem degradation (e.g. altered through siltation, pollution, modification of banks) result in more long-lasting changes.

11.9.3 Factors driving waterbird community structure and abundance

Some of the main flow-related factors to be considered in estimating the bird community under reference conditions and the alternative scenarios are listed in Tale 11.20.

Table 11.20 Effect of abiotic characteristics and processes, as well as other biotic components on bird groupings (Modified from Van Niekerk *et al* 2013).

Factor	Cormorants & wading piscivores	Kingfishers & fish-eagle	Waterfowl	Waders, gulls and terns
Mouth condition	*Indirectly, through influence on water level and fish*		*Indirectly, through influence on macrophytes*	*Mouth closures has negative effect on preferred sandbanks in lower estuary*
Salinity			*Certain species of waterfowl prefer lower salinities*	
Turbidity	*Negatively affects visibility for foraging*	*Negatively affects visibility for foraging*		
Intertidal area				*Waders rely mostly on intertidal areas for feeding.*
Sediment characteristics (including				*Most waders prefer med to fine sand; a few prefer coarse sand*

Factor	Cormorants & wading piscivores	Kingfishers & fish-eagle	Waterfowl	Waders, gulls and terns
sedimentation)				
Primary productivity	*Indirectly though influence on food supply*			
Submerged macrophytes abundance			*Has positive influence on herbivorous waterfowl numbers*	
Abundance of reeds and sedges			*Has positive influence on some herbivorous waterfowl species*	
Abundance of zooplankton			*Assumed positive for some omnivorous species*	
Benthic invertebrate abundance				*Primary food source for invertebrate-feeding waders*
Fish biomass	*Piscivores will increase with increasing numbers of small to medium-sized fish*			

11.9.4 Summary of the bird condition in Mvoti to Umzimkulu WMA

Table 11.21 provide a summary of the condition of the bird component of the estuaries in Mvoti to Umzimkulu WMA.

Table 11.21 Summary of the bird component condition.

Name	Bird Condition	Estuary Condition	Recreational activities
Mtamvuna	B		*Jet skis, Boating*
Zolwane	B		
Sandlundlu	D	*Habitat destruction, reduced food availability*	
Ku-Boboyi	C		
Tongazi	C		
Kandandhlovu	C		
Mpenjati	B		
Umhlangankulu	C		
Kaba	C		
Mbizana	B		*Canoes*
Mvutshini	C		
Bilanhlolo	D	*Water quality, habitat destruction, reduced food availability*	*Swimming, angling and boating.*
Uvuzana	D	*Water quality, habitat destruction, reduced food availability*	
Kongweni	D	*Flow modification, water quality, severe habitat destruction, reduced food availability*	*Paddle-boating*
Vungu	C		*Swimming, boating and fishing*
Mhlangeni	C		*Boating*
Zotsha	B		

Name	Bird Condition	Estuary Condition	Recreational activities
Boboyi	**C**		
Mbango	**D**	*Flow modification, very poor water quality, severe habitat destruction, reduced food availability*	
Umzimkulu	**B**		*Jet skis*
uMthente	**C**		*Boating*
Mhlangamkulu	**C**		
Damba	**C**		
Koshwana	**C**		
Intshambili	**C**		*ski-boat launch site*
Mzumbe	**E**	*Water quality, habitat destruction (macrophytes), reduced food availability*	
Mhlabatshane	**C**		*Canoeing*
Mhlungwa	**C**		
Mfazazana	**C**		
Kwa-Makosi	**C**		
Mnamfu	**C**		
Mtwalume	**D**	*Poor water quality, habitat destruction, reduced food availability*	*Ski-boat launching site*
Mvuzi	**C**		
Fafa	**D**	*Poor water quality, severe habitat destruction (macrophytes), reduced food availability*	*Paddle craft& canoes*
Mdesingane	**D**	*Flow reduction, poor water quality, habitat destruction, reduced food availability*	
Sezela	**D**	*Poor water quality, habitat destruction, reduced food availability*	
Mkumbane	**D**	*Poor water quality, habitat destruction, reduced food availability*	*Ski boat launch*
uMuziwezinto	**D**	*Poor water quality, habitat destruction, reduced food availability*	
Nkomba	**C**		
Mzimayi	**C**		
Mpambanyoni	**D**	*Poor water quality, habitat destruction, reduced food availability*	*Scottburgh ski-boat club, canoe, paddle craft*
Mahlongwa	**D**	*Medium fishing pressure, poor water quality, habitat destruction, reduced food availability*	*Canoes*
Mahlongwane	**C**		*Canoes*
uMkhomazi	**D**	*Significant flow reduction, poor water quality, habitat destruction, reduced food availability*	*Jet skis*
Ngane	**D**	*Poor water quality, habitat destruction, reduced food availability*	
Umgababa	**B**		
Msimbazi	**B**		
Lovu	**C**		
Little aManzimtoti	**D**	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*	
aManzimtoti	**E**	*Significant flow increase, very poor*	

Name	Bird Condition	Estuary Condition	Recreational activities
		water quality, severe habitat destruction, reduced food availability	
Mbokodweni	**F**	*Significant flow increase, very poor water quality, extreme habitat destruction, reduced food availability*	
Sipingo	**F**	*Very significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*	
Durban Bay	**F**	*High fishing pressure, significant flow reduction, poor water quality, severe habitat destruction (Harbour), reduced food availability*	
uMngeni	**E**	*Significant flow reduction, very poor water quality, severe habitat destruction, reduced food availability*	
Mhlanga	**D**	*Significant flow increase, poor water quality, habitat destruction, reduced food availability*	
uMdloti	**F**	*Flow increase, poor water quality, habitat destruction, reduced food availability*	
uThongathi	**F**	*Very poor water quality, severe habitat destruction, reduced food availability*	
Mhlali	**D**	*Poor water quality, habitat destruction, reduced food availability*	
Bob's Stream	**C**		
Seteni	**C**		
Mvoti	**F**	*Flow reduction, very poor water quality, habitat destruction (sand mining), reduced food availability*	
Mdlotane	**B**		
Nonoti	**D**	*Poor water quality, habitat destruction, reduced food availability*	
Zinkwasi	**D**	*Poor water quality, habitat destruction, reduced food availability*	*Jet skis, Boating*

12 APPENDIX C: ESTUARY ECOLOGICAL IMPORTANCE

12.1.1 National biodiversity importance

The national Estuary Importance Score (EIS) for an estuary takes size, the rarity of the estuary type within its biographical zone, habitat, biodiversity and functional importance of the estuary into account (DWA 2008). Biodiversity importance, in turn is based on the assessment of the importance of the estuary for plants, invertebrates, fish and birds, using rarity indices. These importance scores ideally refer to the system in its natural condition. The scores have been determined for all South African estuaries, apart from functional importance, which is scored by the specialists during EWR workshops (DWA 2008).

To add resolution to the national estuary importance rating the EIS for the estuaries of Mvoti to Umzimkulu WMA *were rated on a 1 (0-20) to 5 (80-100) scale to provide an indication of their biodiversity importance in the region (see Table 12.1 and Table 12.2) (DWA 2008).*

Table 12.1 Ecological Importance rating.

Rating	Estuary Importance Score	Level of importance
1	0 - 20	Little
2	20.1 - 40	Some
3	40.1 - 60	Important
4	60.1 - 80	Very important
5	80.1 -100	Extremely important

Table 12.2 Estuary importance scores on a national scale for the Mvoti to Umzimkulu WMA estuaries. The overall importance score (I) is calculated from the size score (S), habitat importance score (H), zonal type rarity score (Z) and the updated biodiversity importance score (B) (DWAF 2008, Turpie and Clark 2007, Turpie et al. 2002).

Estuary	S	H	Z	B	I	National Biodiversity Importance	Formal Protected Area	Planned PA	Conservation Importance
Mtamvuna	80	50	10	83	66.3	4	Pondoland MPA		5
Zolwane	10	20	10	24.5	16.1	1			1
Sandlundlu	30	40	10	55.5	36.9	2			1
Ku-boboyi	10	20	10	37.5	19.4	1			1
Tongazi	10	70	10	63	38.3	2			1
Kandandhlovu	20	20	10	34.5	22.6	2			1
Mpenjati	40	50	10	73.5	47.9	3	Mpenjati NR	NBA '11 Partial	5
Umhlangankulu	40	80	10	49.5	49.4	3			1
Kaba	20	40	10	25	25.3	2			1
Mbizana	40	70	10	80	54.5	3			1
Mvutshini	10	20	10	10	12.5	1			1
Bilanhlolo	20	60	10	76.5	43.1	3			1
Uvuzana	10	20	10	23	15.8	1			1

Estuary	S	H	Z	B	I	National Biodiversity Importance	Formal Protected Area	Planned PA	Conservation Importance
Kongweni	*10*	*40*	*10*	*48.5*	*27.1*	**2**			**1**
Vungu	*10*	*30*	*10*	*39*	*22.3*	**2**			**1**
Mhlangeni	*20*	*40*	*10*	*59*	*33.8*	**2**			**1**
Zotsha	*30*	*80*	*10*	*55.5*	*46.9*	**3**		*NBA '11 Partial*	**5**
Boboyi	*10*	*40*	*10*	*45.5*	*26.4*	**2**			**1**
Mbango	*10*	*60*	*10*	*31*	*27.8*	**2**			**1**
Umzimkulu	*80*	*100*	*30*	*76*	*79*	**4**		*NBA '11 Partial*	**5**
uMthente	*30*	*80*	*10*	*30.5*	*40.6*	**3**			**1**
Mhlangamkulu	*30*	*10*	*10*	*17*	*19.8*	**1**			**1**
Damba	*20*	*90*	*10*	*25*	*37.8*	**2**		*NBA '11 Partial*	**5**
Koshwana	*10*	*80*	*10*	*24.5*	*31.1*	**2**		*NBA '11 Partial*	**5**
Intshambili	*20*	*80*	*10*	*26*	*35.5*	**2**		*NBA '11 Partial*	**5**
Mzumbe	*50*	*50*	*10*	*53.5*	*46.9*	**3**			**1**
Mhlabatshane	*20*	*90*	*10*	*26.5*	*38.1*	**2**		*NBA '11 Partial*	**5**
Mhlungwa	*20*	*60*	*10*	*47.5*	*35.9*	**2**			**1**
Mfazazana	*20*	*80*	*10*	*57.5*	*43.4*	**3**		*NBA '11 Partial*	**5**
Kwa-Makosi	*20*	*90*	*10*	*39.5*	*41.4*	**3**		*NBA '11 Partial*	**5**
Mnamfu	*10*	*80*	*10*	*10*	*27.5*	**2**			**1**
Mtwalume	*60*	*50*	*10*	*64*	*53.5*	**3**			**1**
Mvuzi	*10*	*50*	*10*	*29.5*	*24.9*	**2**			**1**
Fafa	*70*	*80*	*10*	*63*	*64.8*	**4**			**1**
Mdesingane	*10*	*30*	*10*	*29.5*	*19.9*	**1**			**1**
Sezela	*40*	*50*	*10*	*76.5*	*48.6*	**3**			**1**
Mkumbane	*10*	*40*	*10*	*50.5*	*27.6*	**2**			**1**
uMuziwezinto	*30*	*80*	*10*	*64*	*49*	**3**			**1**
Nkomba						**1**			**1**
Mzimayi	*10*	*40*	*10*	*24.5*	*21.1*	**2**			**1**
Mpambanyoni	*20*	*50*	*10*	*49*	*33.8*	**2**			**1**
Mahlongwa	*30*	*40*	*10*	*44*	*34*	**2**		*KZN*	**5**
Mahlongwana	*30*	*80*	*10*	*48*	*45*	**3**		*KZN*	**5**
uMkhomazi	*80*	*60*	*30*	*91.5*	*72.9*	**4**		*NBA '11 Partial*	**5**
Ngane	*10*	*40*	*10*	*67*	*31.8*	**2**			**1**
Umgababa	*50*	*60*	*10*	*63*	*51.8*	**3**		*NBA '11 Full*	**5**
Msimbazi	*50*	*50*	*10*	*84.5*	*54.6*	**3**		*NBA '11 Full*	**5**

Estuary	S	H	Z	B	I	National Biodiversity Importance	Formal Protected Area	Planned PA	Conservation Importance
Lovu	*40*	*80*	*10*	*78*	*56.5*	**3**		*NBA '11 Partial*	**5**
Little aManzimtoti	*10*	*80*	*10*	*37.5*	*34.4*	**2**			**1**
aManzimtoti	*30*	*70*	*10*	*84*	*51.5*	**3**			**1**
Mbokodweni	*30*	*40*	*10*	*72*	*41*	**3**			**1**
Sipingo	*30*	*100*	*10*	*63.5*	*53.9*	**3**			**1**
Durban Bay	*90*	*100*	*80*	*92.5*	*92.1*	**5**		*NBA '11 Partial*	**5**
uMngeni	*70*	*90*	*10*	*86.5*	*73.1*	**4**	*Beechwood NR*	*NBA '11 Partial*	**5**
Mhlanga	*80*	*70*	*10*	*79*	*70.3*	**4**	*EKZNW*	*NBA '11 Full*	**5**
uMdloti	*80*	*90*	*10*	*69*	*72.8*	**4**			**1**
uThongathi	*70*	*80*	*10*	*54.5*	*62.6*	**4**			**1**
Mhlali	*60*	*90*	*10*	*80*	*67.5*	**4**		*NBA '11 Partial*	**5**
Bob' Stream						**1**			**1**
Seteni	*10*	*80*	*10*	*37.5*	*34.4*	**2**			**1**
Mvoti	*60*	*30*	*70*	*80.5*	*58.6*	**3**		*NBA '11 Full*	**5**
Mdlotane	*60*	*90*	*10*	*65*	*63.8*	**4**		*NBA '11 Full*	**5**
Nonoti	*60*	*60*	*10*	*74.5*	*58.6*	**3**			**1**
Zinkwasi	*80*	*90*	*10*	*80*	*75.5*	**4**		*NBA '11 Partial*	**5**

12.1.2 Regional biodiversity Importance

The biodiversity importance of the Mvoti to Umzimkulu WMA *estuaries were also evaluated on a regional scale, based on available regional scale plant, fish and bird data. This was done to address gaps in the national database and to facilitate a regional perspective.*

12.1.2.1 Macrophytes

Both **uMngeni** *and* **Durban***Bay estuaries are important in terms of macrophytes as they support mangrove communities as well as intertidal salt marsh and submerged macrophytes, exclusively. Mtamvuna, Umzimkulu, Mhlangamkulu and uMkhomazi are important in terms of habitat and floodplain size.. Submerged macrophytes are sensitive to flooding and high sediment loads which result in removal and die-back. The data in Table 12.3 and Tale 12.7.are based on historical records and will need to be checked with field surveys to confirm whether these habitats are currently present in the identified estuaries.*

Table 12.3 Estuaries in the Mvoti-Umzimkulu WMA that support mangrove habitat.

Estuary	Type	Area of mangroves	Total estuarine area	% of total estuarine area
uMngeni	Temporarily closed	20.3	83.3	24.37
Durban Bay	Estuarine bay	16	1148	1.39
Sipingo	Modified permanently open	3.8	26.6	14.29
uMkhomazi	Permanently open	2	74.7	2.68
Mtamvuna	Temporarily closed	0.3	63.58	0.47

Table 12.4 Estuaries in the Mvoti-Umzimkulu WMA that contain submerged macrophytes.

Estuary	Type	Area of present submerged macrophytes	Total estuarine area	% of total estuarine area
Durban Bay	Estuarine bay	8	1148	0.70
Mahlongwana	Temporarily closed	3	20.84	14.40
Umgababa	Temporarily closed	2.5	47.3	5.29
Nonoti	Temporarily closed	2.5	27	9.26
Mhlungwa	Temporarily closed	1.5	16.5	9.09
Fafa	Temporarily closed	1.5	51	2.94
Mdlotane	Temporarily closed	0.71	25.42	2.79
Mdesingane	Temporarily closed	0.5	7.14	7.00
Kaba	Temporarily closed	0.25	14.65	1.71

Only the uMngeni Estuary supports intertidal saltmarsh communities of 2 ha, comprising 2.4 % of the 83.3 ha of estuarine vegetation contained within the system.

Table 12.5 Estuaries in the Mvoti-Umzimkulu WMA that contain supratidal saltmarsh.

Estuary	Type	Area of submerged macrophytes	Total estuarine area	% of total estuarine area
Sipingo	Modified permanently open	3	26.6	11.28
Mzimayi	Temporarily closed	0.07	0.89	19.10

Only five estuaries in the Mvoti to Umzimkulu WMA do not contain reeds and sedges, namely: Zolwane, Tongazi, Mvutshini, Vungu, Nkomba.

Table 12.6 Estuaries in the Mvoti-Umzimkulu WMA that that support the 10 largest reed and sedges habitat.

Estuary	Type	Area of reeds and sedges	Total estuarine area	% of total estuarine area
Mhlangamkulu	Temporarily closed	69.9	100.1	69.83
Zinkwasi	Temporarily closed	39.51	71.16	55.52
Lovu	Temporarily closed	19	39.5	48.10
Umzimkulu	Permanently open	18	117.9	15.27
Sezela	Temporarily closed	18	28	64.29
uThongathi	Temporarily closed	17.2	37.3	46.11
Mpenjati	Temporarily closed	15	33.1	51.36
Mtamvuna	Temporarily closed	15	63.58	23.95
Umgababa	Temporarily closed	14	47.3	31.71

Estuary	Type	Area of reeds and sedges	Total estuarine area	% of total estuarine area
Mvuzi	*Temporarily closed*	*12*	*17.8*	*84.27*

Table 12.7 Estuaries in the Mvoti-Umzimkulu WMA that contain Swamp forest.

Estuary	Type	Area of swamp forest	Total estuarine area	% of total estuarine area
Sipingo	*Modified permanently open*	*16*	*26.6*	*60.15*
Umzimkulu	*Permanently open*	*15*	*117.9*	*12.72*
Mdlotane	*Temporarily closed*	*12.33*	*25.42*	*48.51*
Mhlabatshane	*Temporarily closed*	*11.5*	*19.27*	*59.68*
Zinkwasi	*Temporarily closed*	*11.28*	*71.16*	*15.85*
Damba	*Temporarily closed*	*9*	*19.65*	*45.80*
uMdloti	*Temporarily closed*	*7.8*	*58.1*	*13.43*
Mhlali	*Temporarily closed*	*7*	*42*	*16.67*
Kwa-Makosi	*Temporarily closed*	*7*	*14.95*	*46.82*
Intshambili	*Temporarily closed*	*6.25*	*10.45*	*59.81*

12.1.2.2 Invertebrates

The Mvoti to Umzimkulu WMA estuaries were not ranked for in their importance to invertebrates as no large regional scale assessment have been completed for this component. Important estuaries have been however subsumed as they form part of the National Estuary Biodiversity Plan through expert opinion and are therefore highlighted as important in the preceding sections.

12.1.2.3 Fish

To provide a regional perspective on the importance of the Mvoti to Umzimkulu WMA estuaries for fish the Fish Importance Rating developed by Maree et al 2003 was adjusted for new information and then normalised on a 1 to 5 ranking (Table 12.8).

This assessment showed that 10 estuaries in the region were of high importance to fish, with Durban Bay being the most important even though it is severely transformed.

12.1.2.4 Birds

To provide a regional perspective on the importance of the Mvoti to Umzimkulu WMA estuaries for birds the findings of Ryan et al (1986) were adjusted for new information and then normalised on a 1 to 5 ranking (Table 12.9).

This assessment showed that 23 estuaries in the region were of relative importance to birds, with two – Mbokodweni and Mpambanyoni estuaries - being removed from the original list due to a significant decline in estuary health or importance.

Table 12.8 Relative importance of the estuaries of Mvoti to Umzimkulu WMA for fish (rating 1 – 5 represents lowest - highest importance).

Estuary	Fish Importance Rating
Durban Bay	*5*
Mtamvuna	*4*
Fafa	*4*
uMkhomazi	*4*
Umgababa	*4*
uMngeni	*4*
Mhlanga	*4*
uMdloti	*4*
Mhlali	*4*
Mdlotane	*4*
Zolwane	*3*
Sandlundlu	*3*
Tongazi	*3*
Kandandhlovu	*3*
Mpenjati	*3*
Umhlangankulu	*3*
Kaba	*3*
Mbizana	*3*
Mvutshini	*3*
Bilanhlolo	*3*
Uvuzana	*3*
Kongweni	*3*
Vungu	*3*
Mhlangeni	*3*
Zotsha	*3*
Boboyi	*3*
Mbango	*3*
Umzimkulu	*3*
uMthente	*3*
Mhlangamkulu	*3*
Damba	*3*
Koshwana	*3*
Intshambili	*3*
Mzumbe	*3*
Mhlabatshane	*3*
Mhlungwa	*3*
Mfazazana	*3*
Kwa-Makosi	*3*
Mnamfu	*3*
Mtwalume	*3*
Mvuzi	*3*
Mdesingane	*3*
Sezela	*3*
Mkumbane	*3*
uMuziwezinto	*3*
Mzimayi	*3*
Mpambanyoni	*3*
Mahlongwa	*3*
Mahlongwana	*3*
Ngane	*3*
Msimbazi	*3*
Lovu	*3*
Little aManzimtoti	*3*
aManzimtoti	*3*
Mbokodweni	*3*
Sipingo	*3*
uThongathi	*3*
Seteni	*3*
Mvoti	*3*
Nonoti	*3*
Zinkwasi	*3*
Ku-boboyi	*2*
Nkomba	*1*
Bob' Stream	*1*

Table 12.9 Relative importance of the estuaries of Mvoti to Umzimkulu WMA for birds.

Estuary	Bird Importance ranking
Durban Bay	*5*
uMngeni	*4*
Mvoti	*3*
Mhlali	*3*
uMkhomazi	*3*
Zinkwasi	*2*
uMdloti	*2*
Mhlanga	*2*
uThongathi	*2*
Msimbazi	*2*
Mbizana	*2*
Mtamvuna	*2*
Mzumbe	*1*
Intshambili	*1*
Fafa	*1*
Mtwalume	*1*
Sezela	*1*
Mdlotane	*1*
Sipingo	*1*
Lovu	*1*
aManzimtoti	*1*
Umzimkulu	*1*
Mpenjati	*1*

13 APPENDIX D: REPORT COMMENTS

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
25 September 2013: Comments from Tovho Nyamande				
		DWA logo on the first page.	*Done*	
		Check numbering flow from section 2.	*Done*	
Page i		*Is the Forbes involved?*	*n/a*	*They are involved in the field work and higher level EWR studies. They were not available for the Desktop study.*
Page ii second paragraph, 3rd sentence		*write Water Quality in full.*	*Done*	
Page ii second paragraph, 5th sentence		*"waterquality" – space.*	*Done*	
Page iii Table 1		*Include a table with the explanation of EC A-D and colour coding.*	*Done*	
Page xiv paragraph 2		*spelling mistake "**t**estuary-assessments".*	*Done*	
Section 1: Page 5, sub-section 1.4		*"In this study, effort lay somewhere between a rapid and intermediate study..." – Why not up to Comprehensive?*	*Done*	*Included "very limited historical field data were available that would allow for the correlation between river inflow, mouth state and water quality parameters"*
Section 2: Page 1, paragraph 1, 3rd sentence		*spelling mistakes "delin**e**ation fo**r**".*	*Done*	
4th paragraph, last sentence		*spelling mistakes: systems, truthing.*	*Done*	
Section 3: bottom of page 11		*duplication of "in".*	*Done*	

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
		Change Estuary names to Gazetted names.	*Done*	
25 September 2013: Comments from Mmaphefo Thwala				
		Change estuary names to reflect government Gazette notice, but not maps to reflect DWA database.	*Done*	
		Page for signatures: remove "and Forestry" on the DWA name.	*Done*	
		The Use of Mzimkhulu on the Title and throughout the document instead of UUmzimkulu	*Done*	*Instructed to use Umzimkulu*
page ii		*EHI Score full name should be provided on page ii since this is the first mention.*	*Done*	
page 1 paragraph 4, last sentence		*Systems*	*Done*	
page 6 paragraph 2 under section 3.3.1		*should read "...data was* **sourced**...*"*	*Done*	
page 7 paragraph 2 under section 3.3.4		*should read "....South* **African**....*"*	*Done*	
page 36 section 3.9.1 second sentence		*correct the word "***a***nd"*	*Done*	
page 52 section 3.12 second paragraph, last sentence		*water quality is written an one word*	*Done*	
page 62 section 4.2.2.2 last sentence		*...there***fore** *highlighted..."*	*Done*	
page 64 section 4.2.2.4		*"the findings of Ryan et al ...* **are**...*" , second paragraph, use same size dashes.*	*Done*	
Page 68 paragraph 2		*second sentence – the word "category" is missing*	*Done*	*Changed to importance*
Page 68 paragraph 5		*Remember to insert the Figure number and*	*Done*	

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
		the Chapter number later		
page 57		*Estuary Importance section is repeated exactly as in the Executive Summary (page v), summarise for the Executive summary.*	*Done*	
25 September 2013: Comments from Bill Pfaff (eThekwini Municipality)				
		There are a couple of text errors *i) - page ix , below table 8. Viz : All the estuaries listed in table 7 (should read table 5)) should be prioritised ……….* *ii) ref on page x to Table 8.1. This table as included in the Summary is shown as table 10.*	*Done*	
		2. The comment is provided in detail below the table. The major issue is regarding the lack of sufficient water level recorders and/or flow gauging structures that do not allow for higher confidence estuary EWRs to be undertaken.	*n/a*	*General comment, not action pertaining to report necessary.*
		3. This is a general statement which links to two above. The comment is provided in detail below the table. One statement made is incorrect however: *- the Ecological Reserves have only considered the ecological water (volume) requirements and have not considered water quality*	*n/a*	*EWR assessment consider water quality in terms of habitat requirements for biota in all cases*
		4. An input to determine the 'hotspot' is the 'water resource use importance' scoring which combines scores for "use" , "operational" , "future development" and "water quality" (Table 6.2 in the main report). It is not clear what factors are taken into the respective scoring of these 4 factors but it is clear that the overall "water use importance " does not adequately take into account the use of the	*No*	*Summarised from a range of reports and available on data CD.*

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
		water resource to accommodate the ultimate disposal of wastewater.		
Table 5		*5. The report identifies "priority areas with overall importance" as so-called 'hotspots'. The Mbokodweni and Little Manzimtoti are excluded from this list.* *Of the 16 eThekwini estuaries it has been identified previously that only 8 are impacted in any way by "ultimate wastewater flows".* *Of this 8 the Durban Bay and Isipingo are in a very poor condition as a result of structure related issues and with the Mbokodweni and Little Manzimtoti identified in this report as having no "overall importance ," it is suggested that the focus of the (proposed) eThekwini study should be on the four remaining eThekwini estuaries (Mgeni , Mhlhanga , Mhloti and Tongati) .* *We would welcome having this discussion with the DWA project / study team.*	*No*	*Hotspots identified based on their ecological/social importance, PES and current/future level of resource use. Mbokodweni and Little Manzimtoti of average ecological importance therefore not keyed out as a hotspot.* *Refer to DWA*
Table 8.1 (Table 10 in the Summary)		*6. Includes comments under 'aspects that need targeting for restoration / rehabilitation to occur. These comments need to be checked for consistency . Viz Mgeni , which needs additional flow , is noted as "significant flow reduction' , whereas Mdloti , which also needs additional flow, is noted as " flow increase ".*	*Done*	*Agree, will address.*
		7. It is not clear why the Umgababa estuary has been identified for EWR study when there is little development – no significant flow related pressures - and no wastewater impacts planned. Table 8.1 refers to " flow reduction " ?	*No*	*Umgababa Estuary keyed out as a result of Biodiversity importance (5) and Ecosystem services (4) in combination with PES = C. Not driven by a flow issue as indicated by 3 rating.*
		8. The final recommendation in the report is that general and special standards be	*No*	*Current discharge values exceed the carrying capacity of the estuaries*

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
		replaced by the "application of receiving water quality standards". As the "classification" will provide the quantity and quality of water this raises the question as to how these standards will be determined for each estuary when the data required to assess these standards AT THE REQUIRED LEVEL OF CONFIDENCE does not exist and there are no ongoing efforts to collect additional data.		*significantly in a number of key systems. As indicated before, while target ranges can be provide for cost estimate purposes, refining these estimates will require numerical modelling on a case-by-case basis. This is not part of the scope of an EWR study, but rather the domain of an EIA evaluation.*
Tables 2 , 3 and 4		*9. For completeness the report needs to note that the Minimum EC are NOT a legal requirement, but rather have the status of policy guidelines and can be reduced under certain circumstances.*	*n/a*	*The report does not imply that it is a legal requirement. The report states that it is following the EWR methods for estuaries. Note reference is DWAF 2008 not National Water Act.* *This is the ecological assesment. Any trade-off/deviation from EWR methods rule will need to be done in subsequent integration /classification reports.*
2. Notwithstanding the above, which are easily corrected, the ongoing concern around this part of the study is the quality of the data which is being used to make decisions which will have the potential for significant impacts for eThekwini and the study area in general. *This concern was raised at the commencement of the study and little, if anything, seems to have been initiated in the way of any monitoring programmes which might have provided supporting information.* *This report - refer Note on page x for example – reinforces this concern. Not only are the existing studies which have been quoted dependent upon low confidence hydrology (and hence low confidence (i.e. <40% confidence) predicted abiotic states) but there is no added data from any recent monitoring programmes, notwithstanding that the need for continuous monitoring has been a recommendation of every estuarine ecological reserve conducted in the area and various subsequent undertakings by DWA that monitoring would be given priority.* *As such, and as notified at the commencement of our involvement in this study, eThekwini will not be able to make decisions based on the outcomes of the study with any degree of certainty unless the analysis by the specialists throughout all facets of the study is based on data with which the specialists are able to use with the required degree of confidence.* *Given the potential impact of the project on the means for the disposal of treated wastewater and the potential cost implications to Municipalities in possible 'mitigation' measures, this report cannot be supported whilst the specialists record that data which they rely on "cannot be resolved with any*				

PAGE &/ OR SECTION	REPORT STATEMENT	COMMENTS	CHANGES MADE TO REPORT	AUTHOR COMMENT
degree of confidence". *The manner in which the study is being conducted continues to be in conflict with the aim of producing a "comprehensive" reserve for the Mvoti to uMzimkulu Water Management Area.*				
3. The presence of an existing EWR study is being relied upon as a strategic tool to guide the conclusions of this part of the study and to determine which areas are in need of detailed monitoring. Hence Mgeni , Mhlanga , Mhloti and Tongati are excluded notwithstanding that *- continuous monitoring was a specific recommendation in each of the detailed studies and has yet to commence* *- confidence in the hydrology in each of the studies is low , which leads to low confidence predicted abiotic states* *- the Ecological Reserves have only considered the ecological water (volume) requirements and have not considered water quality* *- none of the existing reserves have considered the discharge of treated wastewater at the volumes resulting from the SDF (refer to the input from eThekwini to the 'visioning' process) although future water-resource development is stated as being the driver for the selection of a "focus area."* *- none of the 'non-flow' related recommendations made in any of the reports have been followed up by DWA* *- we are aware that MER (part of the study team) have recommended that the Mhlanga E R be revisited as the approved procedures for EWR studies have been revised* *- we have advised the study team that new hydrological data for the Tongati casts doubt over the results of the previous study*				