water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

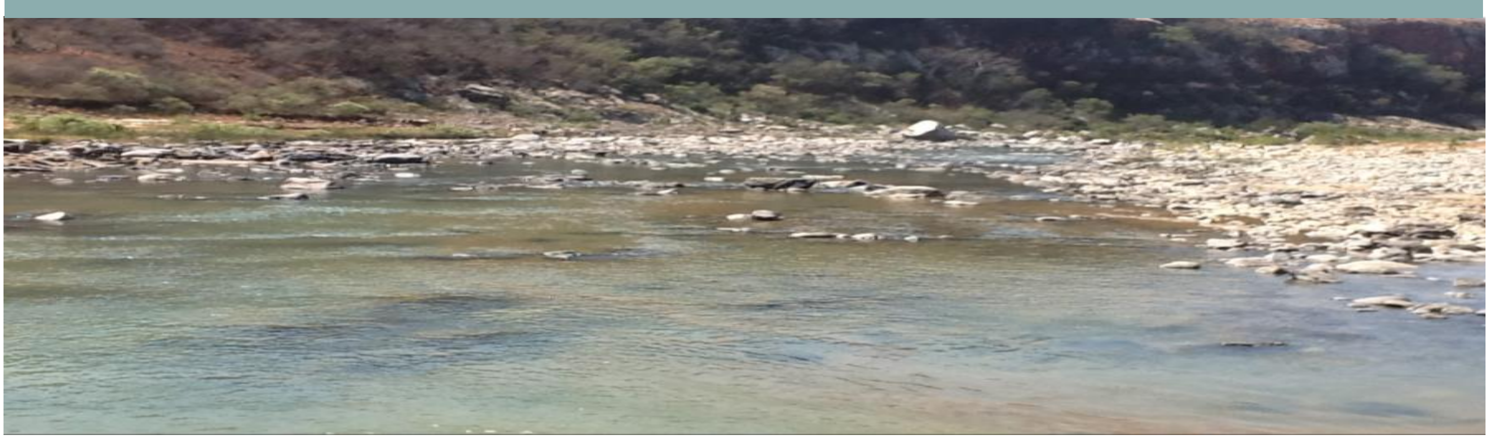
RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA
WP 10544

WETLAND PRIORITISATION AND ASSESSMENT

FINAL

JUNE 2016

Report No. RDM/WMA6/CON/COMP/1113



water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF WATER & SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEMS

CONTRACT NO. WP 10544

RESERVE DETERMINATION STUDIES FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE USUTU/MHLATUZE WATER MANAGEMENT AREA:

WETLAND PRIORITISATION AND ASSESSMENT

FINAL

01 JUNE 2016

This report should be cited as:

Department of Water and Sanitation (DWS), 2016. Chief Directorate - Water Ecosystems: Reserve determination study of selected surface water and groundwater resources in the Usutu/Mhlathuze Water Management Area. Wetland Prioritisation and Assessment. Prepared by Tlou Consulting (Pty) Ltd and Wetland Consulting Services. Report no: RDM/WMA6/CON/COMP/1113.

Contract Title:	Reserve determination studies for selected surface water, groundwater, estuaries and wetlands in the Usutu - Mhlathuze Water Management Area
Report Title:	Wetland Prioritisation and Assessment
Authors:	Bhuti Dlamini – Wetland Consulting Services (Pty) Ltd. Gary Marneweck - Wetland Consulting Services (Pty) Ltd.

Revision	Date	Report Status
1.2	24 September 2014	Draft
1.3	17 October 2014	Draft
1.4	18 May 2016	Final Draft
1.5	1 June 2016	Final

Consultants: Tlou Consulting (Pty) Ltd and Wetland Consulting Services

Approved for the Consultants by:

……………………………………………..

A Singh

Project Manager

Client: Department of Water and Sanitation

Approved for the DWS:

……………………………………………..

N Mohapi

Chief Director: Water Ecosystems

ACKNOWLEDGEMENTS

This report was compiled by Mr. Bhuti Dlamini and Gary Marneweck of Wetland Consulting Services (Pty) Ltd. with specialist input from the following project members.

Contributors:

Miss S. Davis – Wetland Ecologist at Wetland Consulting Services (Pty) Ltd.

Mr. H Ortmann – Was a junior specialist at Wetland Consulting Services (Pty) Ltd during the field surveys.

Mr. S. Driskill - GIS Specialist at Wetland Consulting Services (Pty) Ltd.

ABBREVIATION AND ACRONYMS

AMD	Acid Mine Drainage
BAS	Best Attainable State
CD: RDM	Chief Director: Resource Directed Measures
CMA	Catchment Management Agency
DAEA	Department of Agriculture & Environmental Affairs
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
FEPA	Freshwater Ecosystem Priority Areas
GDP	Gross Domestic Product
GIS	Geographic Information System
GN	Government Notice
HGM	Hydrogeomorphic
IBA	Important Bird Area
IHI	Index of Habitat Integrity
KZN	KwaZulu Natal
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act (Act 36 of 1998)
NWCS	National Wetland Classification System
PES	Present Ecological Status
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RU	Resource Unit
SANBI	South African National Biodiversity Institute
SFRA	Streamflow Reduction Activities
WARMS	Water Authorisation and Registration Management System
WMA	Water Management Area

WUL	Water Use Licence

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF TABLES

1. BACKGROUND INFORMATION

The Chief Directorate: Resource Directed Measures of the Department of Water and Sanitation (DWS) appointed a Professional Service Provider to undertake Reserve Determinations for selected Surface Water, Groundwater, Estuaries and Wetlands in the Usutu to Mhlatuze Water Management Area (WMA). The focus on these catchments is a result of the conservation status of its water resources, and significant development pressures and the associated impacts on the availability of water. The reserve determination results will assist the Department of Water and Sanitation (DWS) in making informed decisions about the future water use and the magnitude of the impacts of proposed water-resource developments.

The Usutu to Mhlatuze WMA has a vast number of lakes and wetlands, and undertaking a reserve determination for each would be an enormous exercise. Thus, the wetland study focuses on the prioritization of the wetlands and a desktop ecological classification of priority wetlands. The study will also generate a set of conditions and mitigation measures related to particular water uses on specific types of wetlands, but this will form part of another report. This report outlines the findings emanating from the two week field visit and existing datasets accessed.

<u>Tasks and activity schedule</u>

Key dates and deadlines for the Wetland Specialist team:

Deliverables:

- Literature review — 30th June 2014
- Ground truthing/Field work — June-July 2014
- Delineation and wetland typing — 4th August 2014
- Ecological classification — 4th August 2014
- Draft wetland typing and ecological classification report — 1st September 2014
- Draft hydro-geomorphological classification — 1st September 2014
- Integration workshops:
  - WS 1: — 10-12 Nov 2014
  - WS 2: — Feb-May 2015
- Draft Integrated Conceptual hydrogeological characterization: — 28 November 2014
- Coarse level water balance — February 2015
- Final Integrated Conceptual hydrogeological characterization: — June 2015
- Generic management measures and associated Monitoring requirements: — June 2015
- Wetland specialist report:
- Final Report — June 2016

2. LIMITATIONS & ASSUMPTIONS

The wetland information provided in this report was compiled using existing wetland datasets and available information. The available wetland delineation datasets used in the mapping for example, were not verified in the field or ground truthed. Due to the extent of the project study area, it was not possible to develop field derived wetland categorisation. Instead available attribute data and surrogate landuse data supported by GIS modelling was used to derive the Present Ecological State (PES) categories.

Groundwater Resource Units (RUs) were obtained from the Groundwater Reserve Determination Report (Dennis & Dennis 2009; Parsons *et al*., 2009). The interpretation of the data in relation to wetland drivers, including surface-groundwater contributions to the wetlands, was done after a workshop with the groundwater specialist. The RUs do not cover the entire WMA. These areas was discussed at the workshop.

In addition to the above, only rapid field surveys were conducted along pre-defined road routes to try to get an idea of the problems in the various catchments and wetlands visited. At the same time, rapid high level (low confidence) PES assessments were undertaken to see if the results of the desktop modelling based on the surrogate data represented what was observed in the field. Rapid surveys of this nature have limitations. These included:

- Only wetlands near to or adjacent to district and/or national roads could be assessed. The size of the study area meant that it was not possible to obtain landowner permission to access private roads. Thus, some of the sites identified during the desktop planning stage also could not be assessed.
- The roadside survey technique may lead to a bias in terms of the wetland types encountered. It is likely that the systems most visited are valley bottom and riparian systems across which roads pass. This was particularly evident in the Piet Retief area.
- A further limitation during the survey, particularly around the Usutu area, was the fact that almost every wetland visited had been burnt at the time. The resultant lack of vegetation meant that it was difficult to estimate vegetation health or identify zones and/or vegetation structure for the different wetland types visited.

A detailed categorisation of the wetlands was therefore not possible and only a broad level estimated categorization map was produced. Note that the PES scores derived for the wetlands are hence very general and subject to further verification either through higher resolution desktop or better still, field surveys using the available wetland assessment tools. The PES scores indicated in this report can only be used as a general indication of the expected integrity/health status of the wetlands in a particular area or region. Detailed PES assessments will therefore always replace any of the categories indicated as these are derived from surrogate indicators.

Given these limitations, on site assessments of affected wetlands must be undertaken to support specific water use applications. These assessments should include accurate wetland delineations, PES and EIS.

3. DESCRIPTION OF THE STUDY AREA - (DWAF, 2004C & 2010)

The Usutu-Mhlatuze WMA is situated in the northern KwaZulu-Natal province, but also occupies the south eastern corner of the Mpumalanga province (west of Swaziland). It borders both Swaziland and Mozambique, and shares two major river systems, the Usutu and Phongola Rivers, with these countries. The Indian Ocean borders the WMA in the east and the Drakensberg Mountain Range forms the border in the north-west. Altitude ranges from sea level to approximately 2000 metres above sea level. Rainfall varies from almost 1500 mm/annum in the western mountainous areas to as low as 600 mm/annum in the vicinity of the Pongolapoort Dam.

The WMA is drained by the Usuthu, Pongola, Mgwavuma, Mkuze, Hluhluwe, Mfolozi and Mhlatuze Rivers. Other important aquatic ecosystems include Kosi Bay, Lake Sibaya, Lake St. Lucia and the Richards Bay estuary. There are 10 major dams – the Jericho, Westoe, Morgenstond, Heyshope, Grootdraai, Goedertrouw, Hluhluwe, Pongolopoort, Klipfontein and Bivane Dams. Water is managed mainly by the district municipalities, local municipalities, Water User Associations, the Mhlatuze Water Board, the Catchment Management Agency (CMA) and DWA's regional office. The dominant land uses for the catchment are nature reserves and afforestation with other significant uses including rural settlements, irrigated crops, sugar cane, and indigenous forests. The Usutu to Mhlatuze WMA is important for conservation and contains a number of protected areas, natural heritage sites, including a number of cultural and historical sites, and other conservation areas. Lake St. Lucia is a World Heritage Site, and there are six RAMSAR sites within the WMA. Protected areas account for about 9% of the area and some 30% of the WMA is communal land. The Usutu to Mhlatuze WMA made a relatively small contribution of 1.94% to South Africa's Gross Domestic Product (GDP) in 1997. Manufacturing and agriculture are the most important activities. Pulp and paper manufacturing and aluminum smelting are the key industries particularly in Richards Bay area, while timber and sugar provide important raw materials for the industrial sector. Tourism is also an important part of the local economy. The population in 2000 was estimated at 2.3 million, with 18% urban and the remaining 82% rural.

The main contributors to the local economy are manufacturing and mining (35.5%), agriculture (15.2%), and transport (12.5%), with all other sectors contributing the remaining (36.8%). There are a number of different land uses within the study area. Commercial agriculture, in the form of sugarcane and citrus as examples, is the predominant land use type present. As a result a significant number of dams exist to support this land use with sufficient access to irrigation. In the upper catchments forestry plantations of wattle, eucalyptus and pines dominate. Other landuses common in these upper regions of the catchments are subsistence farming and the presence of communal livestock herds. **Figure 5-1** below indicates the location and the extent of the WMA, including major towns as indicated in the above sections.

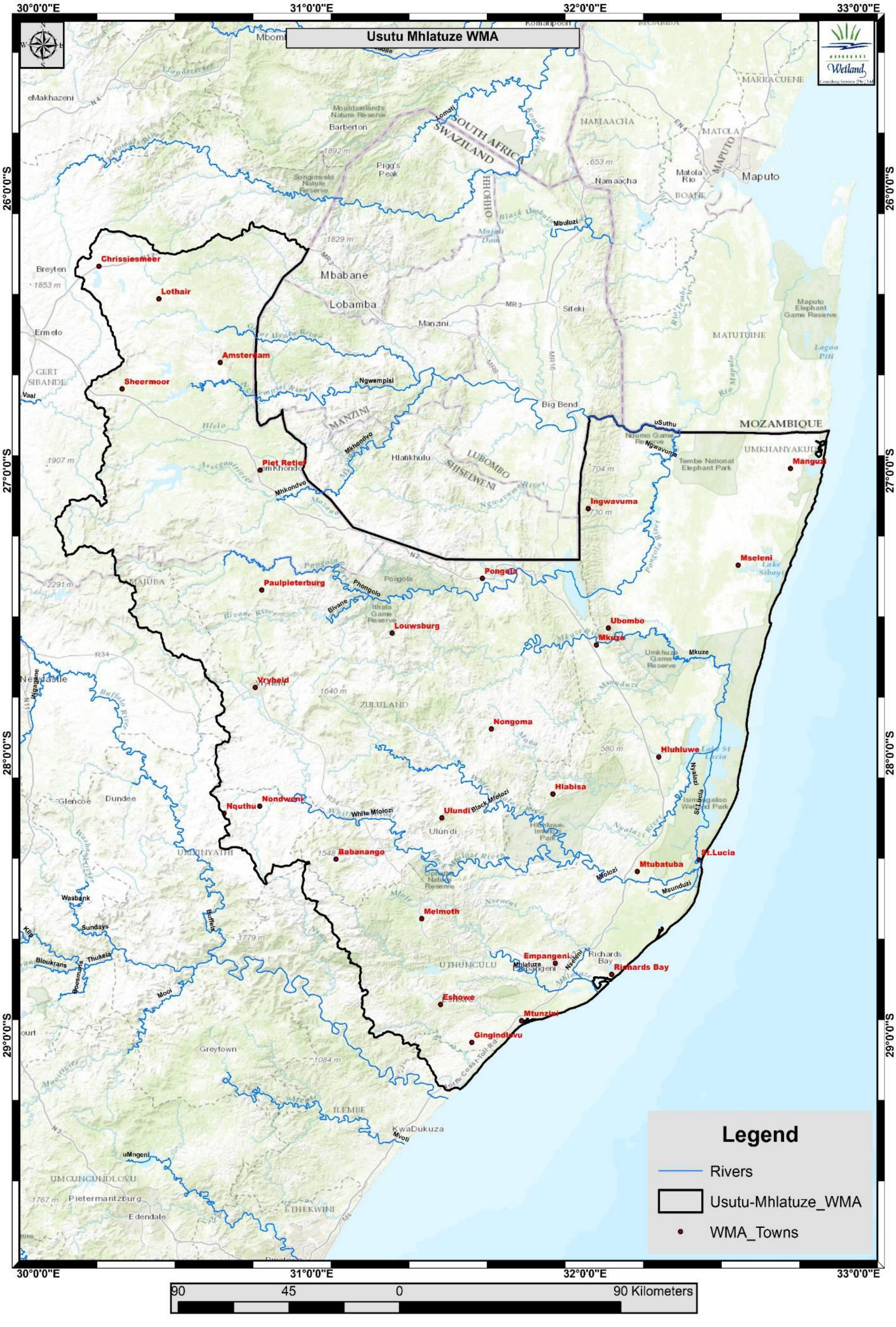


Figure 3-1: Map showing location and extent of the WMA including surrounding towns.

3.1 Review of literature pertaining to wetlands in the study area

3.1.1 Wetland definition

One of the most widely accepted definitions of a wetland is that of the Ramsar Convention whereby wetlands are defined as "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for its proposed National Wetland Classification System (NWCS), (SANBI, 2009), with a few modifications. Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of *ten* metres at low tide, as this is recognised as a good approximation for the seaward boundary of the shallow photic zone.

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses *all* ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA) where wetlands are defined as "*land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil*." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition.

3.1.2 Wetland ecoregions in the study area

South Africa's (Including Lesotho and Swaziland) wetlands were defined into 26 different wetland regions by Cowan (1995). The basis of the distinction between types is topography, hydrology and nutrient regimes (Figure 5.2 and Table 5.1 - description of different wetland regions as illustrated in Figure 3.2). Based on geomorphology and climate the 26 different wetland regions can broadly be classified into the following four groups:

1. Plateau wetland group;
2. Mountain wetland regions;
3. Coastal slopes and rimland wetland regions; and
4. Coastal plains.

Figure 3-2: Wetland Region of South Africa (Cowan, 1995 pp. 25).

Table 3-1:: Wetland regions of South Africa as described by Cowan (1995) pp 24.

REGION	MORPHOLOGY	CLIMATE
P	**Plateau wetland group**	
PW.w	Western plateau	desert region
PW.sn	Western plateau	steppe region
PS.w	Southern plateau	desert region
PS.ss	Southern plateau	steppe region
PE.h	Eastern plateau	highveld region
PNB.nt	Bankenveld	northern Transvaal region
PNW.nt	Waterberg	northern Transvaal region
PNBb.nt	Bushveld basin	northern Transvaal region
PNP.nt	Pietersburg plateau	northern Transvaal region
M	**Mountain wetland regions**	
MD.d	Drakensberg/Maluti	drakensberg region
MCF.k	Cape Fold mountains	karoo region
MCF.m	Cape Fold mountains	mediterranean region
S	**Coastal slope and rimland wetland regions**	
SW.w	Western coastal slope	desert region
SW.m	Western coastal slope	mediterranean region
SSE.w	Southern escarpment	desert region
SK.k	Karoo	karoo region
SSE.ss	Southern escarpment	southern steppe region
SS.a	Southern coast	temperate region
SE.d	Eastern coastal slope	drakensberg region
SE.se	East coast	south-east coastal region
SE.e	East coast	sub-tropical region
SNE.l	Northern escarpment	lowveld region
SL.l	Lowveld	lowveld region
SLV.nt	Limpopo valley	northern Transvaal region
SOR.w	Orange River canyon	desert region
C	**Coastal plain**	
C.e	Coastal plain	sub-tropical region

Within each of these groups are various subdivisions based on differences in geology. Each wetland region has characteristic wetland types. A total of five ecoregions within two of the main groupings (Coastal slopes and Coastal Plain) fall within the study area (Figure 5.2 and Table 5.2).

Table 3-2: Wetland regions described by Cowan (1995), typical wetlands found in the regions and well known wetlands in some of the regions.

Region	Typical wetlands	Examples within WMA
Coastal slopes and rimland		
East coastal slope, Drakensberg region	Grass and restio marshes and reed swamps	Stilwater Vlei (Vryheid)
East coast, subtropical region	Lagoons, reed marshes, swamp forest and mangrove swamps	Mhlatuze and Mfolozi floodplain
Northern Escarpment, Lowveld region	Diverse, pans and grassland Vleis	Lake Chrissie (Mpumalanga Province)
Lowveld, Lowveld region	Rivers with distinctive riparian communities	Usuthu floodplain just before Phongola floodplain confluence
Coastal Plain		
Coastal plain, subtropical region	Floodplains, swam forest, coastal lakes and coral reefs	Lake St. Lucia, Lake Sibaya and Kosi system

a. East coast – UMhlatuze and Mfolozi floodplain;
b. Lowveld – Pongola floodplain;
c. Northern escarpment – Chrissiesmeer (Mpumalanga Lake District);
d. Eastern coastal slope – Stilwater Vlei; and
e. Coastal plain – St Lucia, Lake Sibaya and Kosi System.

3.1.3 Summary of existing information

Wetlands have been identified as important ecosystems in South Africa. The need for their conservation was confirmed when South Africa become the fifth contracting party to the Convention on Wetlands of International Importance (Ramsar Convention) (Cowen, 1995). Wetlands are sometimes described as “kidneys of the landscape” for the functions they perform in the hydrological and chemical cycles, and as the downstream receivers of waste from both natural and human sources (Begg, 1989). Begg (1989), identified 24 priority wetlands within the entire Kwa-Zulu Natal region and these included several known “Vleis” in the headwater regions of major rivers, and some large “swamps” in the lower reaches of the catchments. Out of these 24 priority wetlands, 8 systems fall within this WMA.

1. Pongola floodplain;

2. Muzi swamps;
3. Greater Mkuze Swamp system;
4. Mfolozi swamps;
5. Aloeboom Vlei;
6. Mvamanzi Pan;
7. Stilwater Vlei; and
8. Greater Mhlatuze Wetland system which includes:
    a. Richards Bay Sanctuary;
    b. Lake Nsese;
    c. Lake Mzingazi; and
    d. Lake Chubu.

Within this WMA, South Africa has designated 4 wetlands to the list of Wetlands of International Importance in terms of the Ramsar Convention and these are:

1. Kosi Bay;
2. Lake Sibaya;
3. St Lucia System; and
4. Turtle Beaches and Reefs of Tongoland.

One of the most important indicators of the state of wetlands would be a measure of how many have been lost and no longer function as wetlands. A wetland is considered to be lost if it has been degraded or developed to the point that it has lost most of its wetland properties (e.g. waterlogged soils) and associated ecological services. Such wetlands are sometimes described as relict.

In the Mfolozi catchment Begg (1988) recorded that 33% of the wetlands had been lost, with a further 24% having lost portions of the wetland at that time. Wetland loss is expressed as a function of the overall aerial extent of remaining wetland in the catchment. The ecological status of priority wetlands in 2010 indicated the following (DAEA, 2010):

1. Muzi Swamp – Good;
2. Pongola Floodplain - Poor;
3. Mkuze swamp – Fair;
4. Mvamazi Pan – Fair;
5. Mfolozi swamp – Poor; and
6. Mhlatuze swamp – Poor.

These are wetlands perceived to have substantial ecosystem functions and resource value, and which are regarded as having a high priority for attention as far as management and policy formulation is concerned.

The responses predicted (future) within wetlands due to ongoing alterations are as follows (DAEA, 2010)

1. Muzi Swamp – Highly deteriorated - Due to extent of subsistence agricultural and plans of extensive afforestation in the catchments;
2. Pongola Floodplain - Highly deteriorated - Due to the extent of abstraction associated with further agricultural development projects proposed in the area;
3. Mkuze swamp – Moderately deteriorated - Extent of onsite cultivation is likely to increase;
4. Mvamazi Pan – Moderately deteriorated – Erosion incision could advance and further desiccate the wetland;
5. Mfolozi swamp – Moderately deteriorated - Extent of onsite cultivation is likely to increase; AND
6. Mhlatuze swamp – Highly deteriorated - Planned expansion of harbour and further developments of hardened surfaces will aggravate peak discharges into the wetland potentially causing further localised erosion.

While all ecosystems have an intrinsic right to existence, it is their provision of goods and services or benefits to society which gives them greater value in the eyes of that society. Most wetlands score at least slightly important for the majority of ecological services (ranging from water storage to wildlife protection). The Mkuze Swamp system and the Mhlatuze System scored highest with regards to ecological services, with the Mkuze playing a critical role in trapping sediment that would otherwise enter the Lake St. Lucia system, and the Mhlatuze assimilating pollutants that would otherwise enter Lake Mzingazi (important in the supply of water to Richards Bay) (DAEA, 2010). The most widespread of the goods provided by the wetlands in the region is livestock grazing. While crops and fibre for crafts and construction score very highly for some wetlands, these uses are not as widespread, and subsistence fisheries are restricted to only a few wetlands (DAEA, 2010). It is important to emphasize that even in an overall poor state, a wetland such as the Pongola floodplain may continue to deliver a high level of a particular goods and service, even though these benefits may be considerably less than could have potentially been derived from a wetland in a good ecological state. It should be remembered that many of the smaller and less well known wetlands may none-the-less supply considerable goods and services. (DAEA, 2010) pointed out that it is important therefore that attention not be focused only on the priority wetlands in good condition.

There are currently no wetlands that have been designated to the list of Wetlands of International Importance in terms of the Ramsar Convention within the Usuthu Catchment, which falls predominantly within the Mpumalanga Province. However, from a regional perspective, Chrissiesmeer (Mpumalanga Lake District) in the latest Mpumalanga Biodiversity Sector Plan 2013 has been classified as being an *irreplaceable* Critical Biodiversity Area.

The majority of this ecosystem falls within the Chrissiesmeer Panveld Ecosystem which has been listed as *Endangered* in the National List of Ecosystems that are Threatened and in Need of Protection (GN1002 of 9 December 2011). In terms of the Mpumalanga Provincial Gazette Extraordinary (Notice 19 of 2014) the Mpumalanga Lake District forms part of the Chrissiesmeer Protected Environment (CPE). This area is unique due to the high density of pans, several of which are permanently saturated. The pans range in size from less than a hectare to over a thousand hectares (Lake Chrissie). Collectively the pans inside the pan field are known as the Mpumalanga Lakes District.

The pans in the west (Mpumalanga inland) are mostly ephemeral whilst the pans in the Mpumalanga Lake District are more perennial and also less saline. Water sources range from precipitation, run-off and groundwater contributions. Run-off is less important in terms of the regional drainage as the Mpumalanga Lake district occurs within a plateau surrounded by the drainage basins of important river systems that arise around the fringes of the pan field, namely the Vaal River, the Komati River (via the Boesmanspruit), the uMpuluzi River and the Usutu River (McCarthy *et al*., 2007). However, run-off from the immediate (though small) catchments is locally important for each pan as clastic sedimentation and nutrient input take place from the surrounding landscape (McCarthy *et al*., 2007). A total of approximately 320 pans occur in the Mpumalanga Lakes District, of which the Tevreden Pan is the biggest, covered by a dense growth of *Phragmites australis* (reeds) with a narrow outer ring of open water. The reed pans in the Mpumalanga Lakes District have the most saturated hydroperiod of all the pan-types and usually retain high water levels throughout the year (McCarthy *et al*., 2007). Peat has been found in some of these pans, and peatlands are not common features in the South African landscape. Most of the peatlands found in South Africa are valley bottom fens with some also occurring on hillslopes and interdune depressions on the coast. According to McCarthy *et al*., 2007, it is the first time that a peatland has been described occurring in an endorheic pan in the Highveld, interior, of South Africa. The Tevreden Pan Peatland Complex therefore represents a unique wetland type and should be conserved at the highest possible level.

According to McCarthy *et al*., 2007, Tevreden Pan, along with other pans in the Mpumalanga Lakes District should be nominated/proposed for Listing as Wetlands of International Importance in terms of the Ramsar Convention, given the uniqueness of the area, which includes its status as a globally important bird area (Global IBA: SA019 Chrissie Pans of approximately 62500 ha), as well as its geomorphological and hydrological uniqueness (Barnes, 1998; McCarthy *et al*., 2007). The need for conservation has become critical, with new threats posed by a recent open cast coal mining application in the area. The proposed mining activities are regarded by certain specialists as being likely to cause an irreversible negative impact on pans inside the pan field (McCarthy *et al*., 2007). Based on this regional assessment this area is added to the list of priority wetlands.

It must be mentioned that, particularly for KZN, wetlands smaller than 100 ha were not included by Begg (1989) for consideration in the original maps, recognizing, however, that there are likely to be smaller wetlands of very high importance, particularly in a collective sense (Begg,1989). Similarly it is likely that more recent mapping datasets of wetlands for this area such as the NFEPA data also does not capture many of these smaller wetlands. Capturing these systems will need to happen on a project by project basis or alternatively through higher resolution mapping.

3.1.4 Value of wetlands within the WMA (DWA, 2010)

In the Usutu to Mhlatuze WMA, wetland densities are particularly high in the Upper Usutu catchment and on the coastal plain of the Mkuze catchment (Figure 6-2-1 and 6-2-2). The total area of natural wetlands is estimated to be in the order of 104 000 ha (DWA, 2010). Nine estuaries fall within the Usutu to Mhlatuze WMA. From north to south these are the Kosi, Mgobezeleni, St. Lucia, Mfolozi, Nhlabane, Richards Bay/Mhlatuze, Mlalazi, Siyai and the Matigulu/Nyoni. Based on detailed land cover data (KZN Wildlife), these range in size from 9 ha to South Africa’s largest estuary, the St Lucia estuary, of approximately 48 000 ha, with a total area of all nine estuaries of approximately 65 000 ha.

The wetlands in the study area were estimated to be worth a total of R709 million per annum (DWA, 2010). Provisioning services accounted for 84% of this value, regulating services for 13.5% of this value and cultural services for 2.2% (DWA, 2010). Spatial variation in the value of wetlands is shown in Figure 6-2-1 and 6-2-2. The values of all the services valued are summarised per catchment in Table 5-3.

Table 3-3: Value of wetlands in R millions (2009) (DWA, 2010)

Catchment	Wetland (ha)	Provisioning			Regulating					Cultural			TOTAL
		Livestock	Harvested natural resources	Total	Flood Attenuation	Groundwater Recharge	WQ Treatment	C seq	Total	Angling	Tourism	Total	
Upper Usutu	9756	11.0	51.0	**62.0**	0.0	1.9	1.9	0.5	**4.2**	2.9	2.5	**5.3**	**71.2**
Pongola	39385	99.0	96.0	**194.0**	14.7	5.6	3.4	5.7	**29.5**	0.1	3.7	**3.8**	**227.5**
Mfolozi	22971	31.0	117.0	**148.0**	19.6	3.6	9.1	3.0	**35.2**	0.1	1.1	**1.2**	**184.8**
Mkuze	26038	14.0	68.0	**82.0**	7.1	5.0	1.4	4.1	**17.6**	0.6	3.7	**4.2**	**104.2**
Mhlatuze	7311	8.0	102.0	**111.0**	1.2	3.0	3.7	1.2	**9.1**	0.7	0.5	**1.2**	**121.1**
Total	**105461**	**163.00**	**434.00**	**597.00**	**42.60**	**19.10**	**19.50**	**14.50**	**95.60**	**4.40**	**11.50**	**15.70**	**708.80**

According to DWA, 2010, the total value of the estuaries in the study area was estimated to be in the order of R395 million per annum (Table 5-4). Regulating services were the most important service, amounting to some R209.5 million in value (DWA, 2010). Cultural services amounted to at least R175 million, with the majority of this derived from tourism activities. The lowest value of estuaries came in terms of their provisioning services, namely fishing in the estuaries which derived a value of R6.9 million (DWA, 2010). St Lucia accounted for nearly 80% of the value.

Table 3-4: Value of provisioning, regulating and cultural services from the nine estuaries (taken from DWA, 2010).

Estuary	Provisioning		Regulating		Cultural		Total (Rm)
	Plants	Fishing (Rm)	C seq (Rm)	Nursery & Export (Rm)	Tourism (Rm)	Scientific (Rm)	
Kosi	1.3	3.1	0.2	13.6	22.3	0.0	40.5
Mgobozeleni	0.0	0.0	0.1	0.0	0.1	0.0	0.2
St Lucia	1.0	1.4	2.4	155.5	148.1	0.2	308.6
Mfolozi	0.3	0.7	0.5	11.5	3.9	0.0	16.9
Nhlabane	0.2	1.2	0.0	0.1	0.6	0.0	2.0
Richards Bay/Mhlatuze	0.1	0.4	0.3	19.1	0.1	0.1	20.0
Mlalazi	0.0	0.1	0.0	5.4	0.0	0.0	5.5
Sibaya	0.0	0.0	0.0	0.1	0.3	0.0	0.4
Matigulu/Nyoni	0.0	0.0	0.0	0.7	0.0	0.0	0.7
TOTAL	**2.90**	**6.90**	**3.50**	**206.00**	**175.40**	**0.30**	**394.80**

According to DWA, 2010, the term “value” imposes an anthropocentric orientation on a discussion of wetlands. The term is often used in an ecological sense to refer to functional processes. The reasons that wetlands are often legally protected have to do with their value to society, not with the abstruse ecological processes that occur in wetlands (Mitsch & Gosselink, 2000). Perceived values arise from the functional ecological process described in the above sections but are determined also by human perceptions, the location of a particular wetland, the human population pressures on it, and the extent of the resource (Mitsch & Gosselink, 2000). Wetlands are integral parts of larger landscapes – drainage basins, estuaries. Their functions and their values to people in these landscapes depend on both their extent and their location.

According to DWA (2010) any attempt to place Rand values on the natural resources raises public awareness of the high value of goods and services of nature, and in this way helps in efforts to conserve and protect natural resources. DWA (2010) states further that with this understanding it therefore becomes critical to determine all important and significant systems that provide extra ordinary functions so as to ensure appropriate studies are undertaken to understand these systems and appropriate measures are put in place to ensure their sustainability and continuous provision of goods and services within our changing environment.

4. APPROACH AND METHODOLOGY

4.1 Delineation of Resource Units within the WMA (Parsons, 2009 & Dennis and Dennis, 2009)

Resource Units (RUs) are areas of similar physical or ecological properties that are grouped or typed to simplify the reserve determination process. For intermediate and comprehensive assessments, more detailed delineation may be required based on factors such as geology, topography, surface and groundwater dependence and use. Quaternary catchments are used as the primary delineation of water RUs in RDM assessments. Secondary delineation takes into account surface water, when it is necessary to delineate zones of similar ecology within the study area.

Groundwater RUs are delineated using geo-hydrological characteristics, but may coincide with other water RUs, or parts thereof. There are 88 quaternary catchments in the WMA, making delineation a complex process. Thus, the first step in the delineation process was to identify six sub-catchments with broadly similar geo-hydrological characteristics, namely the:

- Usutu
- Pongola
- Mkuze (Hluhluwe and St Lucia)
- Mfolozi
- Mhlatuze and
- Lake Sibaya and Kosi Bay.

Each area is then divided into smaller RUs, taking into consideration:

- Geology;
- Climate;
- Recharge; and
- Surface water and groundwater stresses.

Figure 6-1 indicates the extent and locality of the Groundwater RUs delineated for the Usutu-Mthlatuze WMA.

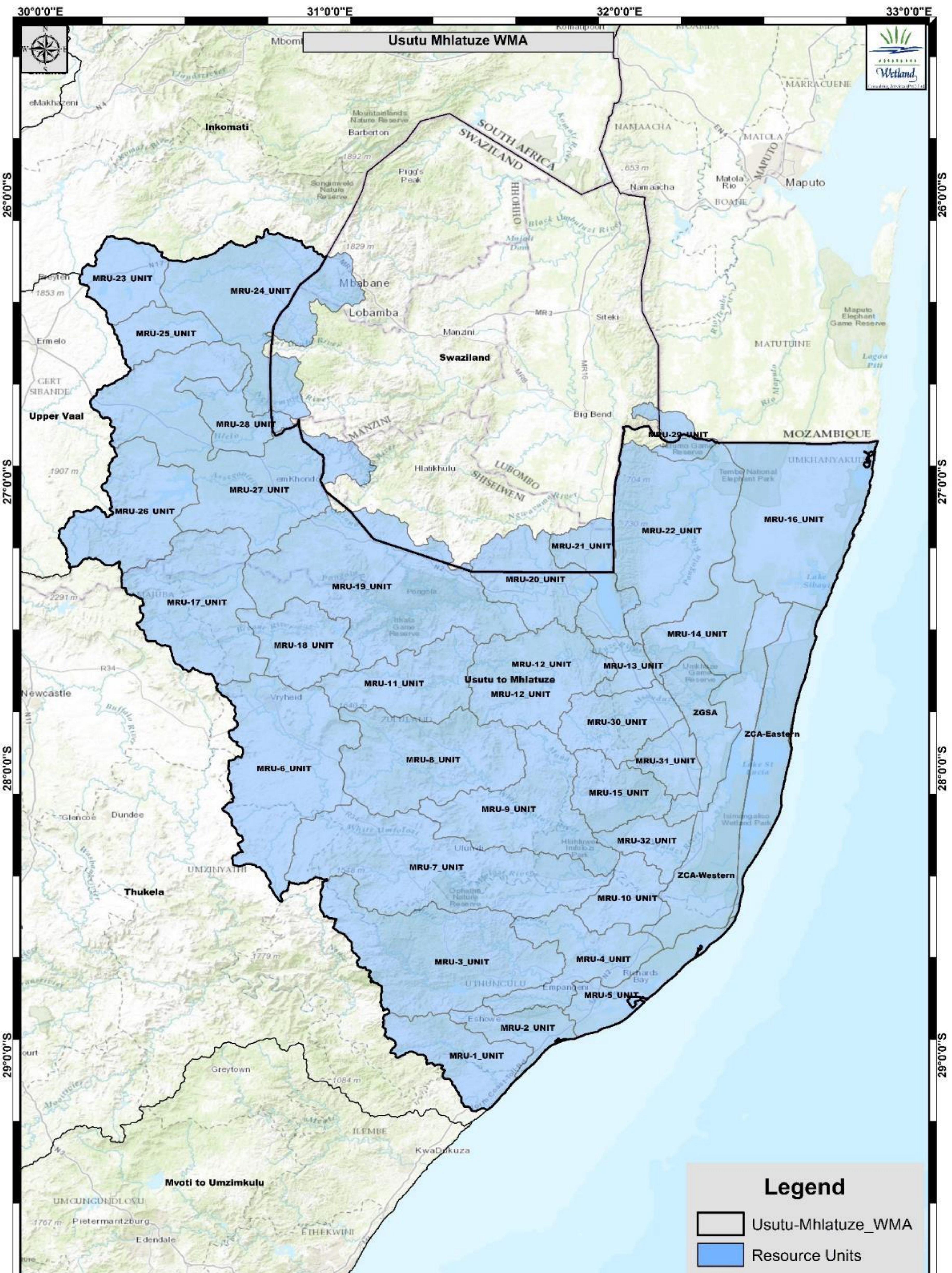


Figure 4-1: Map showing the resource units of the Usutu to Mhlatuze Water Management Area (Dennis and Dennis, 2009).

4.2 Wetland typing and ecological classification

4.2.1 Wetland typing

The typing of wetlands follows the HydroGeoMorphic (HGM) approach to wetland classification, which uses hydrological and geomorphological characteristics to distinguish primary wetland units. The HGM approach is, therefore, based on factors that influence how wetlands function. This is in contrast to the more traditional approach developed by the United States Fish and Wildlife Service (Cowardin *et al*. 1979), by which different wetland units are distinguished at the broadest level on the basis of structural features (such as size, depth, vegetation cover and presence of surface water) that are relatively easy to identify from aerial photography and other remote- sensing information sources. This more traditional approach to wetland classification is often referred to as the "Cowardin approach" or the "Cowardin-based approach", after the first author of the well-cited document on the "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin *et al*. 1979).

While Cowardin-based approaches have the advantage of being relatively easy to use for identifying wetlands from remote sources, they are structurally-based and therefore do not group wetlands effectively in term of functional features (Cowardin *et al*. 1979). Their usefulness as a starting point for most of the wetland health and functional assessment techniques currently used for the management and conservation of wetlands in South Africa is therefore limited. A shift towards the HGM approach for the NWCS is consistent with a general move towards the HGM approach, both internationally (e.g. Brinson, 2003) and in South Africa (e.g. Kotze *et al*. 2008, Macfarlane *et al*. 2008,), largely because geomorphology and hydrology are recognised as the fundamental features that determine the existence of wetlands and how they function.

For the purpose of this report Level 4 classification (SANBI, 2009) has been used to classify and for the typing of wetlands within the WMA. Level 4 of the proposed National (South African) Wetland Classification System (SANBI, 2009) classifies the HGM Units, which are defined primarily according to (i) landform, which defines the shape and localised setting of a wetland; (ii) hydrological characteristics, which describe the nature of water movement into, through and out of the wetland; and (iii) hydrodynamics, which describe the direction and strength of flow through the wetland. Together these factors affect the geomorphological processes acting within the wetland such as erosion and deposition, as well as biogeochemical processes. There are eight primary HydroGeoMorphic (HGM) Types that are recognised for Inland Systems at Level 4A of the proposed NWCS, on the basis of hydrology and geomorphology, namely:

1. *Channel (river, including the banks):* an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies.
2. *Channelled valley-bottom wetland*: a mostly flat valley-bottom wetland dissected by and typically elevated above a channel (see *channel*).
3. *Unchannelled valley-bottom wetland*: a mostly flat valley-bottom wetland area without a major channel running through it, characterised by an absence of distinct channel banks and the prevalence of diffuse flows, even during and after high rainfall events.
4. *Floodplain wetland*: the mostly flat or gently sloping wetland area <u>adjacent to and formed by a Lowland or Upland Floodplain river,</u> and subject to periodic inundation by overtopping of the channel bank. For purposes of the classification system, the location adjacent to a river in the Lowland or Upland Floodplain Zone is the key criterion for distinguishing a *floodplain wetland* from a *channelled valley-bottom wetland*.
5. *Depression*: a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
6. *Flat*: a near-level wetland area (i.e. with little or no relief) with little or no gradient, situated on a plain or a bench in terms of landscape setting.
7. *Hillslope seep*: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope.
8. *Valley head seep:* a gently-sloping, typically concave wetland area located on a valley floor at the head of a drainage line, with water inputs mainly from subsurface flow (although there is usually also a convergence of diffuse overland water flow in these areas during and after rainfall events).

Appendix 1 of this report provides schematic diagrams indicating these HGM types. For further sub-categorization of certain HGM types please refer to SANBI (2009). A detailed HGM table description is provided in **Appendix 2**.

The wetland types occurring in each RU were described with reference to their HGM classification as were individually prioritized systems for which the classification was already known or which was determined based on examination of available aerial imagery;

The wetland types (based on the NFEPA coverage plus the additional mapping undertaken as part of this study) are shown in **Figure 6-2-1** and **6-2-2**. And distribution of wetland types in indicated in **Figure 6-2-3**. **<u>Note:</u>** use of NFEPA datasets was made and some of the wetland particular in the coastal areas are not classified and these are labeled as others in this map.

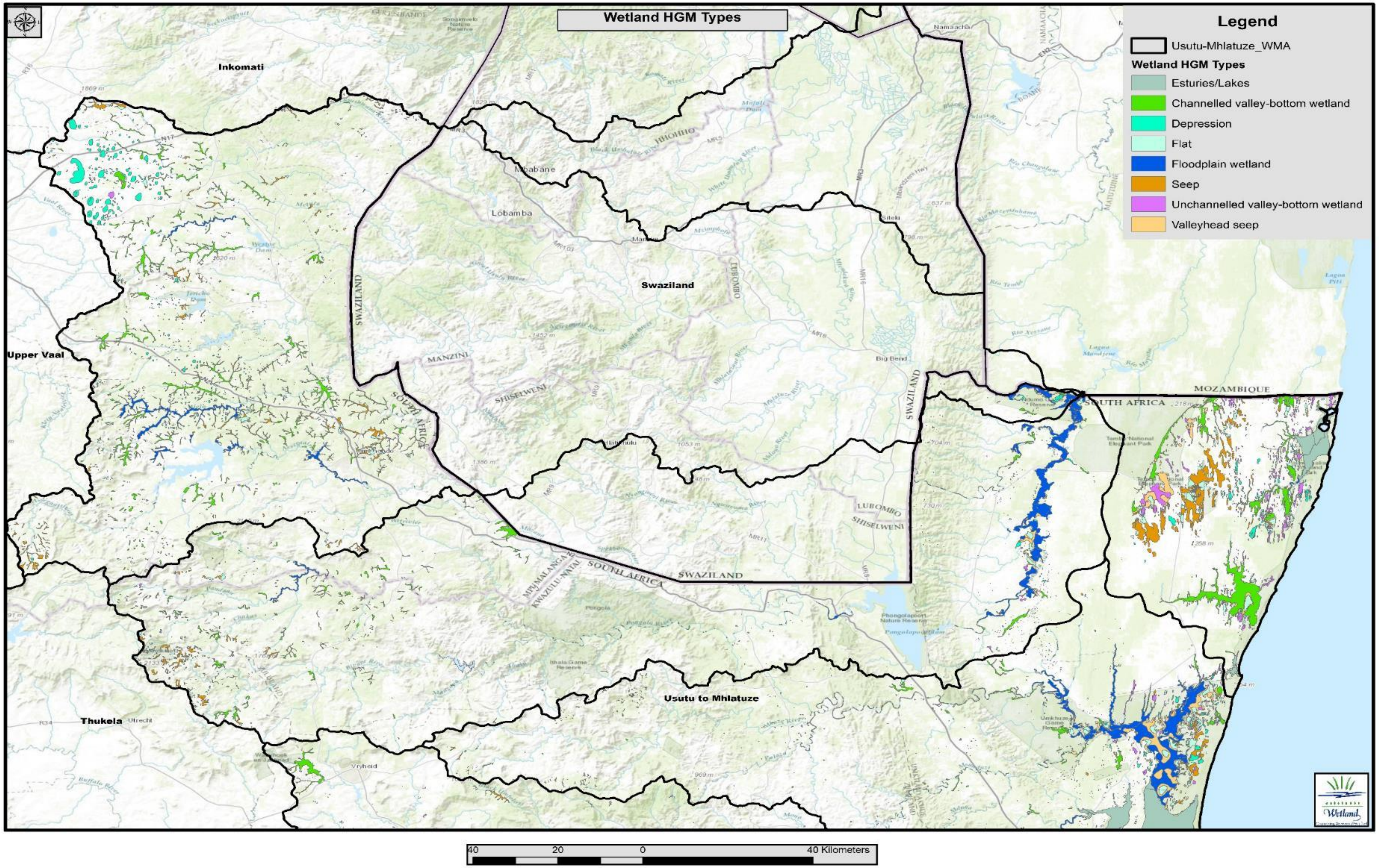


Figure 4-2-1: Map of the wetlands in the upper section of the Usutu-Mhlatuze WMA.

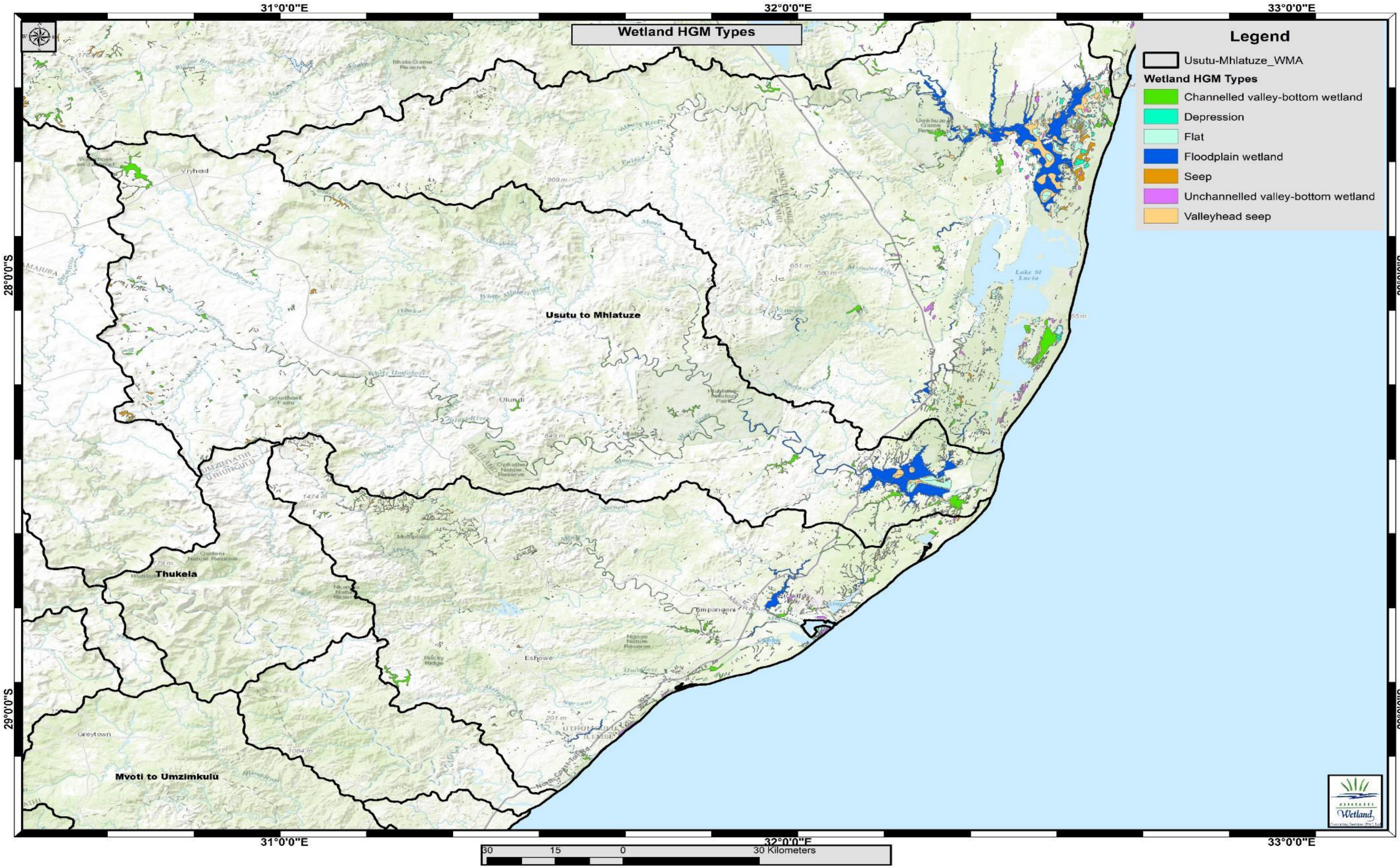


Figure 4-2-2: Map of the wetlands in the lower section of the Usutu-Mhlatuze WMA

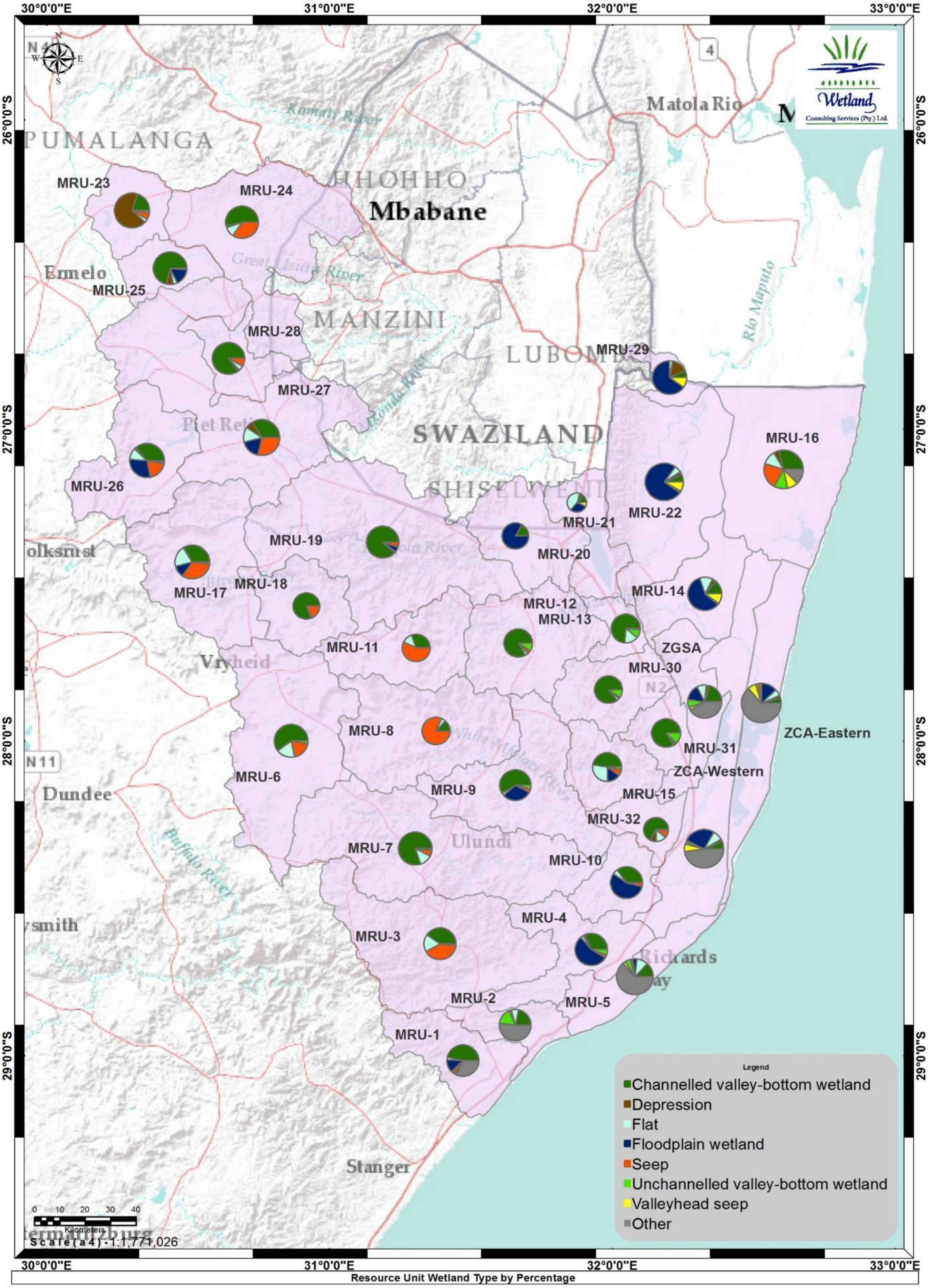


Figure 4-2-3: Map indicating distribution of different wetland types within the Usutu-Mhlatuze WMA based on NFEPA datasets.

4.2.2 Wetland Mapping

Available information on wetlands was obtained from the South African National Biodiversity Institute (SANBI) wetland probability map for South Africa, and the NFEPA wetland coverage of South Africa. In some areas where additional information was available, the wetland coverage was updated, while in others this was replaced by new shapefiles produced as part of the desktop delineation checks of the priority wetlands such as those captured by Begg (1989). In order to come up with a final coverage, the shapefiles were merged with the desktop delineations where there was overlap and additional information.

4.2.3 Categorisation

Due to the extent of the study area only representative samples of wetland areas were visited to inform ecological conditions of the wetlands. The categorisation of wetlands to cover the entire water management area was done in the following categories:

1. PES assessment tools, namely WET-Health (Macfarlane, Kotze, Ellery, Walters, Koopman, Goodman and Goge, 2008) and Wetland Index for Habitat Integrity (IHI) (DWAF, 2007) were used where appropriate at visited sites to inform wetlands ecological status;
2. PES scores derived from assessments results by rivers and estuaries specialists were used in specific systems that were assessed by the specialist; and
3. In wetland systems that were not visited, a surrogate measure was used as an indication of wetland health. For the PES assessment land use was used as a surrogate indicator of wetland health. PES values were assigned to individual wetlands based on the intersection of wetland boundaries with land-cover types derived from SANBI's 2009 national land-cover dataset. The approach provides an indication of the general state of the wetlands within each of the RU's and of problems or wetland health concerns at the individual wetland scale.

The PES categories assigned to a wetland for assessment undertaken under point 1 and 2 above will based on the following table:

Table 4-1: Rating scale used for the PES assessment.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

The PES categories assigned to a wetland for point 3 above will be based on each land cover type were as follows:

- Natural: B
- Degraded: C
- Cultivation: C/D
- Plantation: D
- Urban areas: D/E
- Mining: E/F.

Where a wetland overlapped with more than one type of land-cover, the lower PES score was assigned to the wetland. See **Figure 6-3-1** and **6-3-2** for an overview of the PES scores for wetlands occurring within the study area.

4.2.4 Ecological Importance and Sensitivity of wetlands (EIS)

This included:

- A Stratified field assessments of the representative wetlands within the WMA to collect ecological assessment data to undertake Ecological Importance and Sensitivity (EIS) studies. This will be done in order to establish a baseline of the current state and ecological importance of the wetlands.
- Use of existing information from regional conservation plans, NFEPA datasets and PES assessment data and specialist observations will be used in combinations to inform the sensitivity of the wetlands for the systems that were not visited
- Use of existing EIS assessment results from rivers and estuaries specialist studies and that information will also be incorporated to the EIS database on the wetland onsite.

EIS will only be assessed for the priority systems identified within the WMA using the above criteria. Results of the EIS assessment based on the above approached is presented is section 7.3 Table 7-1 of the priority wetland areas within the WMA.

Table 4-2: Rating scale used for the EIS assessment.

Ecological Importance and Sensitivity categories	Range of Median	Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

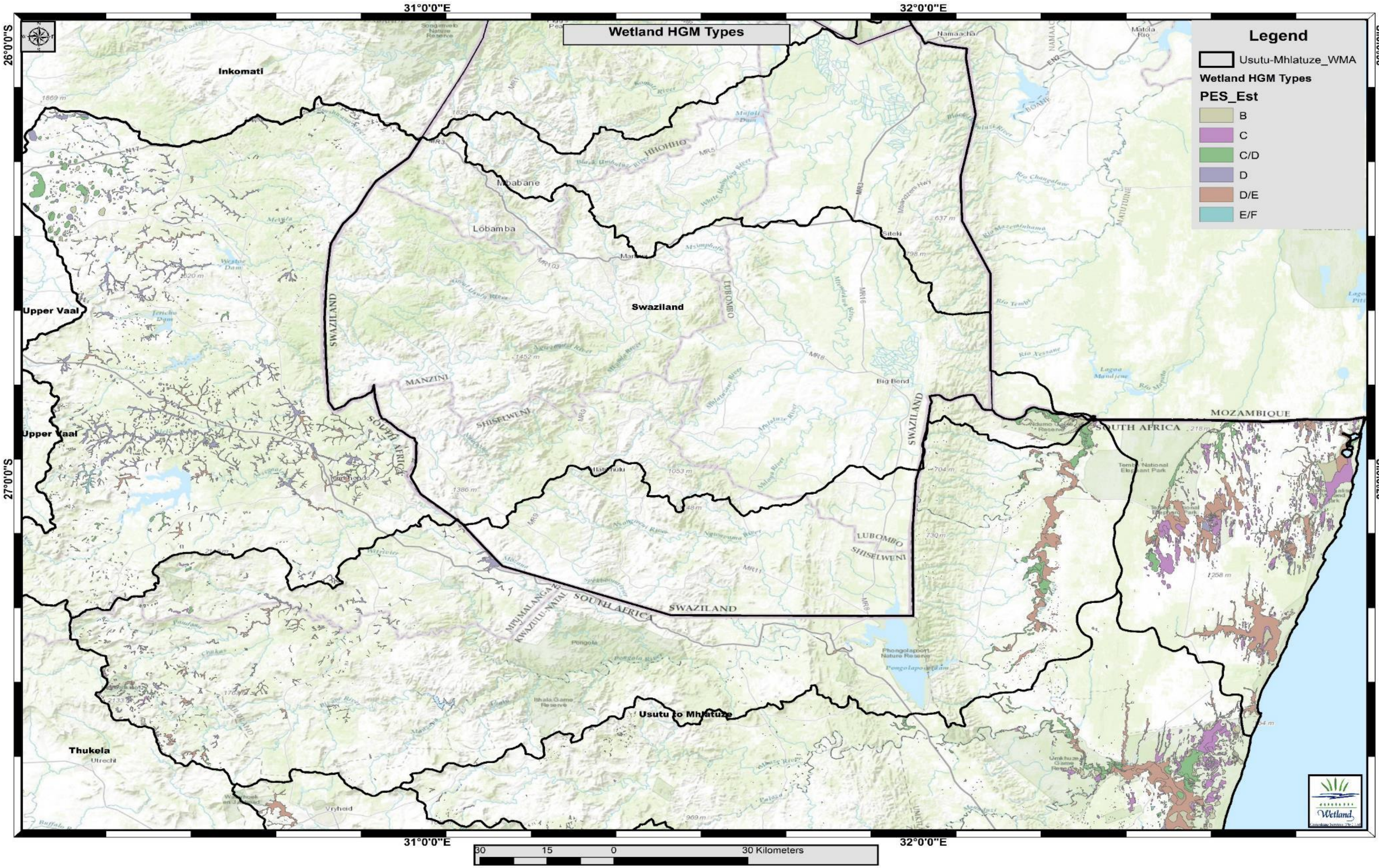


Figure 4-3-1: Preliminary PES classification of wetlands in the upper section of the Usutu-Mhlatuze WMA.

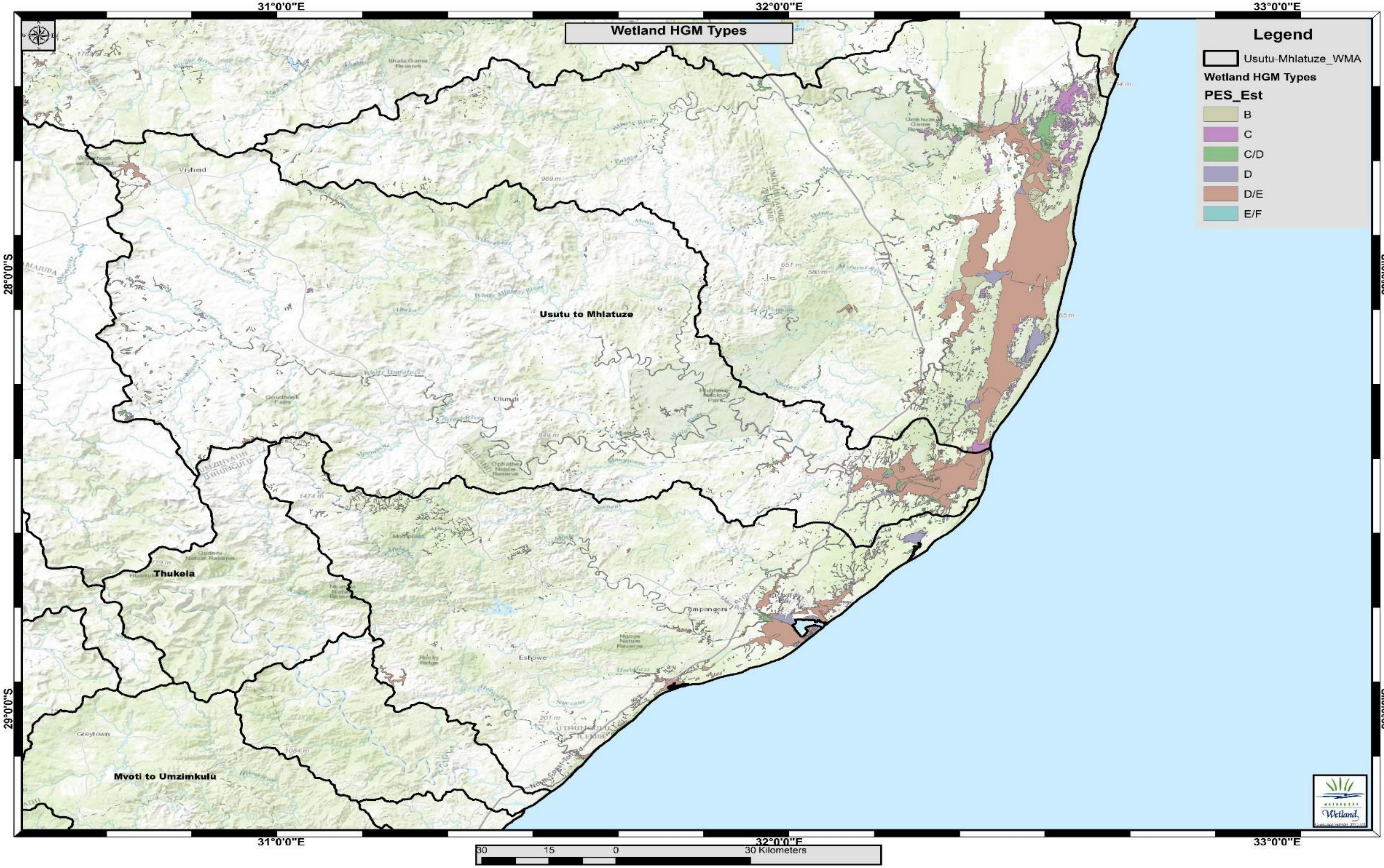


Figure 4-3-2: Preliminary PES classification of wetlands in the lower section of the Usutu-Mhlatuze WMA

4.3 Threatened ecosystem types occurring in the Usuthu-Mhlatuze WMA

According to Driver, Maze, Rouget, Lombard, Nel, Turpie, Cowling, Desmet, Goodman, Harris, Jonas, Reyers, Sink, and Strauss, (2005), there are 35 threatened ecosystem types that occur within the WMA. The most widespread of these is the KaNgwane Montane Grassland, which occurs extensively throughout the Usutu catchment and in the upper reaches of the Pongola catchment.

Six ecosystem types are classified as critically endangered (Driver *et. al.*, 2005). These are: the North Coast Dune Forest, Entumeni Valley, KwaMbonambi Dune Forest, KwaMbonambi Hygrophilous Grasslands, Ngoye Scarp Forest and Grassland; and Eshowe Mtunzini Hilly Grasslands. These ecosystem types occur almost exclusively in the Mhlatuze catchment in the southern parts of the study area. Eight Endangered ecosystem types occur and a further 14 are considered Vulnerable.

Important Note: All Swamp Forest wetland habitat in the WMA (Grundling *et al*., 1998) is categorized as highest priority for protection. Of significance is any remaining Swamp Forest habitat outside of Protected Areas. This is one of the most critically threatened wetland vegetation types in South Africa and its distribution is wholly restricted to the eastern parts of the Usutu-Mhlatuze WMA.

Table 4-3: Threatened ecosystem types occurring within the study area.

Threatened Ecosystem Type	Threat Category
Eastern Highveld Grassland	**Vulnerable (VU)**
KaNgwane Montane Grassland	
Eastern Temperate Freshwater Wetlands	
Low Escarpment Mistbelt Forest	
Lowveld Riverine Forest	
Swamp Forest	
Paulpietersburg Moist Grassland	
Lebombo Summit Sourveld	
Eastern Scarp Forest	
Maputaland Wooded Grassland	
Lebombo Scarp Forest	
Bivane Sour Grassveld and Bushveld	

Louwsberg Mistbelt Grassland eMondlo Sandy Moist Grassland Ngongoni Veld Midlands Mistbelt Grassland Black Rhino Range Hluhluwe Scarp Forest Nkandla Forests and Grasslands Imfolosi Savanna and Sourveld KwaZulu-Natal Coastal Belt	
Chrissiesmeer Panveld Bivane Montane Grassland Wakkerstroom/Luneburg Grasslands Ngome Mistbelt Grassland and Forest Hlabisa Forest Complex KwaZulu-Natal Coastal Forest Mangrove Forest Dukuduku/St Lucia Grasslands and Forests	**Endangered (EN)**
Kwambonambi Dune Forest Eshowe Mtunzini Hilly Grasslands Kwambonambi Hygrophilous Grasslands Ngoye Scarp Forests and Grasslands Entumeni Valley North Coast Dune Forest	**Critically Endangered (CR)**

4.4 Wetland vegetation types occurring in the Usutu-Mhlatuze WMA:

According to Nel, Murray, Maherry, Petersen, Roux, Driver, Hill, van Deventer, Funke, Swartz, Smith-Adao, Mbona, Downsborough, and Nienaber (2011), sixteen wetland vegetation types occur in the WMA Five (31%) of these are critically endangered and four (25%) are endangered. Hence, more than half of the wetland vegetation types in the WMA are classified in the two highest categories of risk of extinction. Furthermore, the level of formal protection offered to these systems is non-existent for ten of the 16 wetland vegetation types. This highlights the urgent need to ensure that some of these systems are protected.

Table 4-4: **Wetland vegetation types occurring within the WMA.**

Wetland Vegetation Type	Threat Category	Level of Protection
Indian Ocean Coastal Belt Group 1	Least Threatened (LT)	**Well Protected**
Indian Ocean Coastal Belt Group 2	CR	mostly **Not Protected**
Lowveld Group 2	CR	**Poorly Protected**
Lowveld Group 3	CR	**Not Protected**
Lowveld Group 9	VU	**Poorly Protected**
Lowveld Group 10	EN	**Poorly** to **Well Protected**
Lowveld Group 11	VU	**Well Protected**
Mesic Highveld Grassland Group 4	CR	**Not Protected**
Mesic Highveld Grassland Group 5	EN	**Not Protected**
Mesic Highveld Grassland Group 8	LT	**Not Protected**
Sub-Escarpment Grassland Group 1	LT	**Not Protected**
Sub-Escarpment Grassland Group 2	LT	**Not Protected**
Sub-Escarpment Grassland Group 3	CR	**Not Protected**
Sub-Escarpment Grassland Group 4	EN	**Not Protected**
Sub-Escarpment Savanna	EN	**Not Protected**
Swamp Forest	LT	**Well Protected**

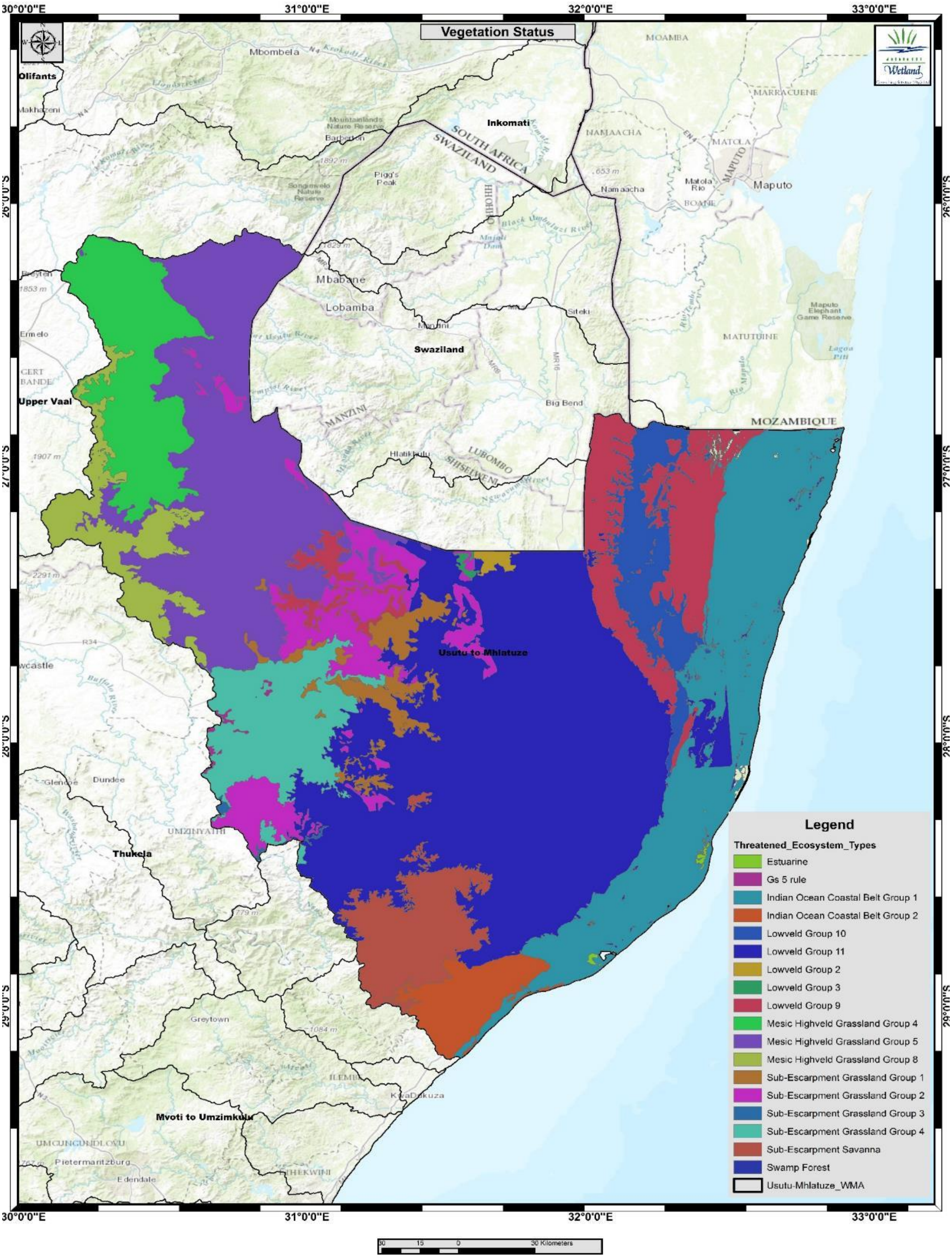


Figure 4-3: Map showing the threatened ecosystem types occurring within the Usutu to Mhlatuze Water Management Area.

4.5 Wetland prioritisation

The prioritisation of the wetlands was based predominantly on available information and limited ground-truthing as part of the fieldwork undertaken (see Results section).

Data sources considered in deriving the prioritization included:

- The National Spatial Biodiversity Assessment (Nel and Driver, 2012);
- The NFEPA wetland layer (Nel *et al.*, 2011);
- The Mpumalanga C-Plan shapefiles and the KZN C-Plan shapefiles; and
- Wetlands recorded by Begg (1989) (All wetlands of the Umfolozi catchment and priority wetlands of KZN).

Based on a review of the above combined layers, a merged wetland layer was derived by combining the NFEPA and Begg (1989) layers. Some desktop mapping was also undertaken where additional wetland signatures were visible on either 1:50 000 topographic maps, Google imagery or aerial photos. This layer was added to the merged wetland layer and used as the final wetland layer.

The first level of prioritization was achieved by identifying wetlands indicated as priority (indicated in the WETNFEPA attributes) in the NFEPA dataset. From these priority wetlands, further prioritisation was carried out based on the ecological importance of terrestrial lands which intersected the wetlands, as indicated by the relevant C-Plan datasets. The prioritizations were ranked as such:

- 1 – Low Priority: Wetlands intersected 100 Percent Transformed areas (as indicated in the KZN C-Plan) or modified areas (as indicated in Mpumalanga C-Plan);
- 2 - Medium Priority: Wetlands intersected Biodiversity Support Areas (as indicated in KZN C-Plan) or either Ecological Support Areas or Other Natural Areas (as indicated in Mpumalanga C-Plan); and
- 3- High Priority: Wetlands intersected any Critical biodiversity areas (as indicated in either dataset).

In the case that a single wetland intersected multiple terrestrial classifications, the lowest priority score was taken for its final ranking. Finally, wetlands were additionally prioritized independently if they fell mostly within Protected Areas as indicated in either C-Plan dataset. From this output, highest priority wetlands were finally classified further into 3 separate categories as follows:

- Highest Priority Wetlands: Which include wetlands that were indicated as priority by NFEPA as previously mentioned and also received a priority ranking of 3 (High Priority), while also were not indicated as falling within a protected area, as these were thought to be the most vulnerable.

- High Priority Wetlands within Protected Areas: Consists of wetlands indicated as priority by NFEPA dataset, while also falling within protected areas.
- High Priority Wetlands Based on Specialist Knowledge (Beggs prioritisation work): Consists of wetlands not necessarily indicated as high priority by NFEPA or C-Plan based priority ranking, yet are known by other means to be important. This includes Beggs' priority wetlands as indicated in NFEPA, and additional knowledge.
- A fourth prioritization category was described by including a dataset of groundwater recharge values using only areas where recharge was greater than 25%. This was done in order to gain a better understanding of any linkages between groundwater and wetlands within the study area. This information is vital in determining which wetlands are driven more significantly by groundwater when compared to systems receiving water mostly through rainfall events.

Based on the assessment of the available datasets and including local knowledge, important wetlands and wetland clusters were then identified and these systems are indicated under the findings section below.

5. FINDINGS

5.1 Catchment Assessment

5.1.1 Usutu Catchment

Major water resources:

1. Usutu River and associated tributaries; and
2. Heyshope, Jericho, Morgenstond and Westoe Dams.

Dominant landuses:

1. Cultivation (communal and commercial);
2. Forest plantations;
3. Urbanisation and developments;
4. Formal and informal roads and associated infrastructures (in towns and around villages);
5. Water abstraction for water supply and irrigation; and
6. Nature Reserves:
   a. Jericho Dam Provincial Nature Reserve
   b. Section of Ndumo Game Reserve on the Eastern edge of the catchment at the confluence of Usutu and Phongola Rivers before entering Mozambique.

Important wetland systems:

1. Cluster of pans in the Chrissiesmeer area (IBA SA019) i.e. Chrissiesmeer Protected Environment; and
2. Wetlands within the Important Bird Area in the south west of the catchment (IBA SA020).

Threatened Ecosystem Types:

- Eastern Highveld Grassland – Vulnerable (VU)
- KaNgwane Montane Grassland - VU
- Eastern Temperate Freshwater Wetlands - VU
- Low Escarpment Mistbelt Forest - VU
- Lowveld Riverine Forest - VU
- Paulpietersburg Moist Grassland - VU
- Lebombo Summit Sourveld - VU
- Chrissiesmeer Panveld – Endangered (EN)
- Wakkerstroom/Luneburg Grasslands – EN.

Wetland Vegetation Types:

- Lowveld Group 9 – Vulnerable (VU); **Poorly Protected**
- Lowveld Group 10 – Endangered (EN); **Poorly** to **Well Protected**
- Lowveld Group 11 – VU; **Well Protected**
- Mesic Highveld Grassland Group 4 – CR; **Not Protected**
- Mesic Highveld Grassland Group 5 – EN; **Not Protected**
- Mesic Highveld Grassland Group 8 – LT; **Not Protected**
- Sub-Escarpment Grassland Group 2 – LT; **Not Protected**.

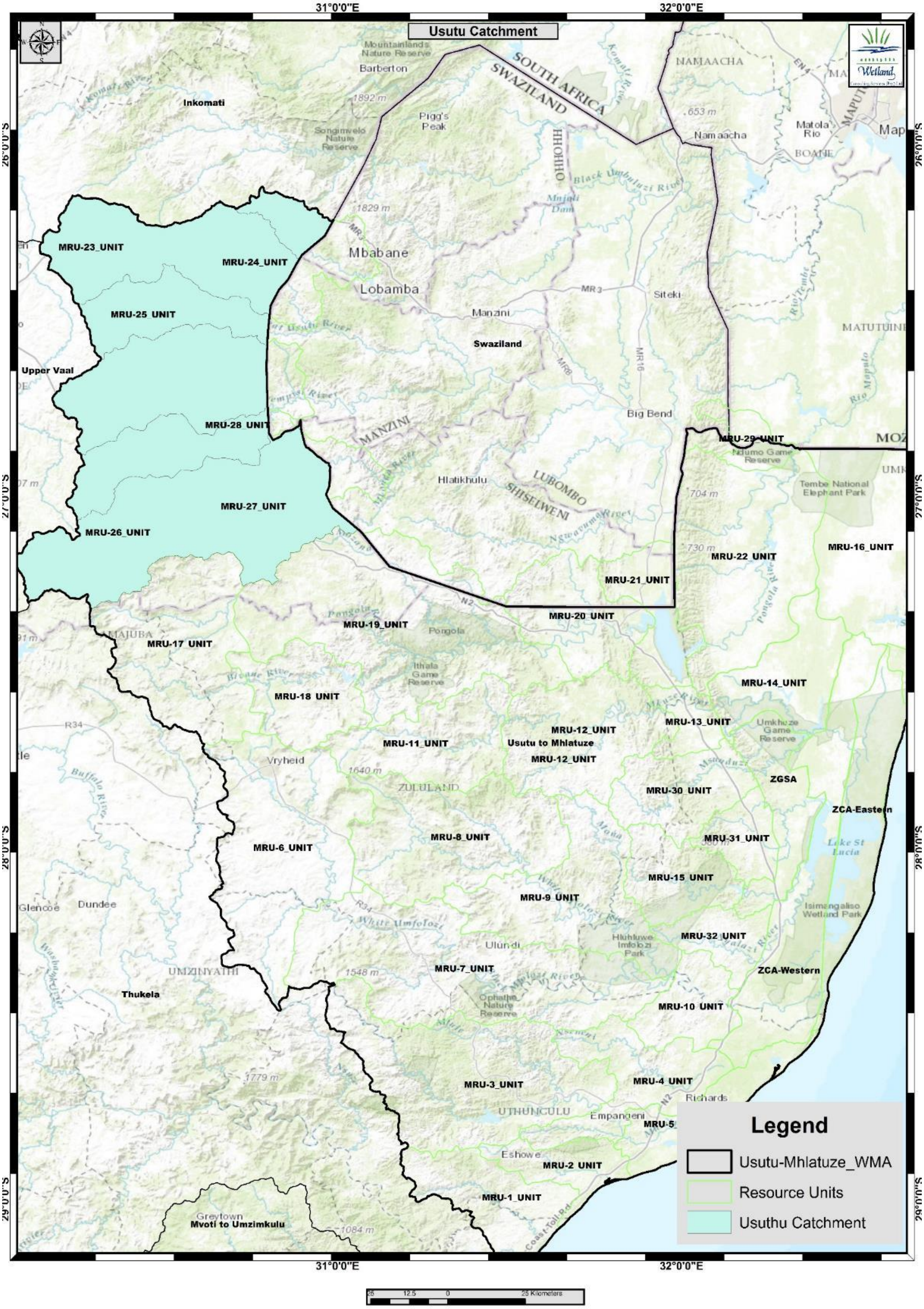


Figure 5-1: RU location and extent within the Usutu Catchment.

5.1.2 Pongola Catchment

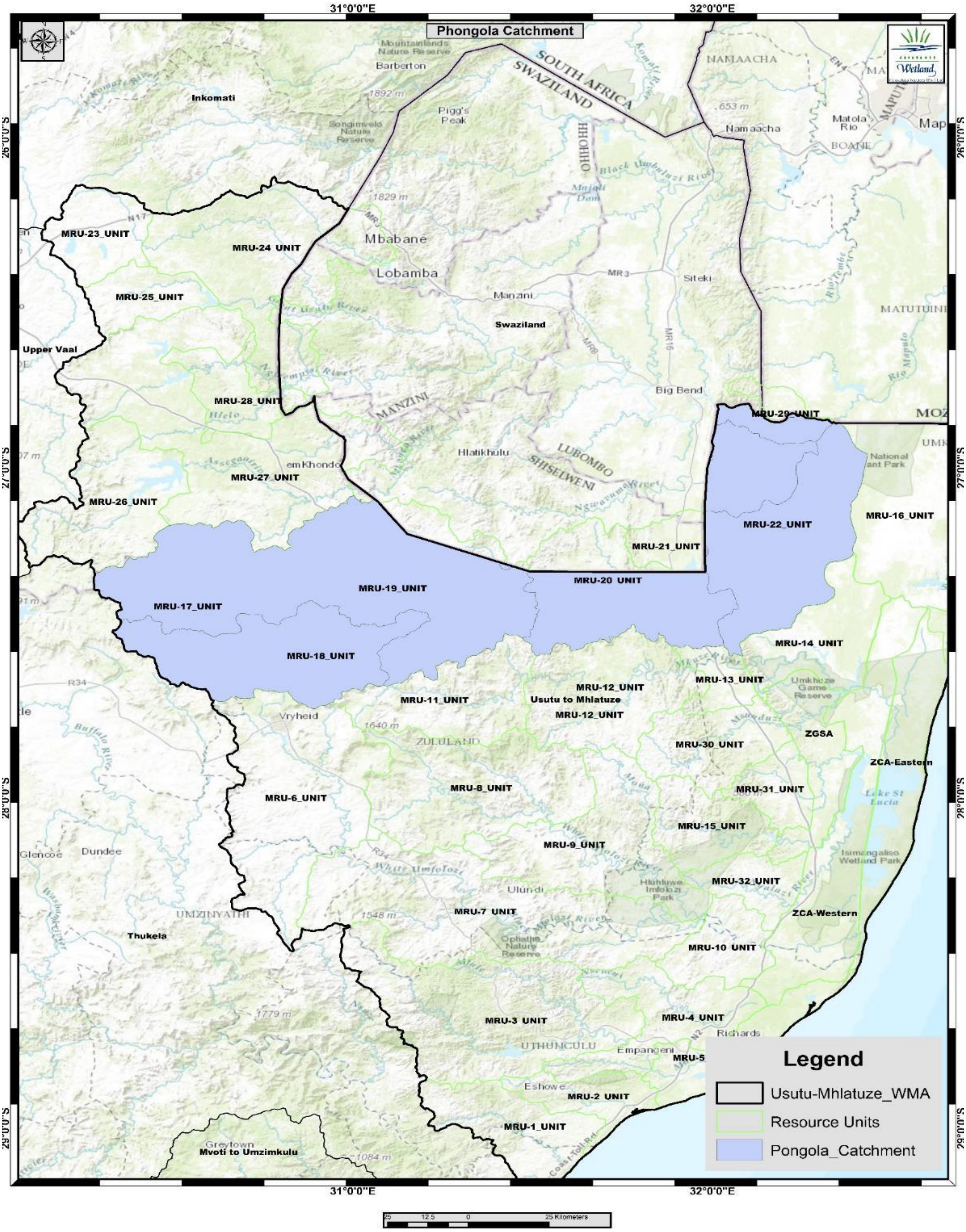


Figure 5-2: RU location and extent within the Pongola Catchment.

Major water resources:

1. Pongola and Assegai Rivers;
2. Pongolapoort Dam; and
3. Valley bottom systems that remain within areas dominated by forestry and any remaining hillslope seepages.

Dominant landuses:

1. Cultivation (communal and commercial);
2. Forest plantations, particularly in the upper reaches of the catchment;
3. Rural communal lands - houses and livestock grazing;
4. Urbanisation and developments (eg. Jozini town and several communal villages);
5. Formal and informal roads and associated infrastructures (in towns and around villages);
6. Nature Reserves:
    c. Pongola Nature Reserve
    d. Pongola Bush Nature Reserve
    e. Pongolapoort Nature Reserve
    f. Ithala Game Reserve
    g. Somkhanda Game Reserve
    h. Ndumo Nature Reserve
    i. Witbad Nature Reserve; and
    j. Ubombo Mountain Nature Reserve; and
7. Water abstraction for water supply and irrigation.

Important wetland systems:

1. Phongola floodplain; and
2. Floodplain and valley bottom systems in the upper reaches of the Pongola catchment.

Threatened Ecosystem Types:

- KaNgwane Montane Grassland - VU
- Eastern Temperate Freshwater Wetlands - VU
- Low Escarpment Mistbelt Forest - VU
- Lowveld Riverine Forest - VU
- Paulpietersburg Moist Grassland - VU
- Lebombo Summit Sourveld - VU
- Eastern Scarp Forest - VU
- Lebombo Scarp Forest - VU
- Bivane Sour Grassveld and Bushveld - VU
- Louwsberg Mistbelt Grassland - VU
- Black Rhino Range - VU
- Bivane Montane Grassland - EN
- Wakkerstroom/Luneburg Grasslands – EN.

Wetland Vegetation Types:

- Indian Ocean Coastal Belt Group 1 – Least Threatened (LT); mostly **Well Protected**
- Lowveld Group 2 – CR; **Poorly Protected**
- Lowveld Group 3 – CR; **Not Protected**
- Lowveld Group 9 – Vulnerable (VU); **Poorly Protected**
- Lowveld Group 10 – Endangered (EN); **Poorly to Well Protected**
- Lowveld Group 11 – VU; **Well Protected**
- Mesic Highveld Grassland Group 5 – EN; **Not Protected**
- Mesic Highveld Grassland Group 8 – LT; **Not Protected**
- Sub-Escarpment Grassland Group 1 – LT; **Not Protected**
- Sub-Escarpment Grassland Group 2 – LT; **Not Protected**
- Sub-Escarpment Grassland Group 4 – EN; **Not Protected**.

5.1.3 Mkuze Catchment

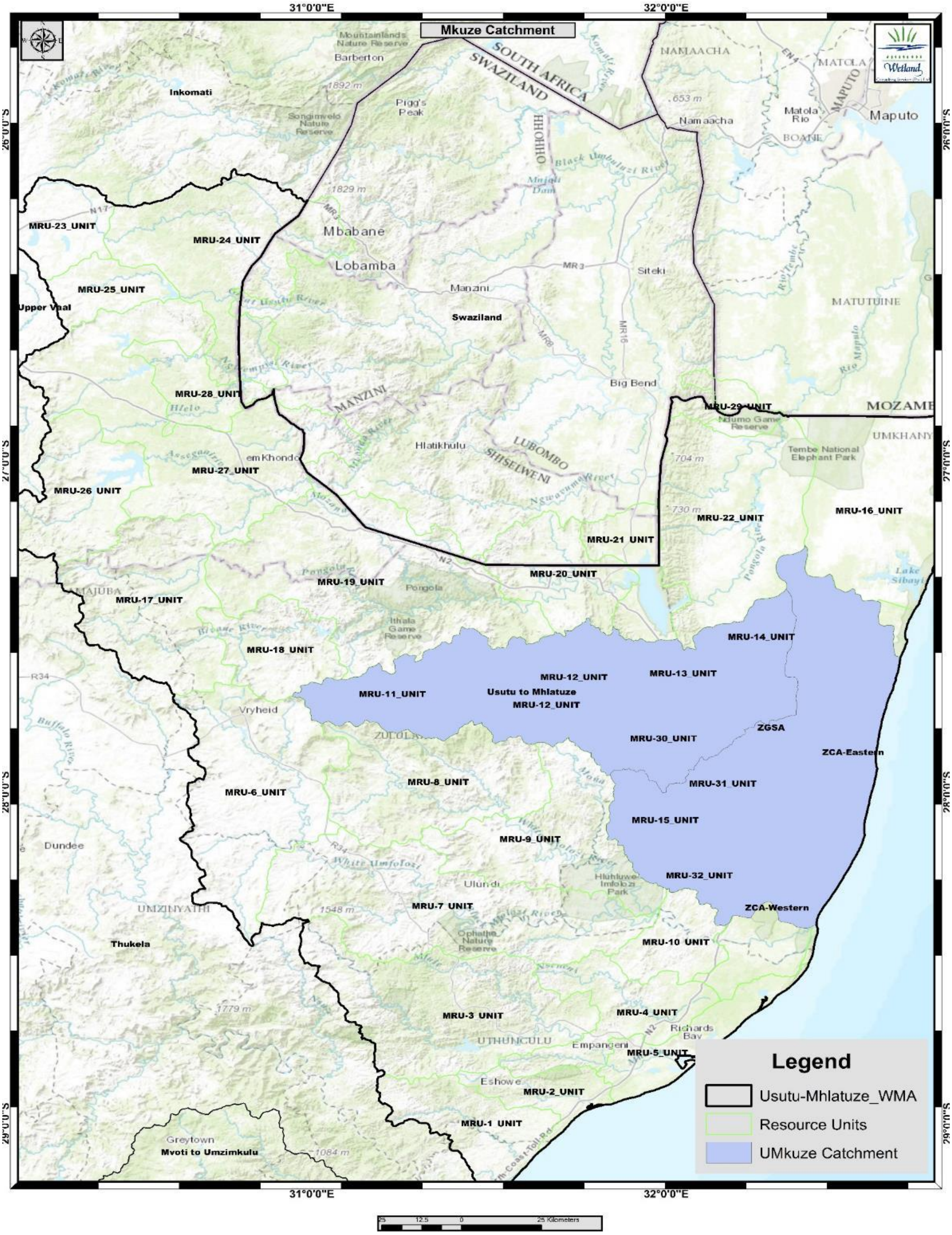


Figure 5-3: RU location and extent within the Mkuze Catchment.

5.1.3.1 Mkuze Sub-catchment

Major water resources:

1. Mkuze, Msunduzi and Ndlamyane rivers and associated floodplains;
2. A number of tributaries and associated valley bottom systems draining to Mkuze River;
3. Mountain seeps and hillslope seepage wetlands; and
4. Dams used for irrigation in the upper reaches of the catchment.

Dominant landuses:

1. Cultivation (communal and commercial);
2. Forest plantations;
3. Rural communal lands - houses and livestock grazing;
4. Urbanisation and developments (Hlobane, Mkuze and Vaalbank);
5. Formal and informal roads and associated infrastructures;
6. Nature Reserves:
   a. Mkuze Game Reserve;
   b. Several Private Game farms and Nature Reserves;
7. Water abstraction for water supply and irrigation; and
8. Coal mining in Hlobane.

Important wetland systems:

1. Mkuze River floodplain;
2. Ndlamyane River floodplain;
3. Msunduzi River valley bottom wetlands and associated seepages areas;
4. Msumu River channel valley bottom wetland; and
5. Mountain seeps and hillslope seepage wetlands associated with the head waters of Sihlengeni River.

5.1.3.2 Hluhluwe Sub-catchment

Major water resources:

1. Mkuze, Hluhluwe, Nyalazi rivers and associated floodplains;
2. A number of tributaries and associated valley bottom systems draining to the Mkuze River;
3. Mountain seeps and hillslope seepage wetlands;
4. Lake St. Lucia;
5. Muzi Pan;
6. Sodwana Bay; and
7. Hluhluwe Dam and impoundments used for irrigation in the lower reaches of the catchment.

Dominant landuses:

1. Cultivation (communal and commercial);
2. Forest plantations;
3. Rural communal lands - houses and livestock grazing;
4. Urbanisation and developments (Hluhluwe, Hlabisa and Lake St. Lucia);
5. Formal and informal roads and associated infrastructures;
6. Nature Reserves:
    a. Isimangaliso Wetland Park
    b. Hluhluwe Umfolozi Nature Reserve
    c. Several Private Game farms and Nature Reserves; and
7. Water abstraction for water supply and irrigation.

Important wetland systems:

1. Lake St. Lucia and mosaic wetlands forming part of the Isimangaliso wetland park;
2. Mkuze River floodplain;
3. Several valley bottom wetland systems associated with Khobeyane, Mbazwane and Siphudwini rivers draining into the Mkuze River north of Lake St. Lucia; and
4. Mountain seeps and hillslope seepage wetlands associated and at head waters of the Hluhluwe River.

Threatened Ecosystems:

- Low Escarpment Mistbelt Forest - VU
- Lowveld Riverine Forest - VU
- Swamp Forest - VU
- Lebombo Summit Sourveld - VU
- Eastern Scarp Forest - VU
- Maputaland Wooded Grassland - VU
- Louwsberg Mistbelt Grassland - VU
- Black Rhino Range - VU
- Hluhluwe Scarp Forest – VU
- Ngome Mistbelt Grassland and Forest - EN
- KwaZulu-Natal Coastal Forest - EN
- Mangrove Forest - EN
- Dukuduku/St Lucia Grasslands and Forests – EN.

Wetland Vegetation Types:

- Indian Ocean Coastal Belt Group 1 – Least Threatened (LT); mostly **Well Protected**.
- Lowveld Group 9 – Vulnerable (VU); **Poorly Protected**.
- Lowveld Group 10 – Endangered (EN); **Poorly to Well Protected**.
- Lowveld Group 11 – VU; **Well Protected**.
- Sub-Escarpment Grassland Group 1 – LT; **Not Protected**.
- Sub-Escarpment Grassland Group 2 – LT; **Not Protected**.
- Sub-Escarpment Grassland Group 4 – EN; **Not Protected**.

- Swamp Forest – LT; mostly **Well Protected**.

5.1.4 Mfolozi Catchment

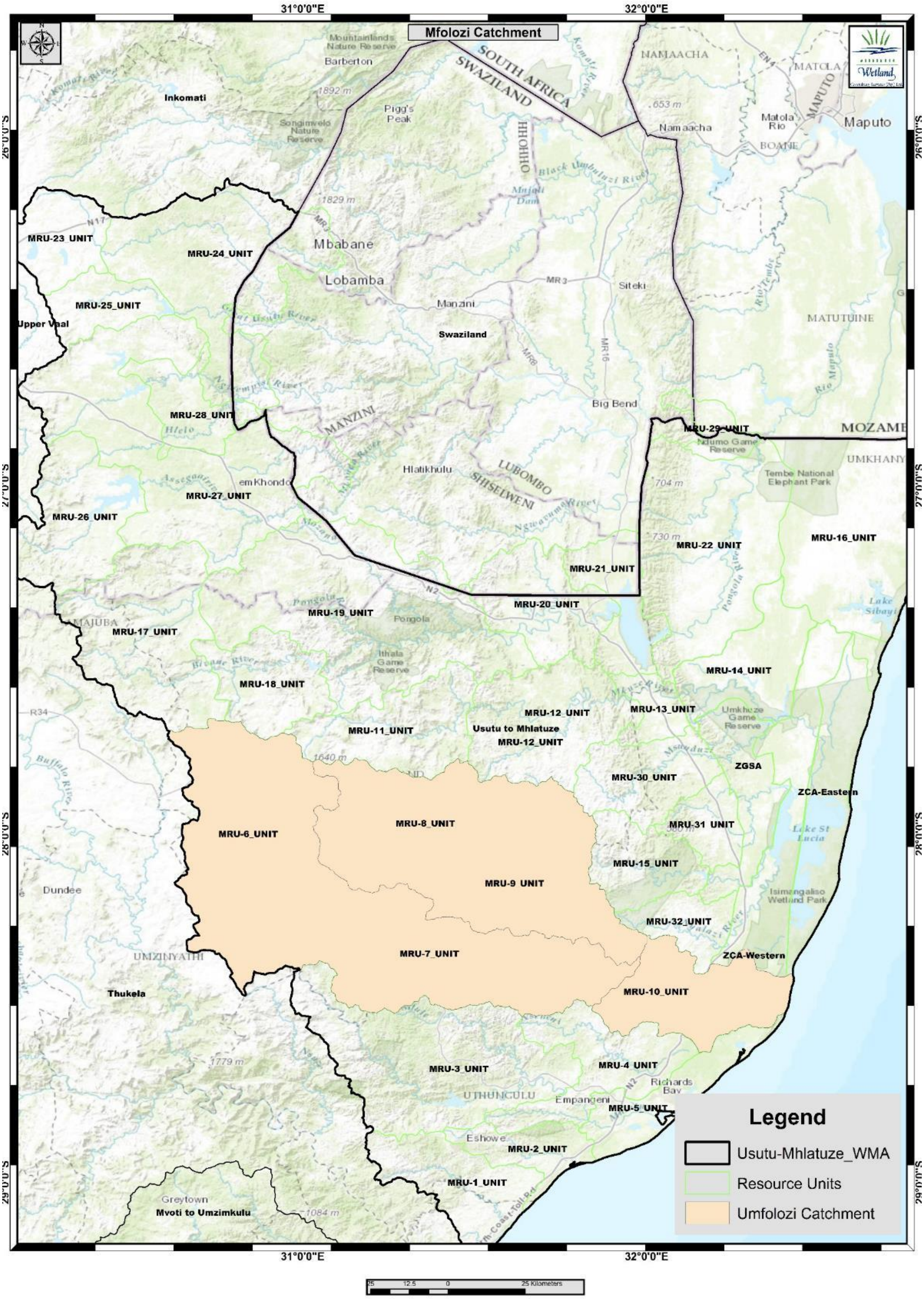


Figure 5-4: RU location and extent within the Mfolozi Catchment.

7.1.4.1 Mfolozi Sub-catchment

Major water resources:

1. Mfolozi River and associated floodplain;
2. Msunduzi River;
3. Teza, Nkatha, Mbukwini, Mvamanzi, Ntweni Lakes and other of lakes along the Mfolozi River towards KwaMsane Township;
4. A number of tributaries and associated valley bottom systems draining to Mfolozi River;
5. Mountain seeps and hillslope seepage wetlands;
6. Pans; and
7. Dams in lower reaches of the catchment.

Dominant landuses:

1. Cultivation (sugarcane and communal gardens);
2. Forest plantations;
3. Communal lands - houses and livestock grazing;
4. Urbanisation and developments (Ulundi, Nongoma, Babanangu, Mtubatuba, Nquthu, Nondweni and Vryheid);
5. Formal and informal roads and associated infrastructures;
6. Nature Reserves:
    a. Vryheid Mountain Nature Reserve
    b. Ntinini Nature Reserve
    c. Matshitsholo Nature Reserve
    d. Ophathe Nature Reserve
    e. Umfolozi Game Reserve
    f. Mapelani Nature Reserve
    g. Fuleni Nature Reserve
    h. Several Private Game farm and Nature Reserves
    i. Klipfontein Dam Nature Reserve;
7. Water abstraction for water supply and irrigation in lower reaches of the catchment; and
8. Coal mining south of Machibini Village.

Important wetland systems:

1. Stilwater Vlei (Vryheid area);
2. Aloeboom Vlei (Vryheid area);
3. Mfolozi Floodplain and associated valley bottom systems in the lower reaches of the catchment;
4. Valley Bottom wetland associated with Nyamanzi River in the lower reaches of the catchment; and
5. Number of lakes indicated above.

Threatened Ecosystem Types:

- Eastern Temperate Freshwater Wetlands - VU
- Low Escarpment Mistbelt Forest - VU
- Paulpietersburg Moist Grassland - VU
- Eastern Scarp Forest - VU
- Maputaland Wooded Grassland - VU
- eMondlo Sandy Moist Grassland – VU
- Ngongoni Veld - VU
- Midlands Mistbelt Grassland - VU
- Imfolosi Savanna and Sourveld - VU
- Ngome Mistbelt Grassland and Forest - EN
- Hlabisa Forest Complex – EN
- KwaZulu-Natal Coastal Forest - EN
- Mangrove Forest - EN
- Dukuduku/St Lucia Grasslands and Forests – EN
- Kwambonambi Dune Forest – Critically Endangered (CR)
- Kwambonambi Hygrophilous Grasslands – CR.

Wetland Vegetation Types:

- Indian Ocean Coastal Belt Group 1 – Least Threatened (LT); mostly **Well Protected**.
- Lowveld Group 11 – VU; **Well Protected**.
- Mesic Highveld Grassland Group 5 – EN; **Not Protected**.
- Mesic Highveld Grassland Group 8 – LT; **Not Protected**.
- Sub-Escarpment Grassland Group 1 – LT; **Not Protected**.
- Sub-Escarpment Grassland Group 3 – CR; **Not Protected**.
- Sub-Escarpment Grassland Group 4 – EN; **Not Protected**.
- Sub-Escarpment Savanna – EN; **Not Protected**.

5.1.5 Lake Sibaya and Kosi Bay Catchments

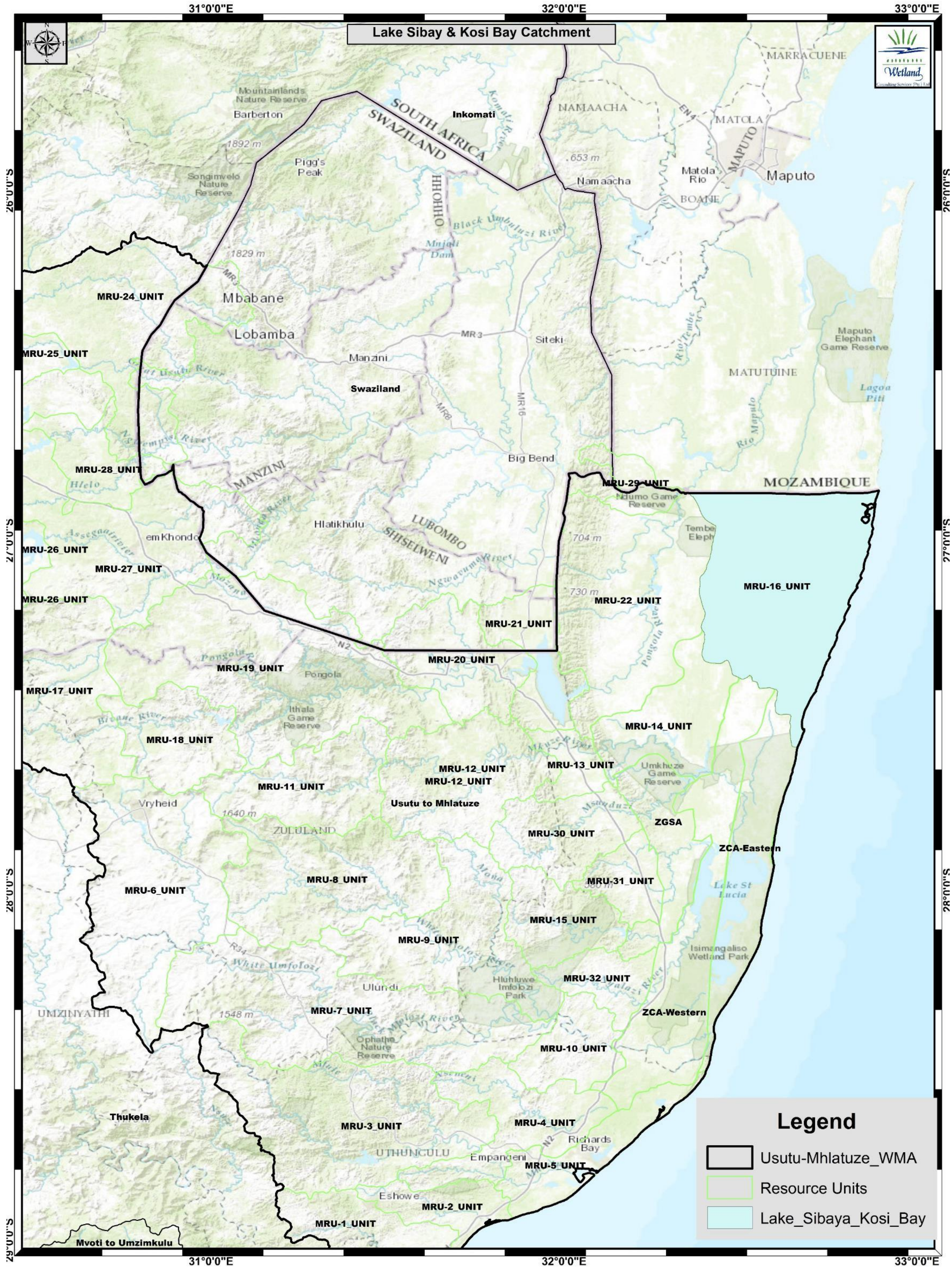


Figure 5-5: RU location and extent within the Lake Sibaya and Kosi Bay catchments.

Major water resources:

1. Lake Sibaya;
2. Kosi Bay;
3. Seepage wetlands associated with sand aquifers; and
4. Malangeni and Swamanzi Rivers and associated valley bottom systems.

Dominant landuses:

1. Cultivation (communal and commercial);
2. Forest plantations;
3. Rural communal lands - houses and livestock grazing;
4. Urbanisation and developments (Manguzi town and several communal villages);
5. Formal and informal roads and associated infrastructures (in town and around villages);
6. Nature Reserves:
    a. Isimangaliso Wetland Park
    b. Tembe Nature Reserve
    c. Sileza Nature Reserve
    d. Manguzi Forest Reserve
    e. Several Private Game farms and Nature Reserves; and
7. Water abstraction for water supply and irrigation.

Important wetland systems:

1. Lake Sibaya;
2. Kosi Bay;
3. Seepage wetlands associated with sand aquifers; and
4. Malangeni and Swamanzi rivers and associated valley bottom systems.

Threatened Ecosystem Types:

- Swamp Forest - VU
- Maputaland Wooded Grassland – VU
- KwaZulu-Natal Coastal Forest – EN
- Mangrove Forest – EN.

Wetland Vegetation Types:

- Indian Ocean Coastal Belt Group 1 – Least Threatened (LT); mostly **Well Protected**
- Swamp Forest – LT; mostly **Well Protected**
- Lowveld Group 9 – Vulnerable (VU); **Poorly Protected**
- Lowveld Group 10 – Endangered (EN); **Poorly** to **Well Protected**.

5.1.6 Mhlatuze Catchment

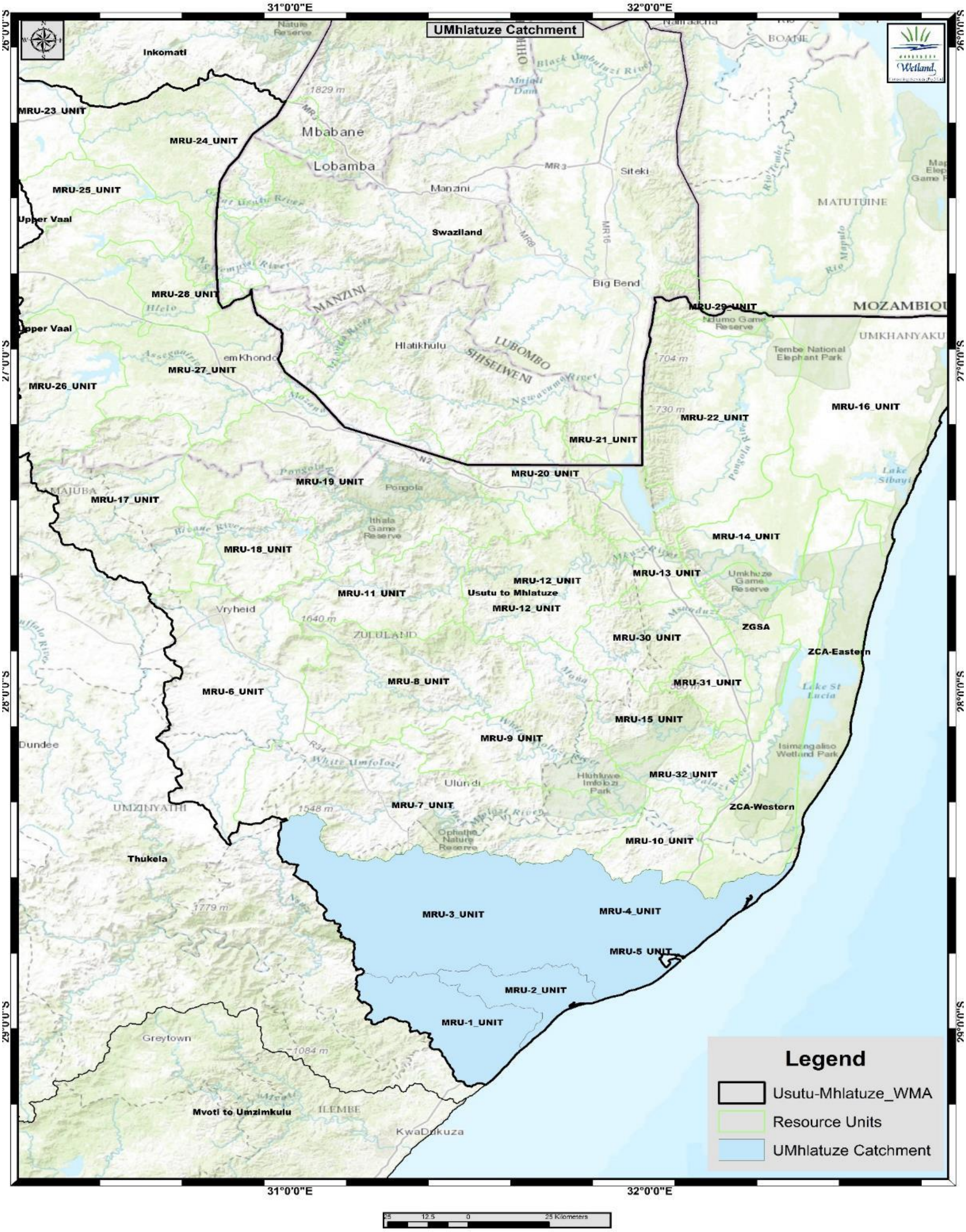


Figure 5-6: RU location and extent within the Mhlatuze Catchment.

5.1.6.1 Matikulu Catchment:

Major water resources:

1. Matikulu and Nyezane Rivers;
2. Several dams;
3. Mbongolwane and Nyezane river floodplains;
4. Riparian areas along most of the riverine habitat;
5. Hillslope seepages;
6. Valley bottom wetland systems; and
7. Matikulu River Estuary.

Dominant landuses:

1. Cultivation (sugarcane and communal gardens);
2. Forest plantations ;
3. Communal lands - houses;
4. Urbanisation and developments (Industrial park i.e. Isithebe, small towns including Gingindlove and Dokodweni, and part of Eshowe);
5. Formal and informal roads and associated infrastructures;
6. Water abstraction for irrigation and water supply; and
7. Nature Reserves:
    a. Matikulu Nature Reserve
    b. Entumeni Nature Reserve
    c. Dlinza Forest Nature Reserve.

Important wetland systems:

1. Mbongolwane wetland;
2. Nyezane Floodplain; and
3. Matikulu Estuary and associated valley bottom wetland feeding into it.

Note: The wise use of Mbongolwane Wetland has helped surrounding communities alleviate poverty by protecting their water resource and the benefits they accrue from it, such as:

1. Income by weaving craft from wetland plants;
2. Employment from the weaving;
3. Empowerment of women who do the weaving and selling; and
4. Growing wetland crops to increase food security.

5.1.6.2 Mlalazi Catchment

Major water resources:

1. Mlalazi, Mkukuze and KwaGugushe rivers;
2. Ihlazi Dams and several irrigation dams and impoundments;
3. Riparian areas along most of the riverine habitat;

4. Hillslope seepages;
5. Valley Bottom wetland systems; and
6. Mlalazi River Estuary.

Dominant landuses:

1. Cultivation (sugarcane and communal gardens);
2. Forest plantations;
3. Communal lands - houses;
4. Urbanisation and developments (Greater part of Eshowe, Mtunzini and Port Dunford);
5. Formal and informal roads and associated infrastructures;
6. Nature Reserves:
    a. Ongoye Nature Reserve
    b. Mlalazi Nature Reserve
    c. Dlinza Forest Nature Reserve; and
7. Dams and water abstraction for irrigation.

Important wetland systems:

1. Mlalazi Estuary and associated valley bottom wetland feeding into it.

5.1.6.3 Mhlathuze Catchment

Major water resources:

1. Mhlatuze and Nseleni rivers;
2. Goedertroudam and several irrigation dams;
3. Several lakes and pans (Cubhu Lake, Mzingazi Lake, Nhlabane Lake and Nsezi Lake);
4. Riparian areas along most of the riverine habitat;
5. Hillslope seepages;
6. Valley bottom wetland systems; and
7. Mhlatuze River Floodplain and Estuary.

Dominant landuses:

1. Cultivation (sugarcane and communal gardens);
2. Forest plantations;
3. Communal lands - houses;
4. Urbanisation and developments (EMpangeni, Richards Bay, Esikhawini, KwaMbonambi, Nkandla and Melmoth);
5. Formal and informal roads and associated infrastructures;
6. Nature Reserves:
    a. Amangwe Forest
    b. Enseleni Nature Reserve
    c. Richards Bay Nature Reserve
    d. Matshenezampisi Nature Reserve

e. Nkandla Nature Reserve; and

7. Dams and water abstraction for water supply and irrigation.

Important wetland systems:

1. Mzingazi, Cubhu and Nhlabane Lake – water supply to Richards Bay and surroundings;
2. Mhlatuze Floodplain;
3. Mhlatuze Estuary and associated valley bottom wetland feeding into it; and
4. Mountainous seeps in the upper reaches of Mhlatuze Rover (NFEPA).

The majority of the lakes indicated above are used for water supply and in some instances there are pump stations and water treatment plants near to these areas e.g. Nhlabane and Mzingazi Lakes.

Threatened Ecosystem Types:

- Swamp Forest - VU
- Eastern Scarp Forest - VU
- Maputaland Wooded Grassland - VU
- Ngongoni Veld – VU
- Midlands Mistbelt Grassland - VU
- Nkandla Forests and Grasslands - VU
- Imfolosi Savanna and Sourveld - VU
- KwaZulu-Natal Coastal Belt - VU
- KwaZulu-Natal Coastal Forest - EN
- Mangrove Forest - EN
- Kwambonambi Dune Forest – Critically Endangered (CR)
- Eshowe Mtunzini Hilly Grasslands - CR
- Kwambonambi Hygrophilous Grasslands - CR
- Ngoye Scarp Forests and Grasslands - CR
- Entumeni Valley - CR
- North Coast Dune Forest – CR.

Wetland Vegetation Types:

- Indian Ocean Coastal Belt Group 1 – Least Threatened (LT); mostly **Well Protected**.
- Indian Ocean Coastal Belt Group 2 – Critically Endangered (CR); mostly **Not Protected**.
- Lowveld Group 11 – VU; **Well Protected.**
- Sub-Escarpment Grassland Group 3 – CR; **Not Protected**.
- Sub-Escarpment Grassland Group 4 – EN; **Not Protected**.
- Sub-Escarpment Savanna – EN; **Not Protected.**
- Swamp Forest – LT; mostly **Well Protected**.

5.2 Impacts Analysis on wetlands within the WMA

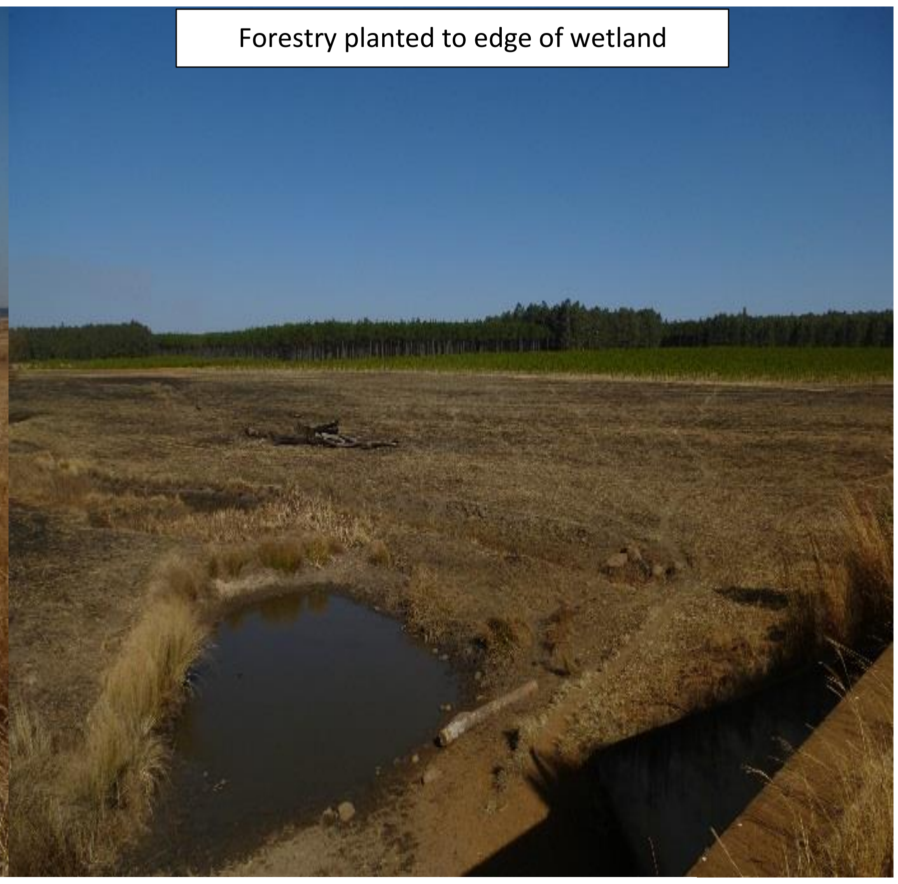
5.2.1 Broader Impacts on wetlands within the WMA

Wetlands perform many functions that have indirect value for society, such as improving water quality, regulating streamflow and providing habitat for wetland dependent plants and animals, many of which are rare or endangered. Wetlands also provide resources, such as grazing lands (which are particularly valuable in drought years) and recreational areas. Consequently their loss should be viewed in a serious light. Population growth in general represents a host of present and potential future impacts and threats to the integrity of wetland systems, and water resources in general, in the WMA. Some of these impacts recorded at visited wetland areas include:

- Cultivation and afforestation resulting in the loss of biodiversity, including Red Data bird species;
- Sugarcane plantations in marginal wet areas, particularly hillslope seepage areas which has resulted in the loss of seepage wetlands within these areas;
- Urbanization (especially wetlands near towns such as Richards Bay, Empangeni, Mtubatuba, Mtunzini);
- Increased livestock numbers within communal areas and uncontrolled/over grazing, which results in erosion and sedimentation;
- Over abstraction of water and increases in streamflow reduction activities which causes drying out of wetland areas due to the reduction of inputs, particularly baseflows, feeding through the wetland systems;
- Utilisation of peatlands (draining for cultivation and crop production) resulting in loss of peat from the soil profile; and
- In most of the lower reaches of the catchments, floodplains and valley bottoms are heavily utilised for cultivation and plantations, this impacts on water quality through pesticide and/or fertilizer application, sedimentation/erosion and loss of wetland purification functioning (these areas include, amongst others, the Mfolozi and Mkuze floodplains);

The following figures highlight some of the impacts and threats recorded in wetland areas visited within different drainage regions.

Figure 5-7: Photographs indicating some of the recorded impacts on wetlands within the Usutu Catchment.



Water abstraction for road surface to a mine

Figure 5-8: Photographs indicating some of the recorded impacts on wetlands within the Pongola Catchment.

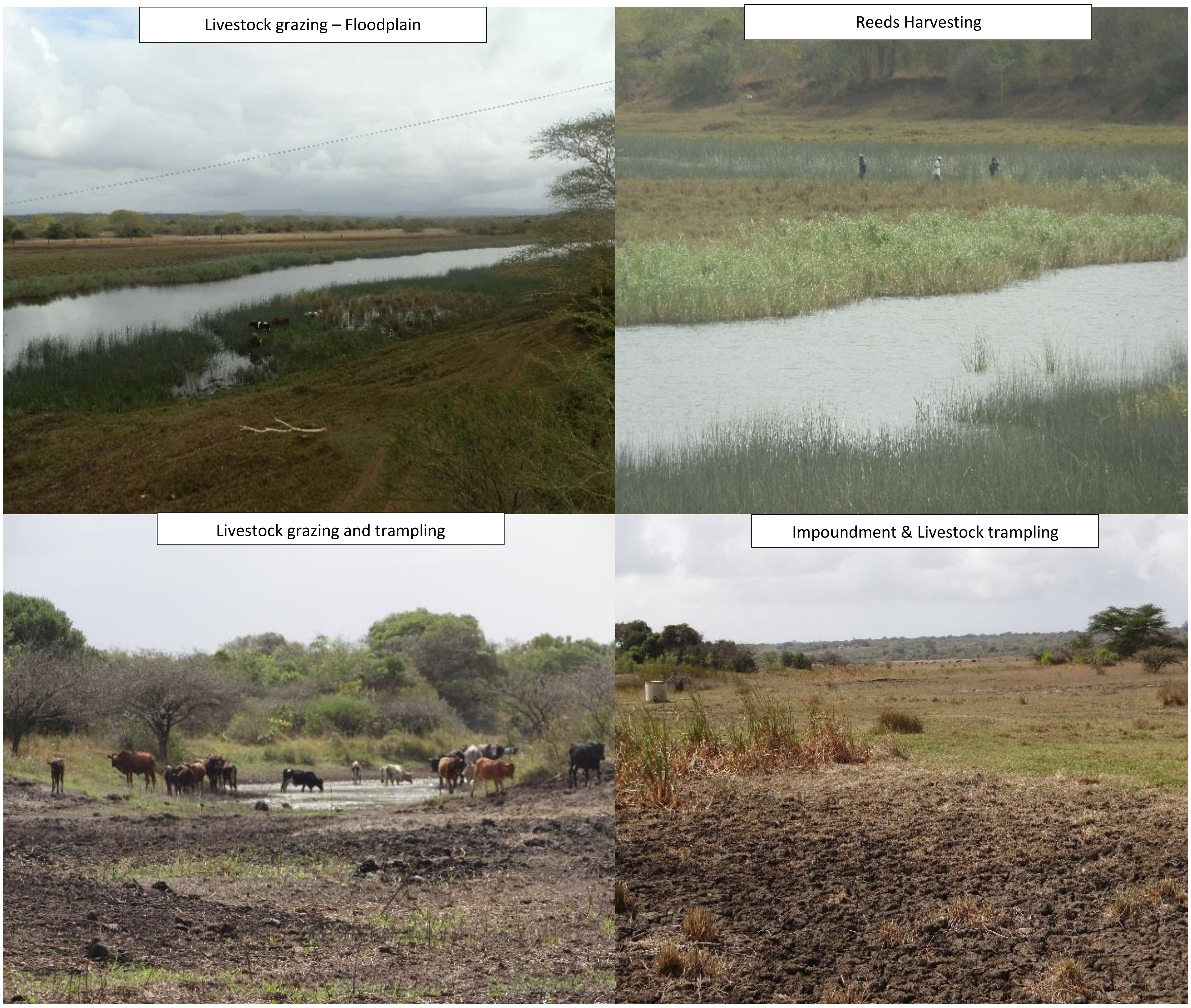


Figure 5-9: Photographs indicating some of the recorded impacts on wetlands in the Mkuze catchment.

Figure 5-10: Photographs indicating some of the recorded impacts on wetlands in the Mfolozi catchment.

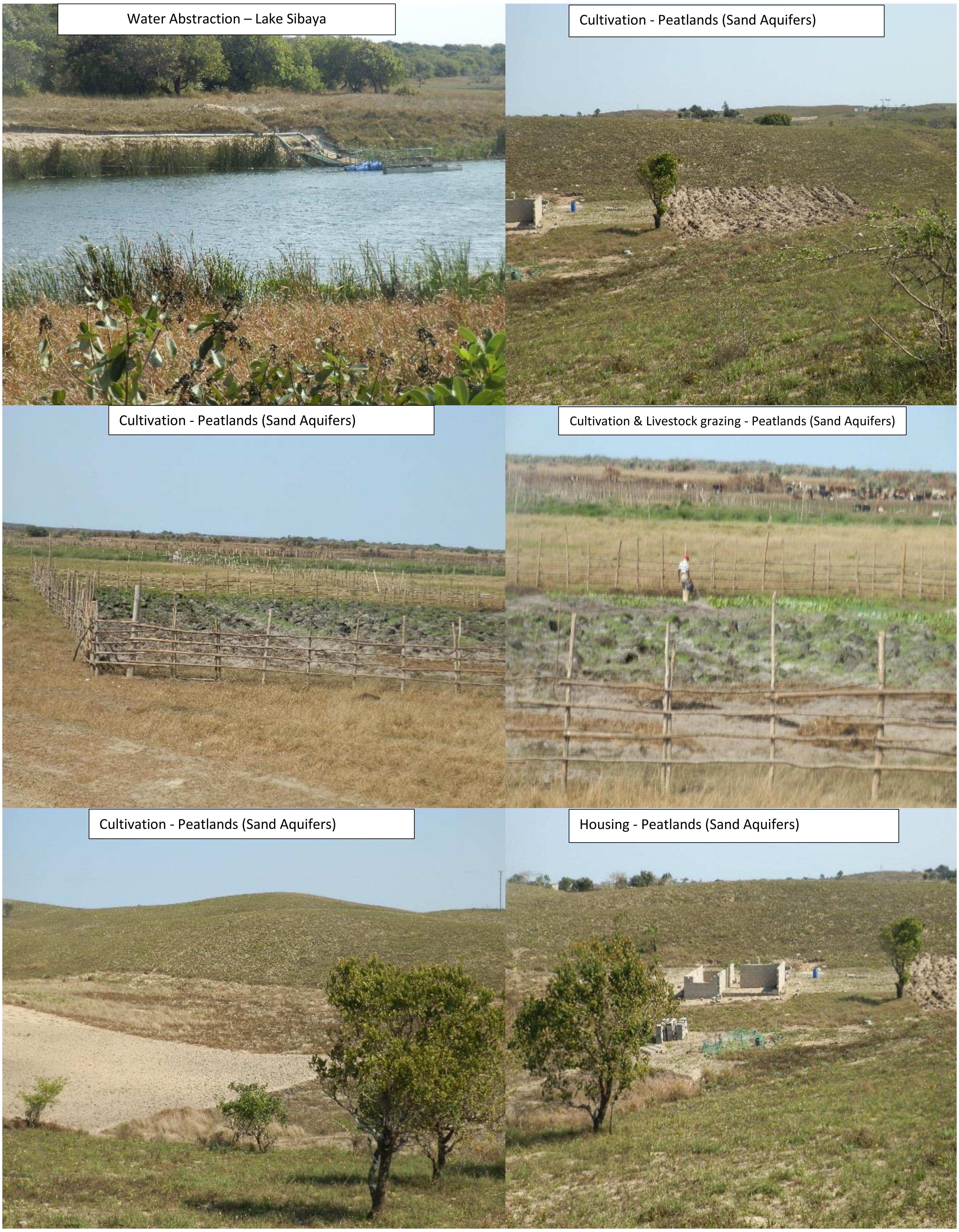
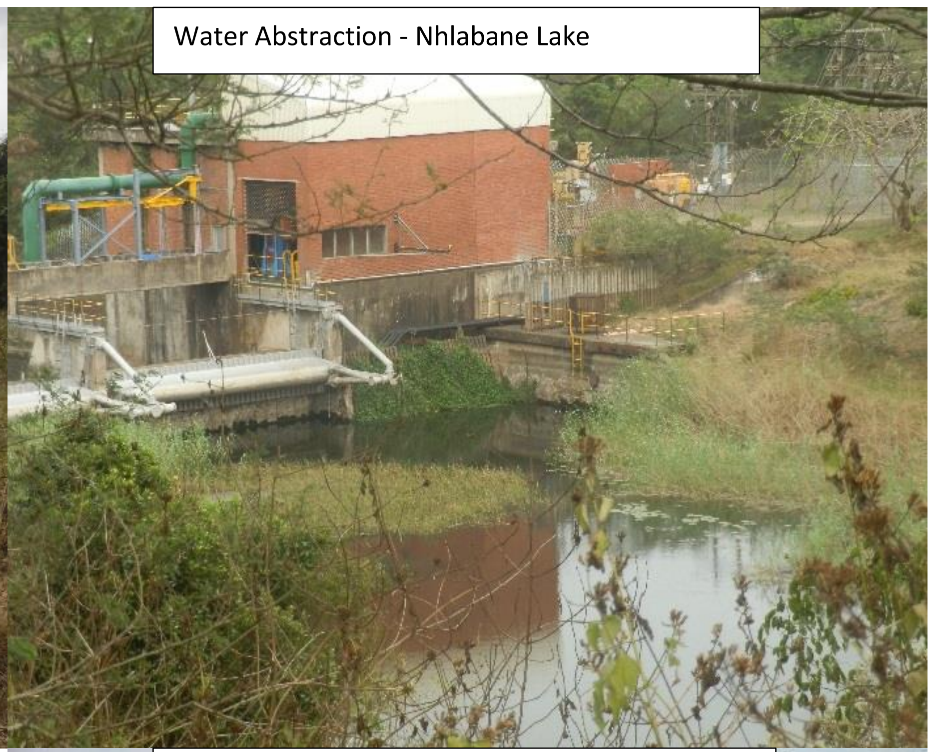


Figure 5-11: Photographs indicating some of the recorded impacts on wetlands within Lake Sibaya and Kosi Bay catchments.


Forest Plantations & Alien Invasive


Water Abstraction - Nhlabane Lake

Sugarcane plantation - Mhlatuze River Floodplain & Seepage areas


Subsistence farming – Mhlatuze Floodplain Forest Plantations


Subsistence farming – Esikhawini Township

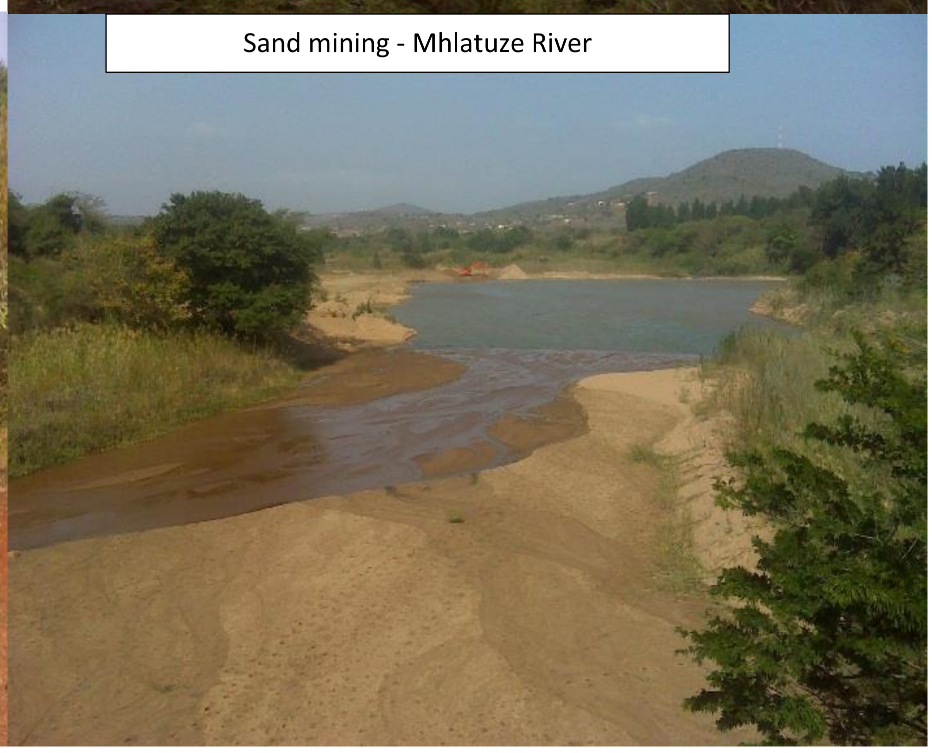

Sand mining - Mhlatuze River

Figure 5-12: Photographs indicating some of the recorded impacts on wetlands in the Mhlatuze catchment.

5.3 Priority wetland areas

Based on the proposed prioritisation approach above, the following figure (Figure 7-13) indicates combined prioritized wetland systems resulted from the following ranking:

- Priority Wetlands 1 – High priority wetlands outside protected areas (Vulnerable systems)
- Priority Wetlands 2 – High priority wetlands within protected areas
- Priority Wetlands 3 – High priority wetlands based on Beggs (1989), prioritisation work and Wetland Freshwater Ecosystem Priority Areas (FEPAs).
- Priority Wetlands 4 – Wetlands that are likely to be groundwater driven

Figure 7-14 indicates priority RUs based on prioritised wetlands systems. Table 7-1 below indicate location of the prioritised wetland systems, their sub-catchments and associated estimated ecological integrity and RUs.

5.3.1 Priority Wetland Systems

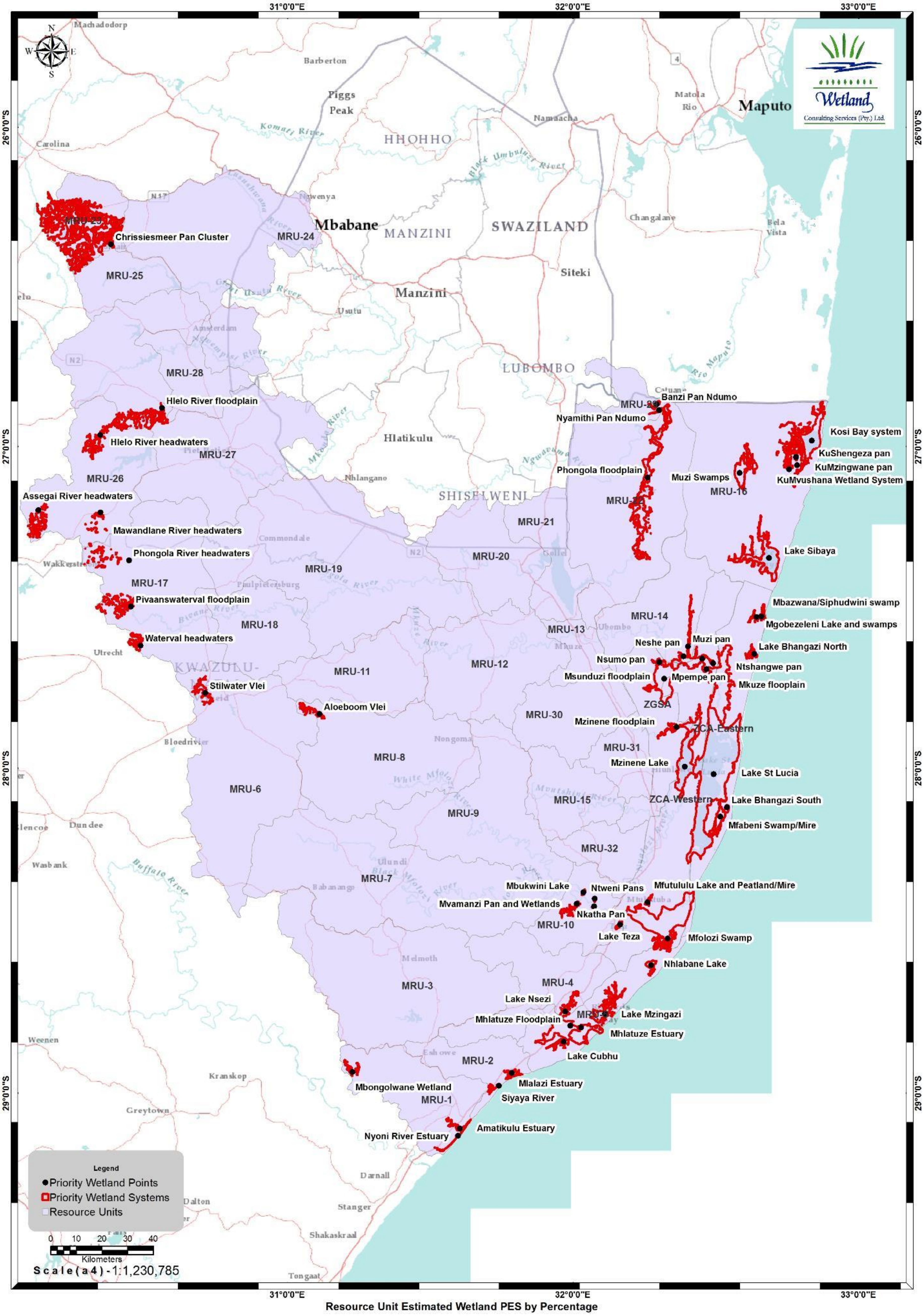


Figure 5-13: Combined priority wetlands map based on the combined ranking as proposed for prioritizing wetlands within the Usutu-Mhlatuze WMA.

Figure 5-14: Specific RUs associated with priority wetlands within the WMA.

5.3.1.1 Priority RU and associated priority wetlands that were assessed onsite

RU 1 includes the catchment of the Amatikulu River. There are two major towns within the RU, namely Eshowe in the upper reaches and Gingindlovu in the lower reaches towards the coast. The majority of the RU consists of communal lands and urban areas associated with the towns. There are five nature reserves within the RU, namely Rocky Ridge, Arcadia, Longhurst, Entumeni and Dlinza Nature Reserves. The land use within the RU is dominated by of forestry plantations, agricultural fields (mostly sugarcane) and communal gardens. Cultivation and disturbances around the watercourses have provided a niche for alien vegetation to become established and encroach into most of the wetlands and riparian areas, leading to many of the systems becoming confined and infested with invasive species. There are three priority wetlands or water resource systems recorded within this RU:

- Mbongolwane wetland system - this wetland system is important for the livelihood of the local communities and it is extensively used for cultivation of crops by locals as part of subsistence farming. Due to the extensive use of this system, its PES is currently rated as D, which indicates a largely modified system. Its EIS is Moderate, as although it is heavily utilised it is still very important for local food production.
- Amatikulu and Nyoni River Estuaries - these two water resources are at the outlet of the catchment and are both protected systems. Peat has been recorded in both of these estuaries. They both have an ecological integrity (PES) score of B which indicates systems that are largely natural. The high integrity of these wetlands is probably due to their protected state which has limited impacts to the systems.

RU 2 includes the catchment of the Mlalazi River. There are two major towns within the RU, namely Eshowe in the upper reaches (which is located along the catchment divide between the Amatikulu and Mlalazi Rivers) and Mtunzini in the lower reaches towards the coast. The upper reaches of the catchment consist of communal lands and the lower reaches are dominated by agricultural lands, such as sugarcane along the coast. There are two nature reserves within the RU, namely Ngoye and Dlinza Nature Reserves. Extensive cultivation and disturbances around the watercourses have provided a niche for alien vegetation to become established and encroach into most of the wetlands and riparian areas, leading to many of the systems becoming confined and infested with invasive species. There are two priority wetlands or water resource systems recorded within this RU:

- Mlalazi Estuary – this is a protected water resource and peatland was confirm in section of this system. The ecological integrity of the system is B which indicate system that largely natural and this is probably because of the protected state and limited encroachments and impacts.

- Siyaya River and associated riparian systems along the coast - Forest plantation is the dominant land use along this wetland system, with some extensive cultivation in places. The system is partially protected, is listed as a FEPA wetland and is identified as a Critical Biodiversity Area according to the Kwa-Zulu Natal Conservation Plan.

RU 4 includes the catchment of the Nseleli River. The only town within this catchment is Empangeni and the Nseleli Township. The upper reaches of the catchment consist of communal lands and the lower reaches are extensively under cultivation, in the form of citrus farms in the middle areas of the catchment and sugarcane along the coast and upstream of the Richards Bay town and terminals. There is only one priority wetland system within this RU and that is Lake Nsezi, which includes important peatlands and is listed as a Critical Biodiversity Area. The PES assessment undertaken indicates that the lake is largely modified with a PES of D and Moderate EIS. The land use impacts around the lake include extensive cultivation and forest plantations. In order to maintain and improve the ecological integrity of the wetland, management of plantations, including such measures as withdrawal of both agricultural lands and forestry, will be required within the catchment of this lake.

RU 5 includes the catchment of the lower reaches of the Mhlatuze River. This area is heavily developed due to the presence of industrial and residential areas associated with Richards Bay. The urbanised areas include Richards Bay and Esikhawini Township. There is one nature reserve within the RU, namely Richards Bay Nature Reserve. The land use within the RU consists mainly of forestry plantations, agricultural fields (mainly sugarcane) and urban and industrial developments. There are five priority wetlands or water resource systems recorded within this RU namely:

- Mhlatuze floodplain and estuary
- Lakes Cubhu, Mzingazi and Nhlabane

Mhlatuze floodplain is heavily cultivated and some sand mining occurs. As a result of these, and other, impacts the ecological integrity of the floodplain is determined to be Seriously Modified (PES of E). The Mhlatuze estuary is protected and due to limited impacts in the protected area, the estuary's ecological integrity is Largely Natural (PES of B). Both the floodplain and estuary have been found to support peatlands. In order to prevent further deterioration of the Mhlatuze floodplain, changes in the morphological characteristics of the floodplain caused by illegal sand mining must be controlled.

Lakes Cubhu, Mzingazi and Nhlabane are used for water supply to supplement water requirements for Richards Bay the town. In order to ensure that the water requirements necessary to sustain these lakes is maintained, the ecological reserve for the three lakes needs to be determined.

Figure 5-15: Sand mining within the Mhlatuze floodplain and water abstraction within Mzingazi lake

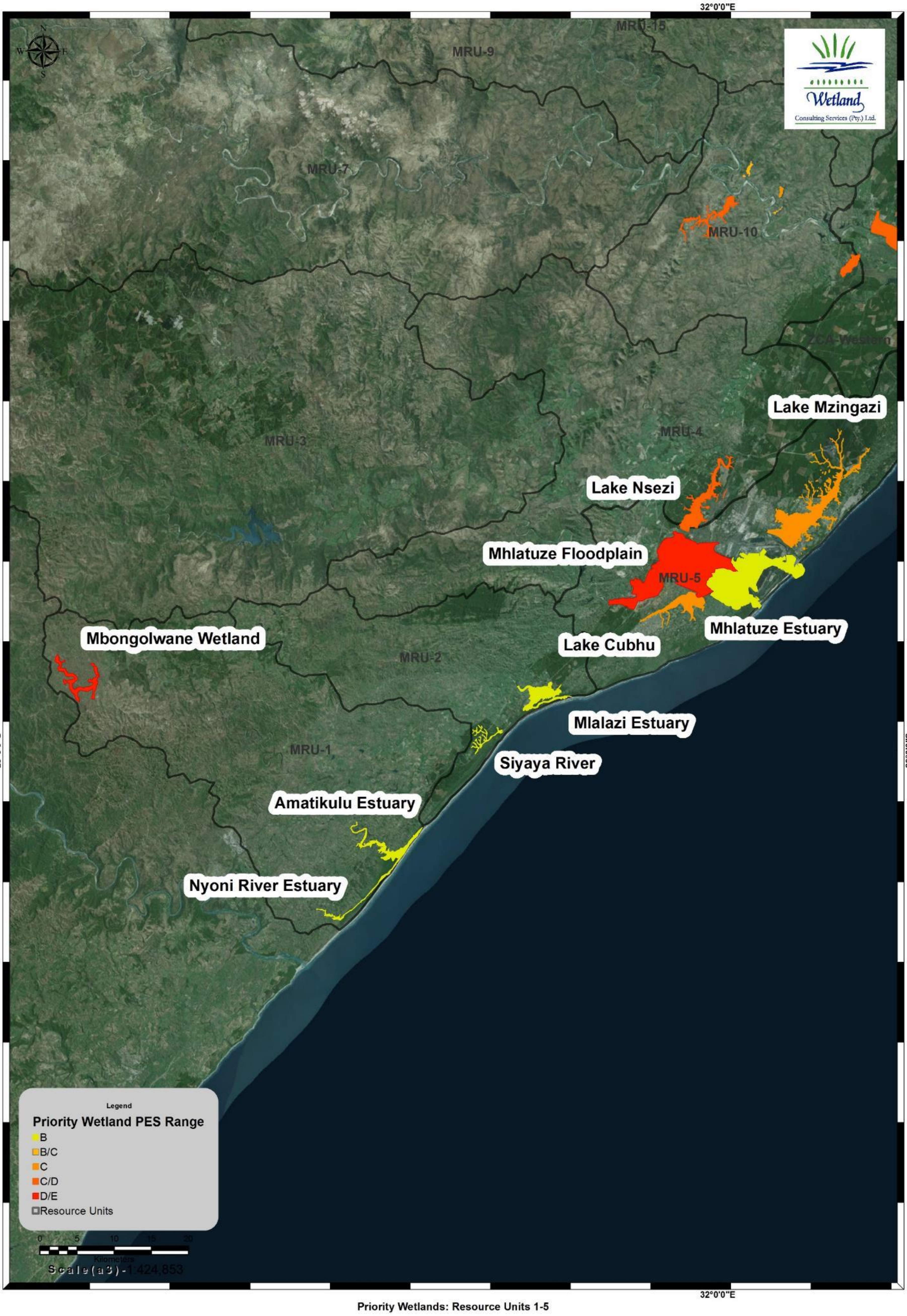


Figure 5-16: Present ecological state of the priority wetland systems within Resource Units 1-5.

RU 6 includes the headwaters of the White Umfolozi River catchment. The majority of the catchment area consists of rural areas, although there are three towns within the RU, namely Vryheid, Nondweni and Nquthu. The main land use is forest plantation, cultivation and livestock grazing. Urban developments are mostly centred around towns and associated townships. There is one priority wetland system within the RU- Stilwater Vlei. The wetland system is impacted upon by cultivation, forest plantations, grazing and several road crossings. There is major incision and channel erosion within the wetland system and this indicates a system that is undergoing both hydrological and geomorphological changes. The ecological integrity of the wetland system is rated as moderately modified with a PES of C and a Moderate EIS. The system supports local biodiversity and is regarded as a Biodiversity Area according to the Kwa-Zulu Natal Conservation Plan. In order to maintain the current status of the system, rehabilitation interventions within the main valley bottom will be required and should be aimed at improving the ecological integrity and functioning of the system under current landuses.

RU 8 includes the headwaters of Black Umfolozi River catchment. The majority of the catchment area consists of forest plantations and agricultural lands. There is only one town within the RU - Kwa Ceza - which is located in the lower reaches of the RU. There is one priority wetland system within the RU - Aloeboom Vlei. This wetland system is impacted upon by forest plantations and several road crossings. Channel erosion is evident in sections of the wetlands; however, the majority of the system is still unchannelled. The presence of erosion, particularly in the upper and lower reaches of the system, indicates that the system is undergoing both hydrological and geomorphological changes, potentially driven by surrounding landuse and impacts. The ecological integrity of the wetland system is rated as moderately modified with a PES of C and a Moderate EIS. The system supports local biodiversity and is regarded as a Biodiversity Area according to the Kwa-Zulu Natal Conservation Plan. In order to maintain and/or improve the current integrity of the system, rehabilitation interventions within the main valley bottom will be required. Removal of forestry plantations within wetland areas and management of erosion within the wetlands would be priorities in terms of future wetland rehabilitation and management. The objectives of future rehabilitation should be to improve the ecological integrity and functioning of the system under current landuses.

RU 17 includes the catchment of the upper reaches of the Pongola River, including associated tributaries, such as the Pivaanswaterval floodplain and Waterval headwaters, which are priority wetland systems. These systems are located along the escarpment, within the Pongola catchment and at the catchment divide between the Thukela and Pongola Rivers. The majority of the catchment consists of rural communal and agricultural lands. The wetland systems within this RU have been impacted upon to some degree by cultivation and alien, invasive vegetation. The headwaters of the Pongola River consist of narrow riparian streams which still support indigenous vegetation, but which have been invaded to a greater or lesser extent by alien species, such as Black wattle. The main Pongola River, where it flows through the upper reaches, is heavily incised and its floodplain is heavily utilised for crop production. The Pivaanswaterval floodplain and Waterval headwaters are still largely intact, particularly so the associated hillslope seepage areas. The Pivaanswaterval floodplain has experienced some incision and channel switching which are processes typical of floodplain systems. Impacts to these priority wetland systems include forestry plantations and livestock grazing by local farmers within the systems' catchments. The ecological integrities for the priority systems within this RU range from moderately to largely modified with PES scores ranging from C to D. The EIS of these systems is High, as they support local biodiversity and are regarded as Critical Biodiversity Areas. In order to ensure that the ecological integrity of these systems are maintained and possibly improved, proper management of forestry plantations and agricultural lands surrounding the wetlands, and water abstraction from the wetlands is required, as appropriate interventions will ensure that water requirements for these systems are maintained.

Figure 5-17: An overview of the Waterval headwaters, indicating livestock grazing and weakly channelled systems

RU 26 includes the catchment of the upper reaches of the Hlelo, Mawandlane and Assegai Rivers which are tributaries to the Usutu River downstream. These systems are located along the escarpment and at the catchment divide between the Upper Vaal and Usutu Rivers. The Assegai and Mawandlane Rivers drain into Heyshope Dam which is used for agricultural and domestic water use. The majority of the catchment consists of rural communal lands, mining areas and agricultural lands. The wetland systems within this RU have been impacted upon to some degree by cultivation, mining, forest plantations and alien, invasive vegetation. The floodplains themselves have experienced some incision and channel switching which are typical of floodplain systems. The ecological integrities for the priority systems within this RU range from moderately to largely modified with PES scores ranging from C to D. The EIS of these systems is rated as high as they support local biodiversity and are regarded as Critical Biodiversity Areas. In order to ensure that the ecological integrity of these systems is maintained and/or improved in future, forestry plantations and agricultural lands will need to be managed and plantations or agricultural fields extending into the floodplains pulled back outside of the wetland areas. Mining activities will need to be strictly regulated and limited, and all forms of water abstraction carefully monitored and regulated to ensure that the ecological water requirements of the these priority water resources are maintained.

Figure 5-18: An overview of the Hlelo River headwaters and downstream floodplains, showing impacts such as mining activities.

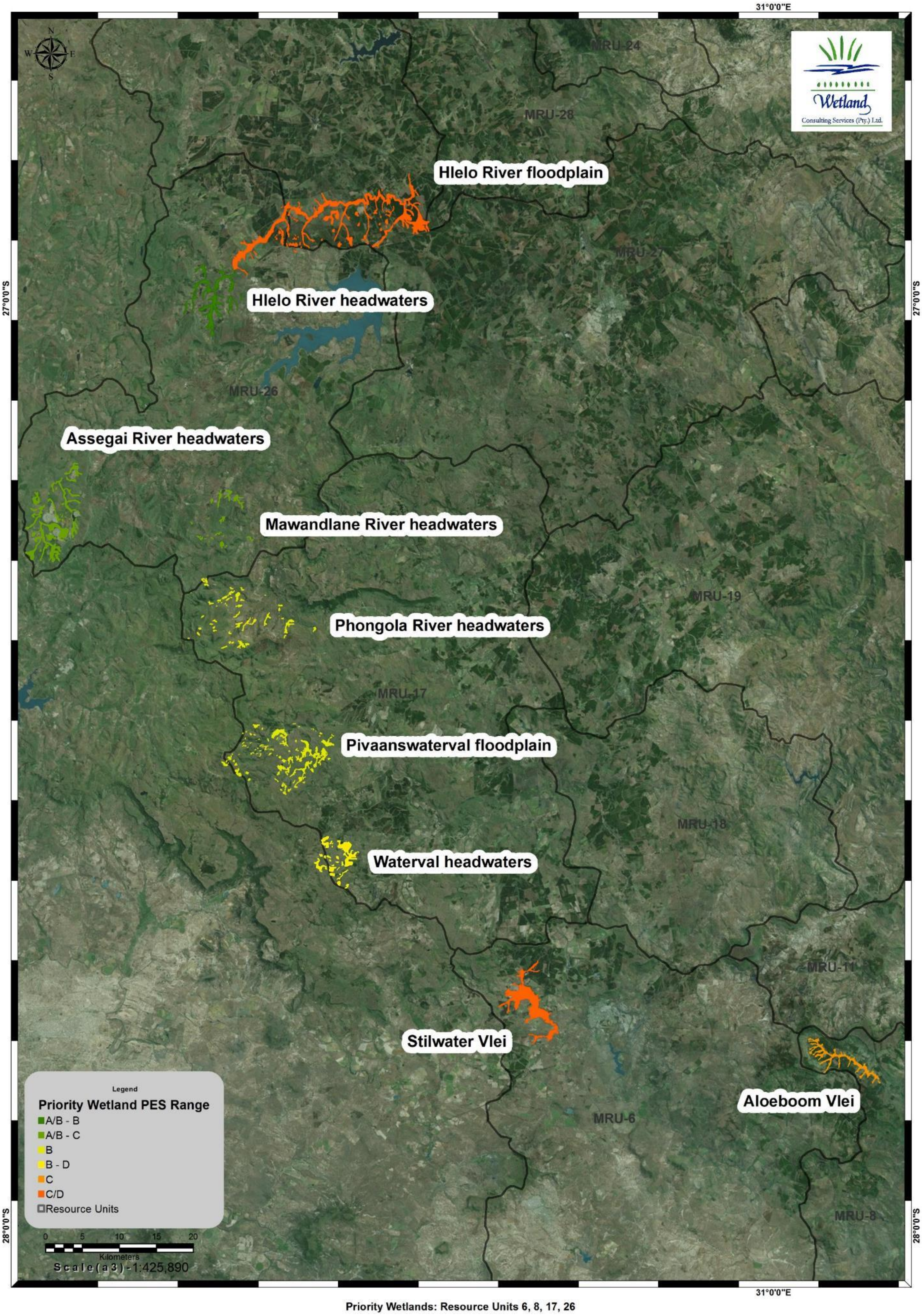


Figure 5-19: Present ecological state of the priority wetland systems within Resource Units 6, 8, 17 and 26.

RU 23 consists of the Chrissiesmeer Panveld Ecosystem which has been listed as *Endangered* in the National List of Ecosystems that are Threatened and in Need of Protection (GN1002 of 9 December 2011). In terms of the Mpumalanga Provincial Gazette Extraordinary (Notice 19 of 2014) the Mpumalanga Lake District forms part of the Chrissiesmeer Protected Environment (CPE). This area is unique due to the high density of pans, several of which are permanently saturated. The pans range in size from less than a hectare to over a thousand hectares (Lake Chrissie). Collectively, the pans inside the pan field are known as the Mpumalanga Lakes District. Mpumalanga Lake District pans are generally more perennial and also less saline. Water sources range from precipitation, run-off and groundwater contributions. A total of approximately 320 pans occur in the Mpumalanga Lakes District, of which the Tevreden Pan is the biggest, covered by a dense growth of *Phragmites australis* (reeds) with a narrow outer ring of open water. The need for conservation has become critical, with new threats posed by a recent open cast coal mining application in the area. The proposed mining activities are regarded by certain specialists as being likely to cause an irreversible negative impact on pans inside the pan field. Based on this regional assessment, this area is added to the list of priority wetlands. The PES of the pans ranges from B to D indicating pans that are largely natural to largely modified. Their EIS is rated as High because of their sensitivity and support to local biodiversity, particularly avifaunal species.

Figure 5-20: An overview of the pan habitat within Mpumalanga Lake District panveld.

Priority Wetlands: Resource Units 23

Figure 5-21: Present ecological state of the priority wetland systems within Resource Unit 23.

RU 16 includes Kosi Bay and the Lake Sibaya systems. The land use within the wetland systems in this RU includes cultivation (communal and commercial); forest plantations; rural communal lands (houses and livestock grazing); Urbanisation and developments (Manguzi, Mseleni and several communal villages); formal and informal roads and associated infrastructures (in town and around villages) and water abstraction for water supply and irrigation. The priority wetlands include:

- Kosi Bay system;
- Muzi swamp;
- Lake Sibaya;
- Kushengeza and KuMzingwane pans; and
- KuMvushana wetland system.

The majority of water use in the RU is in the form of direct water abstraction from the lakes and groundwater. There is peatland confirmed in most of the systems. Based on the activities and impacts to these systems, their ecological integrities range from B (in protected areas) to D (around developed and communal lands) indicating systems that are largely natural to largely modified. Therefore, it is important to manage groundwater abstraction as well as general land use, particularly in those systems which support peatlands, which is a unique and rare wetland feature in southern Africa. Specific requirements and management for peatlands is provided in this report to guide future management and thereby attempt to ensure the continued existence of these systems.

Figure 5-22: An overview of the activities impacting wetlands in RU 16, including water abstraction from Lake Sibaya and cultivation within and around Muzi swamps.

RU 22 and RU 29 include the Pongola floodplain and the lower catchment of the Usutu River and partly the confluence with the Pongola River within the Indumo Nature Reserve. There are three priority systems within this RU, namely the Pongola floodplain, and the Banzi and Nyamithi pans. Banzi Pan is highly impacted upon and currently filled by the Usutu River. The full assessment of these systems is covered in detail within the Pongola Floodplain EWR report (RDM/WMA6/CON/COMP/1113) which has been compiled in parallel with this report. The reader is therefore referred to the Pongola Floodplain EWR report for further detail on these priority systems. . However, it can be summarized that the Pongola floodplain is heavily utilised by local communities both for communal and commercial agricultural uses, including cultivation, crop production, fishing and livestock grazing. Banzi Pan is heavily impacted upon due to active erosion within this pan and surrounding area. The vegetation at Nyamithi Pan appeared to be in relatively good condition with representative examples of most of the main vegetation communities found on the floodplain. The ecological integrity of these systems ranges from B to D. The Pongola floodplain and Banzi Pan are largely modifed and the Nyamithi pan is largely natural. An overview of the impacts within these systems is indicated in the figure below.

Figure 5-23: An overview of the Banzi and Nyamithi Pans, and cultivation and grazing within the Pongola floodplain.

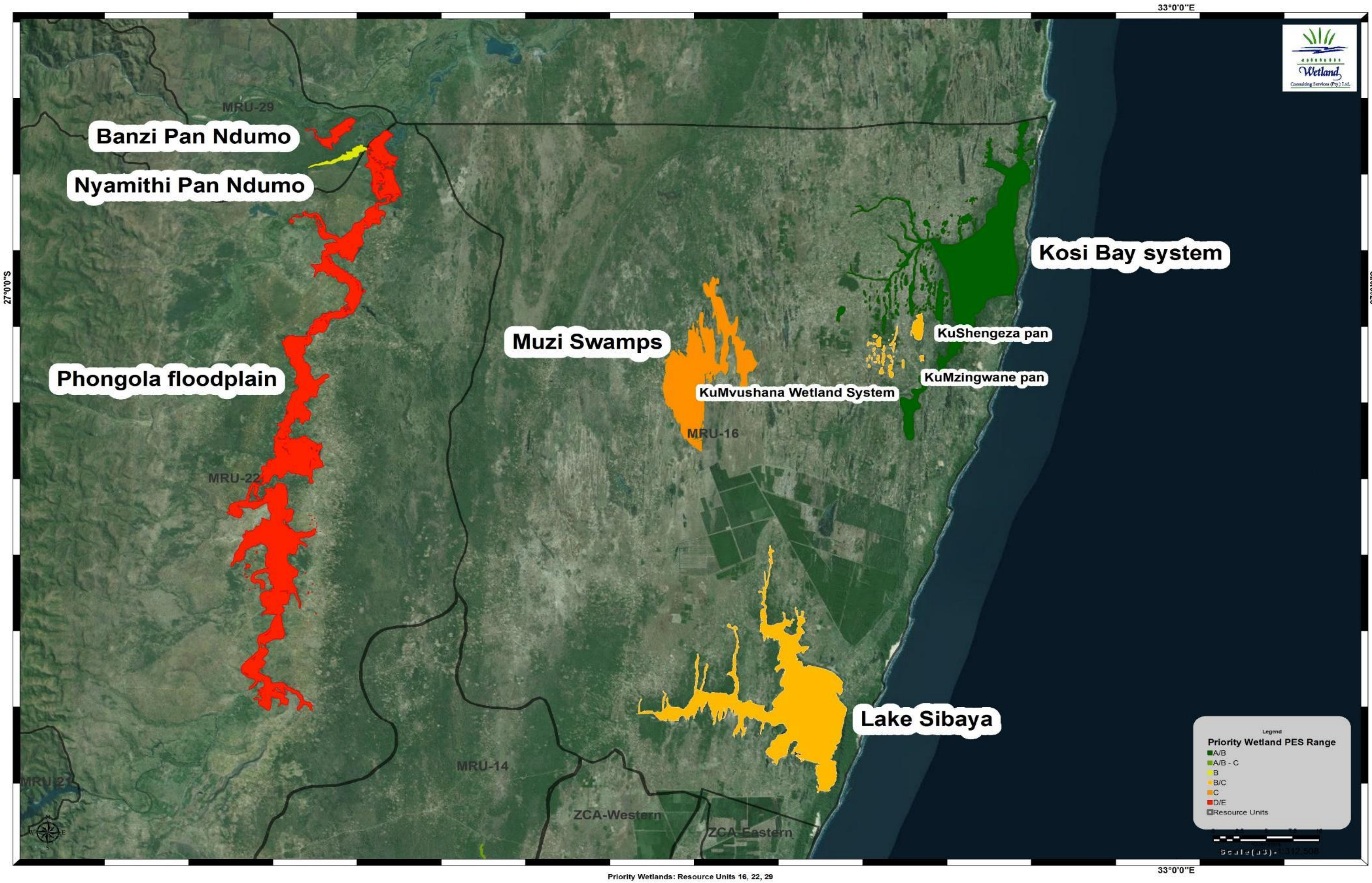


Figure 5-24: Present ecological state of the priority wetland systems within Resource Units 16, 22 and 29.

RU 10 includes the catchment of the lower reaches of the Umfolozi River, the majority of which consists of rural areas. There is one nature reserve within the RU, namely the Fuleni Reserve. There are four priority wetlands or water resource systems recorded within this RU:

- Mvamanzi Pan,
- Ntweni Pan;
- Nkatha Pan; and
- Mbukwini Lake.

The main land use in and around these priority systems is cultivation and grazing by local communities, activities which have impacted heavily on the wetlands. The ecological integrities of the pans and lake range from moderately to largely modified with PES scores between C and D. the EIS of these systems ranges is considered Moderate as they are regarded as Biodiversity Support Areas, particularly for local avifaunal species. The majority water use within this RU both in lakes and pans is direct water abstraction from rivers for rural communities.

Figure 5-25: Grazing in Mbukwini Lake and overview of Mvamazi Pan and surrounding communal lands.

RU's ZGSA, ZCA Western include the Mkuze floodplain, Mfolozi and Nyalazi River upstream of St Lucia, and the Hluhluwe, Msunduzi and Mhlosinga Rivers respectively. The following priority wetlands are included within the above RU's:

- Mzinene Lake;
- Mzinene Floodplain
- Muzi Pan;
- Mfutululu Lake
- Mfolozi Swamp

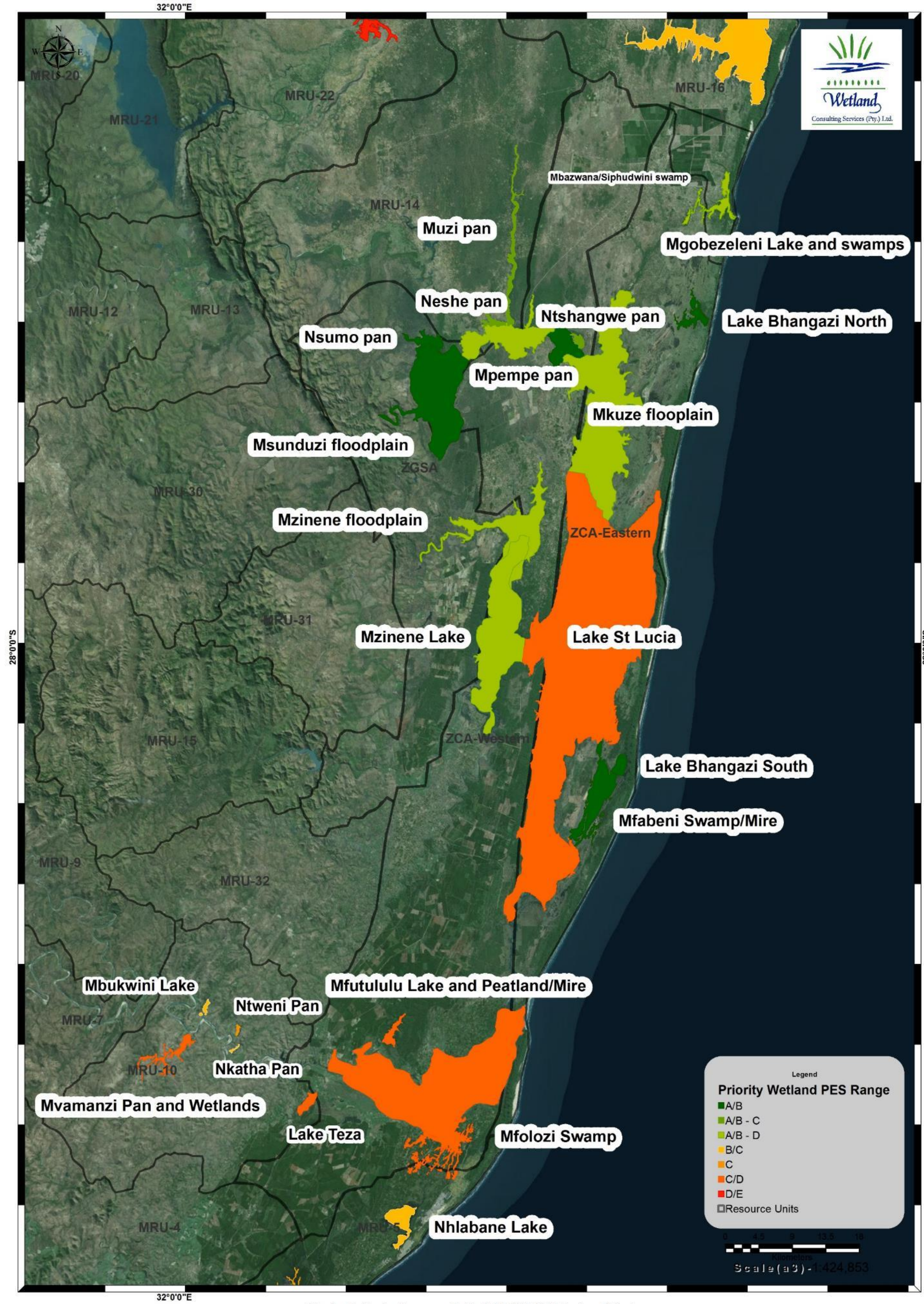
- Mkuze Floodplain;
- Ntshangwe and Mpempe Pans
- Msunduzi Floodplain
- Nsumo Pan

The land use within these RU's includes cultivation (communal and commercial); forest plantations; rural communal lands (houses and livestock grazing); and urbanization and developments (Mtubatuba, St Lucia, Hluhluwe, several townships and communal villages). Peatland has been confirmed in most of the systems indicated above. Based on the activities and impacts on these systems their ecological integrities range from C to D (around developed and communal lands) indicating systems that are moderately to largely modified. It is therefore important to manage groundwater abstraction, forestry plantations and direct water abstraction around and within these RU's. Appropriate interventions should include, but not be limited to, improvement of general land use management practices associated with agricultural activities. Specific requirements and management for peatlands is provided in this report to guide future management and thereby attempt to ensure the continued existence of these systems..

Figure 5-26: An overview of the Msunduzi and Mfolozi Floodplains.

Figure 5-27: An overwiev of the Mzinene and Mkuze Floodplains

Figure 5-28: An overwiev of the Nsumo Pan at Mkuze Nature Reserve



Priority Wetlands: Resource Units 10, ZGSA, ZCA East and West

Figure 5-29: Present ecological state of the priority wetland systems within Resource Units 10, ZGSA, ZGA East and West.

Table 5-1: Table indicting priority wetlands and their associated ecological characteristics and categorisations

Tertiary catchment	Resource Units	Wetland Name	Type	Actual PES*(Lakes and Estuaries)	Actual PES** Other wetlands	NFEPA WETCON***	Modelled PES**** (Landuse based State)	River Condition used by NFEPA	PES Range (Wetland)	EIS*****	NFEPA Vegetation Group and Threat Status	Identified as a WETFEPA	Unique Features/ Important wetland systems
Usutu River	MRU26	Assegai River headwaters	Hillslope seepage wetlands	-	-	A/B	C	B	A/B - C	High	Mesic Highveld Group 8:LT	Yes	Critical Biodiversity Area: Irreplaceable
Usutu River	MRU23	Chrissiesmeer Pan Cluster	Pans	-	B - C	A/B - D	C/D	B	A/B to D	High	Mesic Highveld Group 4:EN	Yes	Critical Biodiversity Area -Irreplaceable to Optimal, Large pan cluster, avifaunal diversity, Peatlands (not in pans I visited, but one of the other cluster pans)
Usutu River	MRU26	Hlelo River floodplain	Floodplain	-	C	C	D	B	C - D	High	Mesic Highveld Group 4:EN	Some	Critical Biodiversity Area -Irreplaceable and Optimal in small areas. Remainder is Modified
Usutu River	MRU26	Hlelo River headwaters	Hillslope seepage wetlands	-	C	A/B	B	B	A/B - B	High	Mesic Highveld Group 4:EN	Yes	Critical Biodiversity Area -Irreplaceable
Usutu River	MRU26	Mawandlane River headwaters	Hillslope seepage wetlands	-	-	A/B	C/D	-	A/B - C/D	High	Mesic Highveld Group 5:EN	Some	Majority Protected and CBA: Irreplaceable
Umkuze River	ZCA-Eastern	Lake Bhangazi North	Lake	-	-	A/B	B	-	A/B	High	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and Protected area
Umkuze River	ZCA-Eastern	Lake Bhangazi South	Lake	-	-	A/B	B	-	A/B	High	Indian Ocean Coastal Belt Group 1: LT	Yes	FEPA and Protected area
Umkuze River	ZCA-Eastern	Lake St Lucia	Lake	D	-	-	D/E	-	C/D	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA and Protected area
Umkuze River	ZCA-Eastern	Mbazwana/Siphudwini swamp	Unchannelled valley bottom	-	-	A/B - C	C/D	-	A/B - D	High	Indian Ocean Coastal Belt Group 1: LT	Some	Peatland, FEPA and Protected area
Umkuze River	ZCA-Eastern	Mfabeni Swamp/Mire	Unchannelled valley bottom	-	B	A/B	-	-	A/B	High	Swamp Forest:LT	Yes	Peatland, FEPA and Protected area
Umkuze River	ZCA-Eastern	Mgobezeleni Lake and swamps	Lake	-	-	A/B - D	D/E		A/B - D	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA and Protected area
Umkuze River	ZCA-Western	Mkuze flooplain	Floodplain	-	D	A/B	D/E	A - B	A/B - D	Moderate	Indian Ocean Coastal Belt Group 1: LT	Yes	FEPA and Protected area
Umkuze River	ZCA-Western	Mpempe pan	Pans	-	-	A/B	D/E	A	A/B	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Biodiversity area, FEPA and Protected area
Umkuze River	ZGSA	Msunduzi floodplain	Floodplain	-	-	A/B	B	-	A/B	Moderate	Lowveld Group 10:EN	Yes	FEPA and Protected area
Umkuze River	MRU14	Muzi pan	Pans	-	D	A/B	D/E	-	A/B -C	High	Lowveld Group 10:EN	Yes	Peatland, FEPA and Protected area
Umkuze River	ZGSA	Mzinene floodplain	Floodplain	-	D	A/B	D/E	-	A/B - D	Moderate	Lowveld Group 11:VU	Yes	FEPA
Umkuze River	ZGSA	Mzinene Lake	Lake	-	D	A/B	D/E	-	A/B - D	Moderate	Lowveld Group 11:VU	Yes	FEPA
Umkuze River	MRU14	Neshe pan	Pans	-	D	A/B	C/D	-	A/B - C	Moderate	Lowveld Group 10:EN	Yes	FEPA and Heavily degraded

Tertiary catchment	Resource Units	Wetland Name	Type	Actual PES*(Lakes and Estuaries)	Actual PES** Other wetlands	NFEPA WETCON***	Modelled PES**** (Landuse based State)	River Condition used by NFEPA	PES Range (Wetland)	EIS*****	NFEPA Vegetation Group and Threat Status	Identified as a WETFEPA	Unique Features/ Important wetland systems
Umkuze River	ZGSA	Nsumo pan	Pans	-	C	A/B	C	-	A/B	High	Lowveld Group 10:EN	None	Peatland and Protected area
Umkuze River	ZCA-Western	Ntshangwe pan	Pans	-	-	A/B	C/D	-	A/B - C	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA and Protected area
Umhlatuze River	MRU5	Lake Cubhu	Lake	-	D	A/B - C	D/E	-	C	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and Heavily transformed
Umhlatuze River	MRU5	Lake Mzingazi	Lake	-	D	A/B - C	D/E	-	C	Moderate	Swamp Forest:LT	None	Peatland, Transformed and Water supply
Umhlatuze River	MRU4	Lake Nsezi	Lake	-	D	C	D/E	-	C/D	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and Biodiversity area
Umhlatuze River	MRU1	Amatikulu Estuary	Estuary	B	-	-	D/E	-	B	Moderate	Indian Ocean Coastal Belt Group 1: LT	Yes	FEPA and Protected area
Umhlatuze River	MRU1	Mbongolwane Wetland	Valle bottom wetlands	-	-	-	D/E	-	D/E	Moderate	Sub-Escarpment Savanna:EN	None	Heavily impacted and important for livelihood
Umhlatuze River	MRU5	Mhlatuze Estuary	Estuary	B	-	-	D	-	B	Moderate	Indian Ocean Coastal Belt Group 1: LT	Some	Peatland and Protected area
Umhlatuze River	MRU5	Mhlatuze Floodplain	Floodplain	-	E	D	D	-	D - E	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Biodiversity area
Umhlatuze River	MRU2	Mlalazi Estuary	Estuary	B	-	-	D/E	-	B	High	Indian Ocean Coastal Belt Group 2	Yes	FEPA, Protected area and Critical biodiversity area
Umhlatuze River	MRU5	Nhlabane Lake	Lake	-	D	A/B - C	D	-	B/C	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and Transformed landscape
Umhlatuze River	MRU1	Nyoni River Estuary	Estuary	B	-	-	B	-	B	Moderate	Indian Ocean Coastal Belt Group 2	Yes	FEPA and Protected area
Umhlatuze River	MRU2	Siyaya River	Valley bottom wetlands	-	-	-	B	-	B	High	Indian Ocean Coastal Belt Group 2	Yes	FEPA, Protected area and Critical biodiversity area
Umfolozi River	MRU8	Aloeboom Vlei	Valley bottom wetlands	-	-	C	D/E	B	C	Moderate	Sub-Escarpment Group 4:EN	None	Biodiversity Area, small area in upper section is CBA 3
Umfolozi River	MRU10	Lake Teza	Lake	-	D	C	D/E	-	C/D	Moderate	Lowveld Group 11:VU	None	Protected area
Umfolozi River	MRU10	Mbukwini Lake	Lake	-	D	A/B	C/D	-	B/C	Moderate	Lowveld Group 11:VU	None	Biodiversity area
Umfolozi River	ZCA-Western	Mfolozi Swamp	Unchannelled valley bottom	-	D	C	C/D	-	C/D	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA and Biodiversity area
Umfolozi River	ZCA-Western	Mfutululu Lake and Peatland/Mire	Lake	-	C	C	D/E	-	C/D	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and Protected area
Umfolozi River	MRU10	Mvamanzi Pan and Wetlands	Pans	-	D	C	D/E	-	C/D	Moderate	Lowveld Group 11:VU	Yes	FEPA, Transformed landscape
Umfolozi River	MRU10	Nkatha Pan	Pans	-	C	A/B	C/D	-	B/C	Moderate	Lowveld Group 11:VU	None	Biodiversity area
Umfolozi River	MRU10	Ntweni Pans	Pans	-	C	C	C/D	-	C	Moderate	Lowveld Group 11:VU	None	Critical biodiversity area 3
Umfolozi River	MRU6	Stilwater Vlei	Channelled valley bottom	-	C	C	D/E	-	C/D	Moderate	Sub-Escarpment Group 4:EN	Yes	Biodiversity area

Tertiary catchment	Resource Units	Wetland Name	Type	Actual PES*(Lakes and Estuaries)	Actual PES** Other wetlands	NFEPA WETCON***	Modelled PES**** (Landuse based State)	River Condition used by NFEPA	PES Range (Wetland)	EIS*****	NFEPA Vegetation Group and Threat Status	Identified as a WETFEPA	Unique Features/ Important wetland systems
Usutu River	MRU29	Banzi Pan Ndumo	Pans	-	D/E	AB	B/C	-	D/E	Moderate	Lowveld Group 10:EN	Yes	FEPA, Protected area and Heavily impacted
Phongola River	MRU29	Nyamithi Pan Ndumo	Pans	-	B	A/B	B/C	-	B	Moderate	Lowveld Group 10:EN	Yes	FEPA and Protected area
Phongola River	MRU22	Phongola floodplain	Floodplain	-	D/E	A/B - C	C/D	C	D/E	High	Lowveld Group 9:VU	Yes	FEPA, Biodiversity area, important for livelihood
Phongola River	MRU17	Phongola River headwaters	Hillslope seepage wetlands	-	-	AB	B	A	B	High	Mesic Highveld Group 5:EN	Yes	Critical Biodiversity Area 3 and Biodiversity Area
Phongola River	MRU17	Pivaanswaterval floodplain	Floodplain	-	-	AB	C	B	B	High	Mesic Highveld Group 8:LT	Yes	Critical Biodiversity Area 1 Mandatory
Phongola River	MRU17	Waterval headwaters	Hillslope seepage wetlands	-	B	AB	D/E	-	B - D	High	Mesic Highveld Group 8:LT	Some	Majority is "Biodiversity Area", small section in northeast is CBA 1 Mandatory
Lake Sibaya & Kosi Bay	MRU16	Kosi Bay System	Lake	A/B	-	A/B		-	A/B	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA, Protected area
Lake Sibaya & Kosi Bay	MRU16	KuMvushana Wetland System	Unchannelled valley bottom	-	C	A/B - C	C	-	B/C	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA, Protected area
Lake Sibaya & Kosi Bay	MRU16	KuMzingwane Pan	Pans	-	C	AB	C	-	B/C	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA, Protected area
Lake Sibaya & Kosi Bay	MRU16	KuShengeza Pan	Pans	-	C	AB	C	-	B/C	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA, Protected area
Lake Sibaya & Kosi Bay	MRU16	Lake Sibaya	Lake	B/C	-	AB	D/E	-	B/C	High	Indian Ocean Coastal Belt Group 1: LT	Yes	Peatland, FEPA, Protected area
Lake Sibaya & Kosi Bay	MRU16	Muzi Swamps	Unchannelled valley bottom	-	D	AB	D/E	-	C	Moderate	Indian Ocean Coastal Belt Group 1: LT	None	Peatland and partly Protected area

* Actual PES - PES assessment based on rivers and estuaries specialists as part of Reserve Determination Studies
**Actual PES - PES assessment based on area weighted impacts recorded and assessed onsite
***NFEPA WETCON - Wetland condition assessment based on NFEPA datasets
****Modelled PES - PES assessment based on surrounding landuses particular for systems that were not onsite assessed
*****EIS - EIS assessment based on existing information from previous studies, peatlands studies, regional conservation plans, NFEPA, WARMS datasets

5.4 Threats analysis on wetlands within the WMA

Within the WMA in general, the main threats to the wetlands and wetland related biota include, but are not restricted to:

- Commercial development;
- Drainage schemes;
- Agriculture – both subsistence and commercial (such as sugarcane and forestry plantations) as well as return flows, and the use of pesticides for intensive agriculture, such as sugarcane, forestry, and commercial crop production;
- Extraction of minerals and peat;
- Toxic pollutants from industrial waste;
- Other water quality issues such as increases in population and nutrient inputs from failing or poorly operated/managed sewage works;
- Over abstraction of both surface and groundwater;
- Dam flow release management and related impacts on fluvial dynamics;
- Construction of new dams and dykes (related mostly to water use and distribution infrastructure as well as, in some cases, related to flood protection; and
- Acid Mine Drainage (AMD) may be a threat from proposed and even some existing mining operations. There is a potential future risk in this regard in the upper catchment in particular.

In order to quantify some of the specific threats per Resource Unit (RUs) within the WMA, the Water Resource Registration Management System (WARMS) database from the Department of Water and Sanitation was evaluated. This database provides different types of licensed and registered water uses within the WMA. The distribution and volumes of water uses is therefore used as the basis for determining threats, particularly if a specific type of water use should be allowed to continue in a specific RU. For the purposes of analysis, the following types of water intercepted in the catchment were considered:

1. Volume of water intercepted by forestry - Stream flow reduction activities;
2. Volume of water stored in impoundments (instream, off stream storages and dams);
3. Water abstracted from water resources (rivers) in terms of total flows; and
4. Water abstracted from water resources (boreholes) in terms of total flows.

5.4.1.1 Volumes of water intercepted by Forestry

The high density of plantation trees, grown in areas which were often previously grassland, intercept larger volumes of water than natural grassland vegetation. Due to this interception, less water reaches the rivers. Figure 7-16 shows that the volumes of water intercepted by the forestry industry are greater than would have been the case for natural grassland.

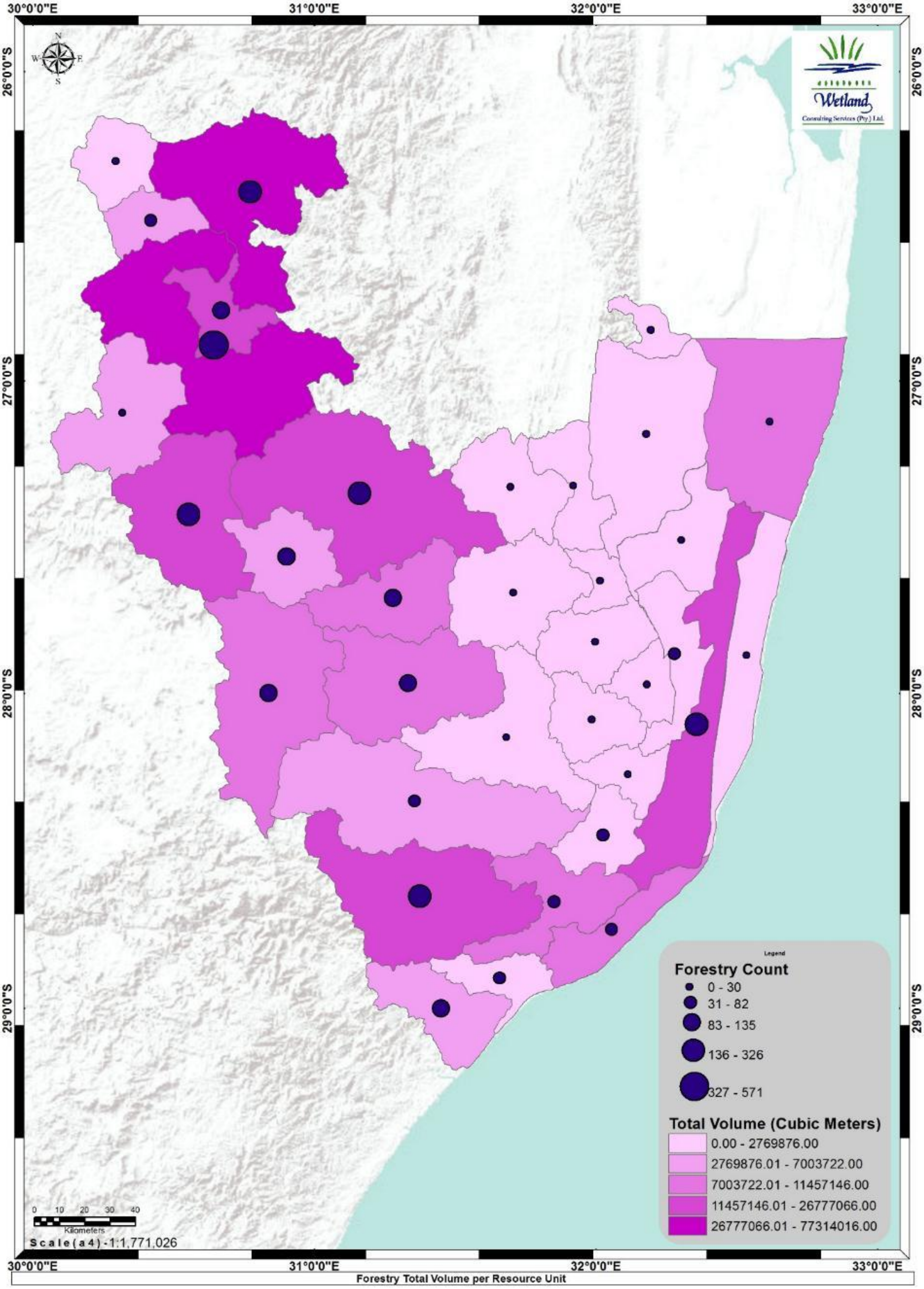


Figure 5-30: Map indicating volumes of water intercepted by the Forestry Industry (WARMS database).

5.4.1.2 Volumes of water stored in impoundments (instream, off stream storages and dams)

A few large dams have been built within the WMA, mostly for the purposes of urban water supply, although a few are used for irrigation. Large numbers of smaller "farm" dams have been built either to retain water for agriculture or for recreation and aesthetic purposes. While the practice of building dams provides some benefits, mostly related to ensuring the supply of water all year round, there are consequent ecological impacts felt mostly in the downstream rivers, estuaries and even in the ocean. Figure 6-16 shows volumes of water per RU stored in impoundments in KwaZulu- Natal. The sheer number of dams and the large volumes of water that they hold have a large impact on the aquatic environment of the province where they impede water flow and the migration of various species, impact on water quality and the movement of sediment in the river. World-wide there is controversy about the impact of such dams on the environment, and in some countries there are even programs to demolish dams that are no longer really needed by society. Dams that contribute to Figure 7-17 are only those that are registered with DWAF and will not include the many other smaller dams.

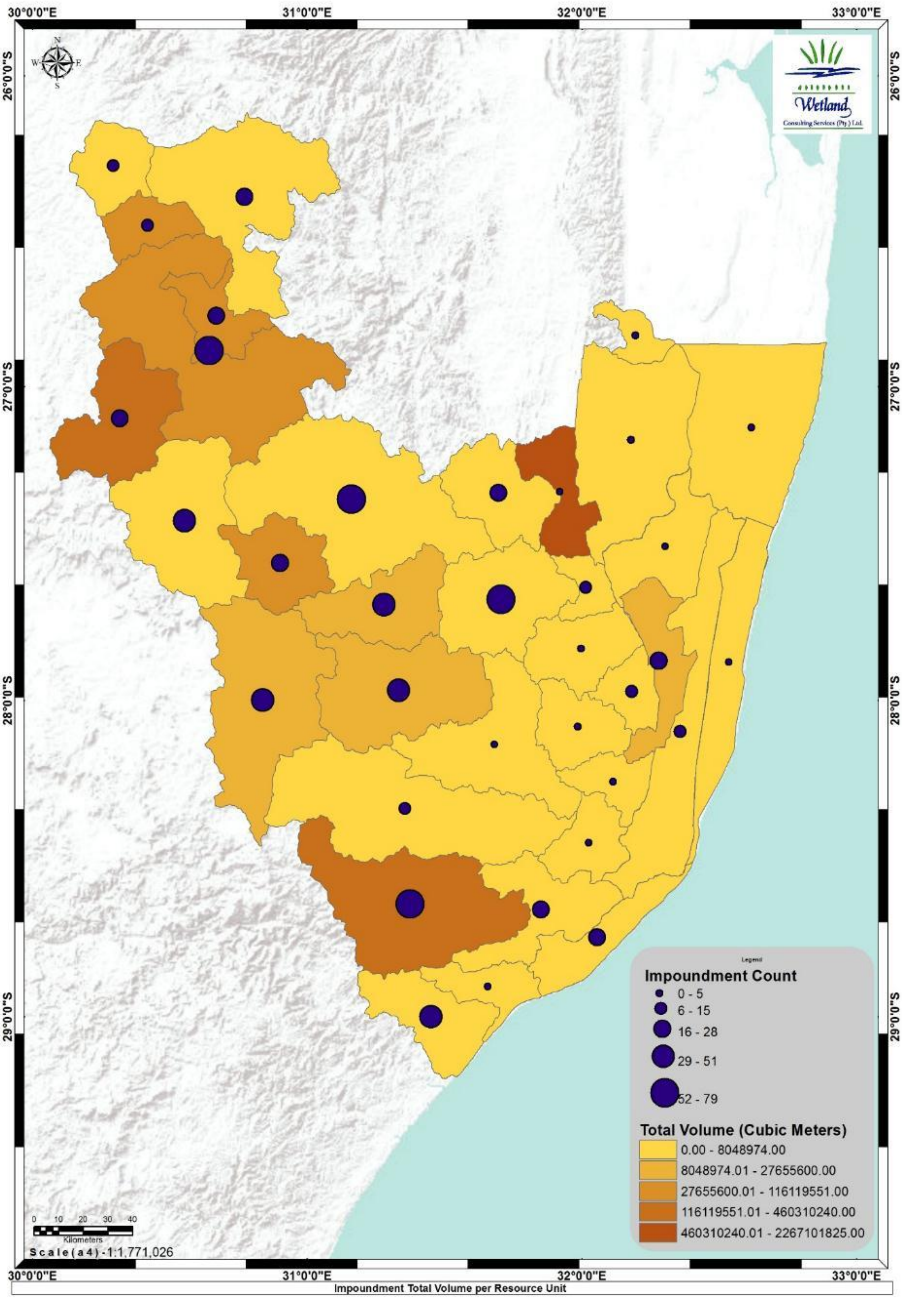


Figure 5-31: Map indicating volumes of water stored in impoundments (WARMS database).

5.4.1.3 Water abstracted from water resources (rivers) for irrigation, industry and domestic use.

In many parts of South Africa, the abstraction of water has reached the maximum possible to the extent that warnings have been issued that water shortages will become a major issue in the decades to come. Most natural aquatic ecosystems have evolved over tens of thousands of years to exist in a balance which is largely determined by how much water is available at particular times of the year. This balance can be upset by the excessive removal of water from the system. The pressure exerted on a river is thus measured by how much water is abstracted (the pressures on the ecosystem are described under the section on ecological health of rivers and wetlands).

While water is essential for the production of food for society, the source of that water is very limited. The amount of water abstracted and used for, amongst others, irrigation purposes within the WMA is indicated in Figure 7-18. This abstraction of water results in less water in the aquatic environment, which in turn, has environmental consequences. A significant portion of the available water within the WMA is used for general purposes, including domestic and industrial uses. Most of this water is supplied by Water Service Authorities but some industries have licenses to abstract water independently.

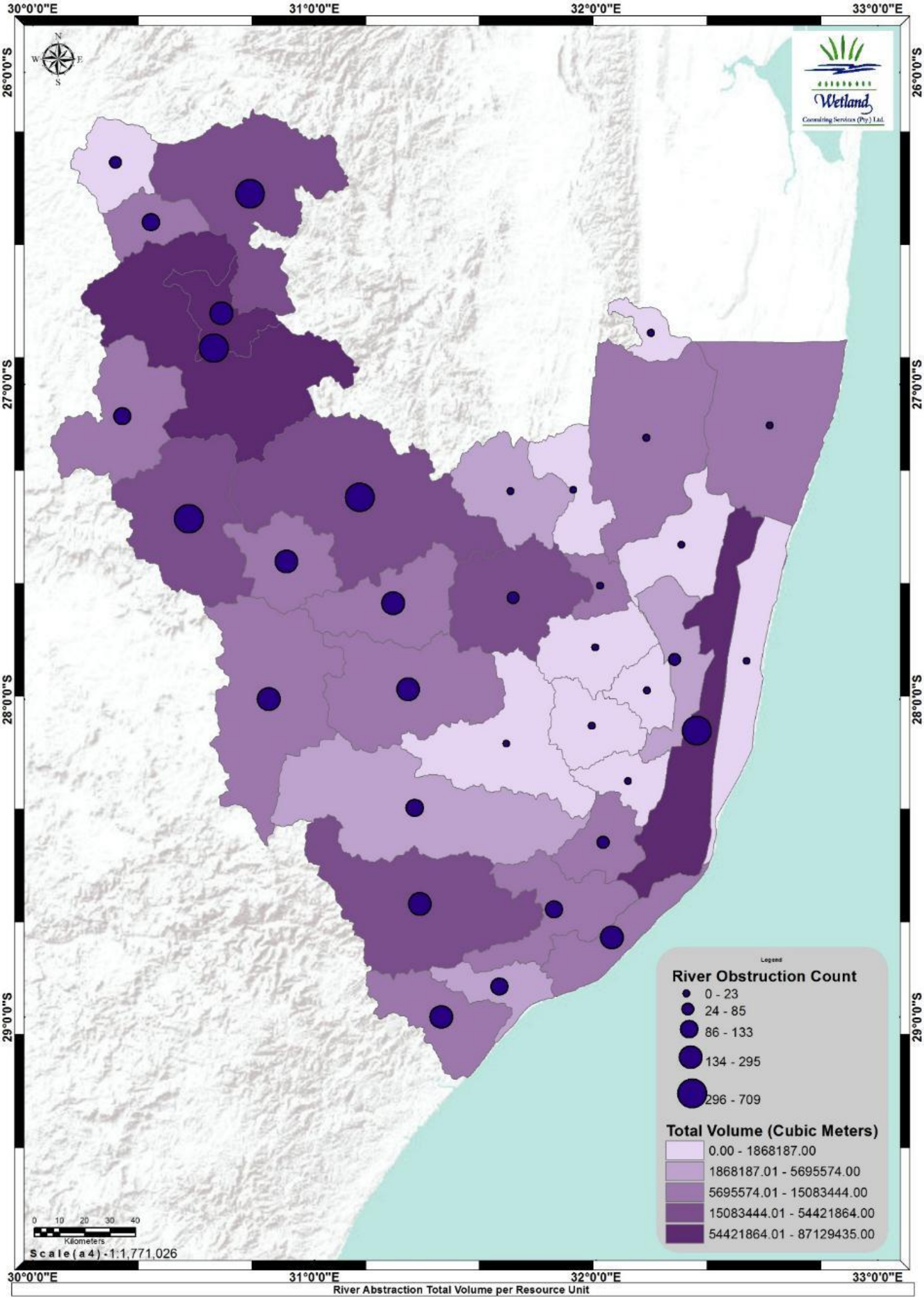


Figure 5-32: Map indicating volumes of water abstracted from the rivers for irrigation, industry and domestic use (WARMS database).

5.4.1.4 Water abstracted from water resources (boreholes) in terms of total flows

An indication of the pressure that is put on the groundwater resource by way of licensed operations to remove it is provided in Figure 7-19. It can be seen that there are a few nodes of high usage. It is suggested that the below representation is a gross under- estimate due to the large number of illegal boreholes that exist in these areas.

The links between groundwater and surface water from an ecological and environmental point of view are the subject of a new science. The most dramatic link is when groundwater is depleted, as this reduces inflow of water to surface water bodies which dry out and there is consequent loss of this fresh-water habitat. There are more refined links as well, such as the ingress of groundwater into streams over most of the year, which sustains the so called "base flow", i.e. river flow that continues in a river after rainfall has abated. Data on the available volume of groundwater within the WMA is not available, but it is likely, as indicated by groundwater specialists, that excessive extraction of groundwater is taking place throughout the province with only a small portion registering a license with DWS.

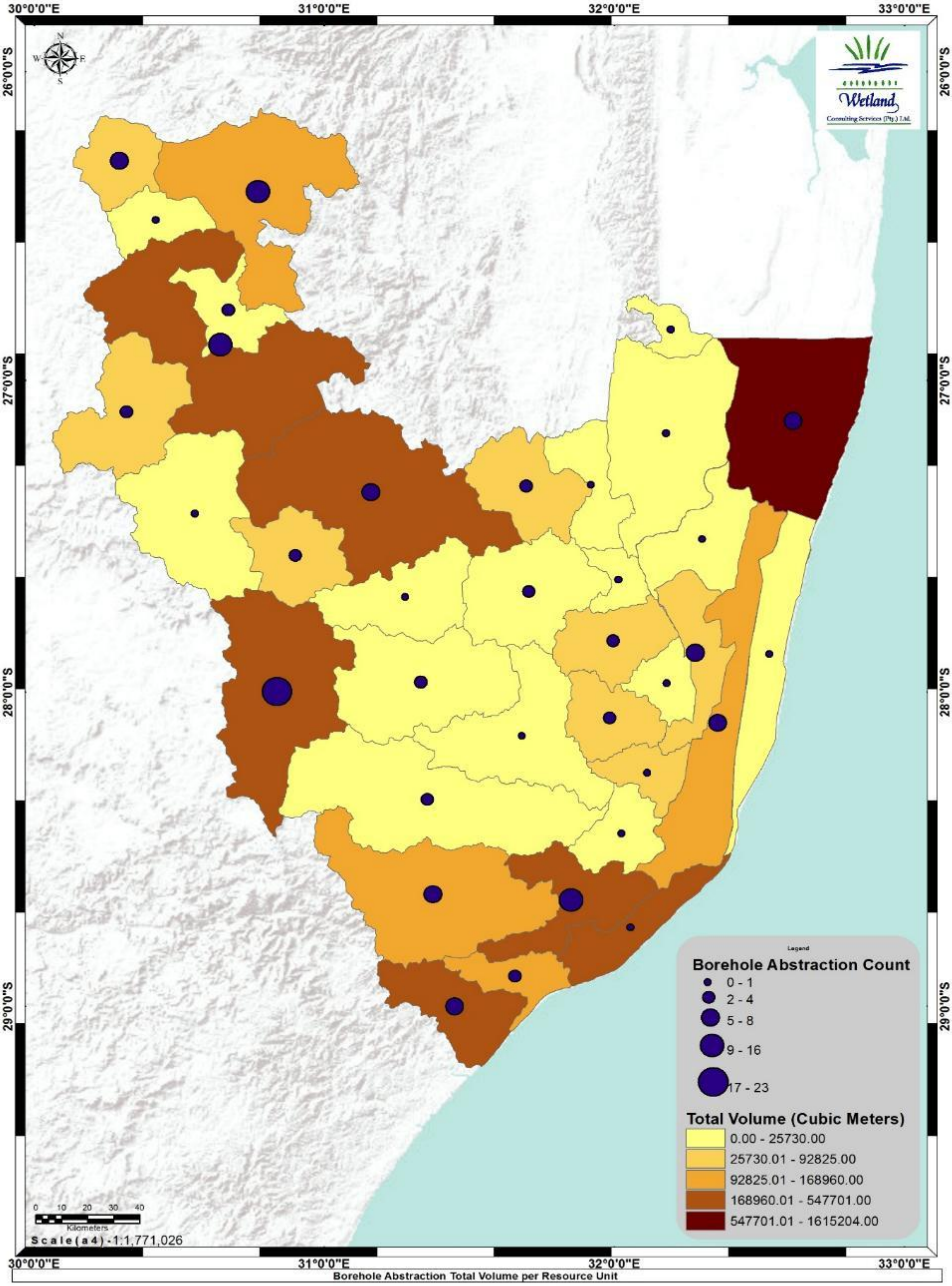


Figure 5-33: Map indicating volumes of water abstracted from groundwater (boreholes) for irrigation, industry and domestic use (WARMS database).

5.4.1.5 Linking Present Ecological Status of wetlands within the WMA to the extent, types and distribution of water uses within the WMA.

Figure 7-20 below provides a distribution of wetlands in terms of coverage within the WMA. It appears that in terms of hectare coverage, most of the wetlands are within the coastal areas and in the upper reaches of the Usutu Catchment. The central section of the WMA appears to have limited wetlands in terms of extent and this could be linked to climatic conditions i.e. the areas may be drier than the coastal and Lowveld upper regions (Upper reaches of Usutu catchment). The ecological status of wetlands within the WMA indicates that the coastal wetlands are largely to seriously modified compared to wetlands in the central and upper reaches. Figure 7-21 indicates the distribution of the ecological status of wetlands within the WMA. The poor condition of wetlands along the coastal area can be attributed to the development nodes (towns and industrial areas) and water abstraction for irrigation, industry and domestic uses (from rivers and boreholes) and forestry.

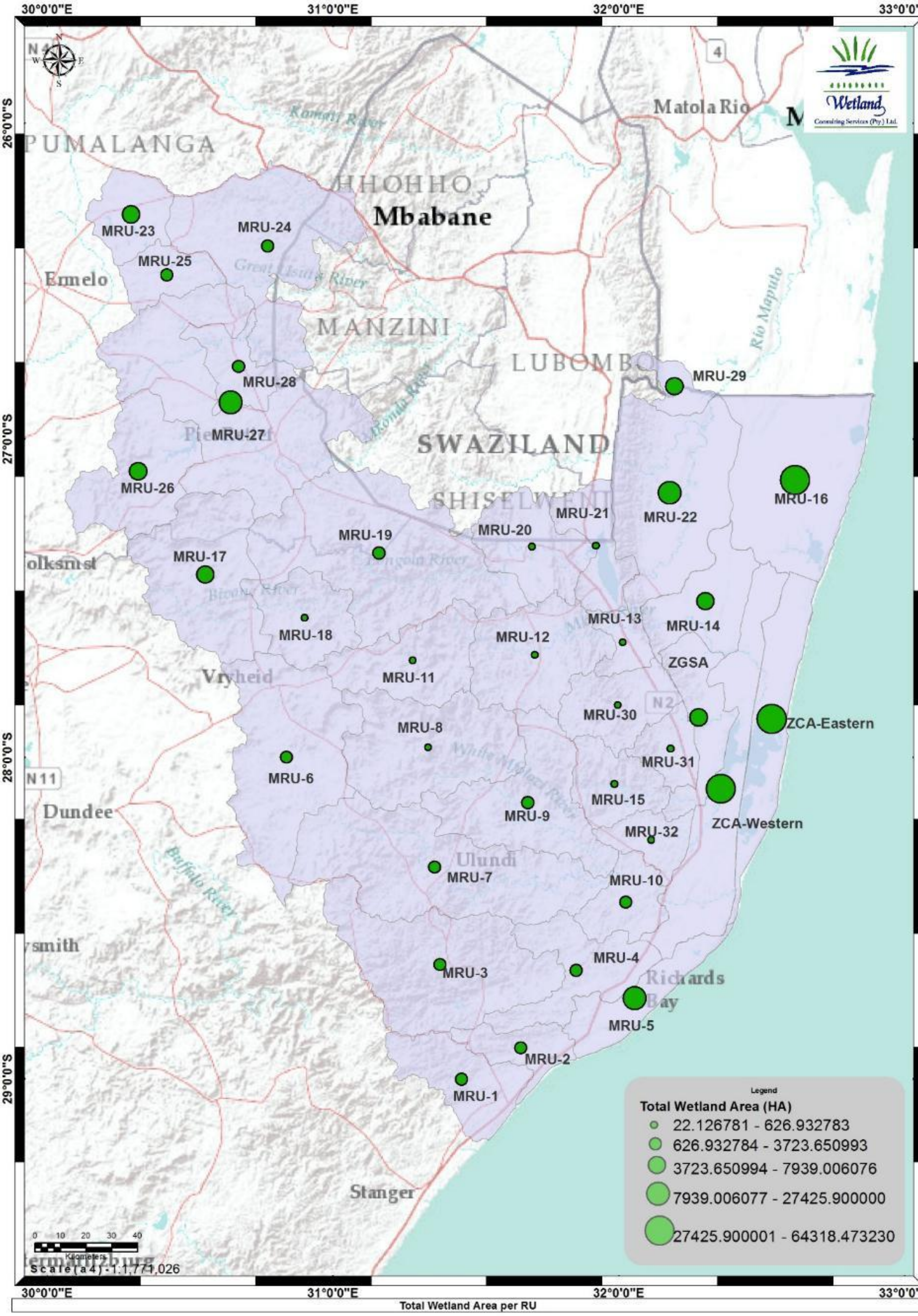


Figure 5-34: Map indicating extent and distribution of wetlands in terms of hectare coverage within the WMA (NFEPA database).

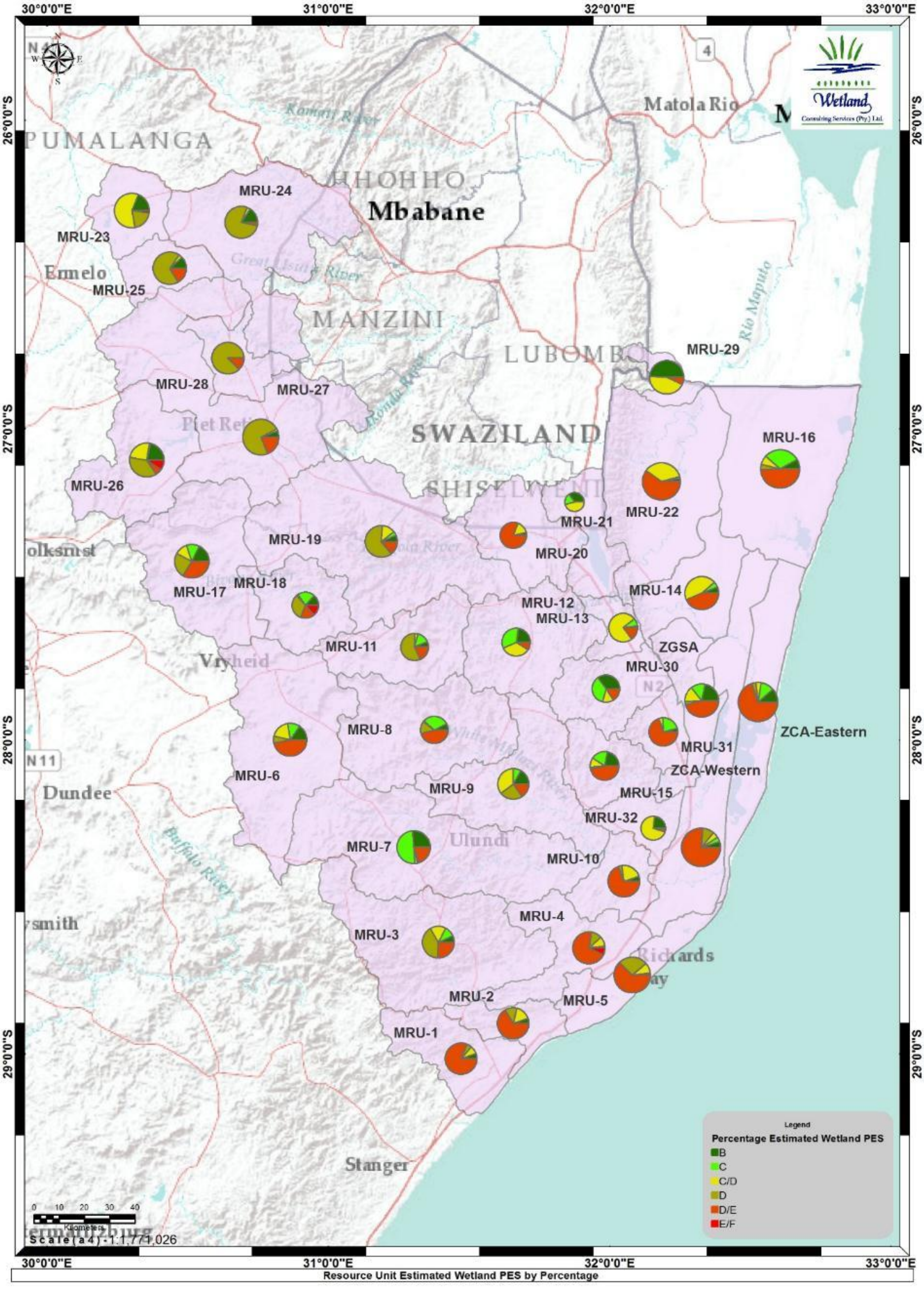


Figure 5-35: Map indicating distribution of ecological status of wetlands within the WMA (NFEPA database).

From a water uses perspective, RUs that already experience high water use in terms of total volumes abstracted are indicated in the maps below. The maps have been categorised as follows:

1. Map indicating RUs that already have high abstraction volumes from direct river abstraction;
2. Map indicating RUs that already have high abstraction volumes in terms of streamflow reduction activities (Forestry);
3. Map indicating RUs that already have high water abstraction in terms of groundwater use (borehole abstraction); and
4. Map indicating RUs that already have high volumes of impoundments and dams.

For the purpose of this assessment, high abstraction volumes are taken as the last two high categories as per classification in the water use total volumes maps above.

Note: it must be noted below (**Figure 7-22 and 7-23**) that both river abstraction and stream flow reduction activities (Forestry) follow the same trend. The reason being that all stream flow reduction activities are regarded as direct river/ stream water abstraction.

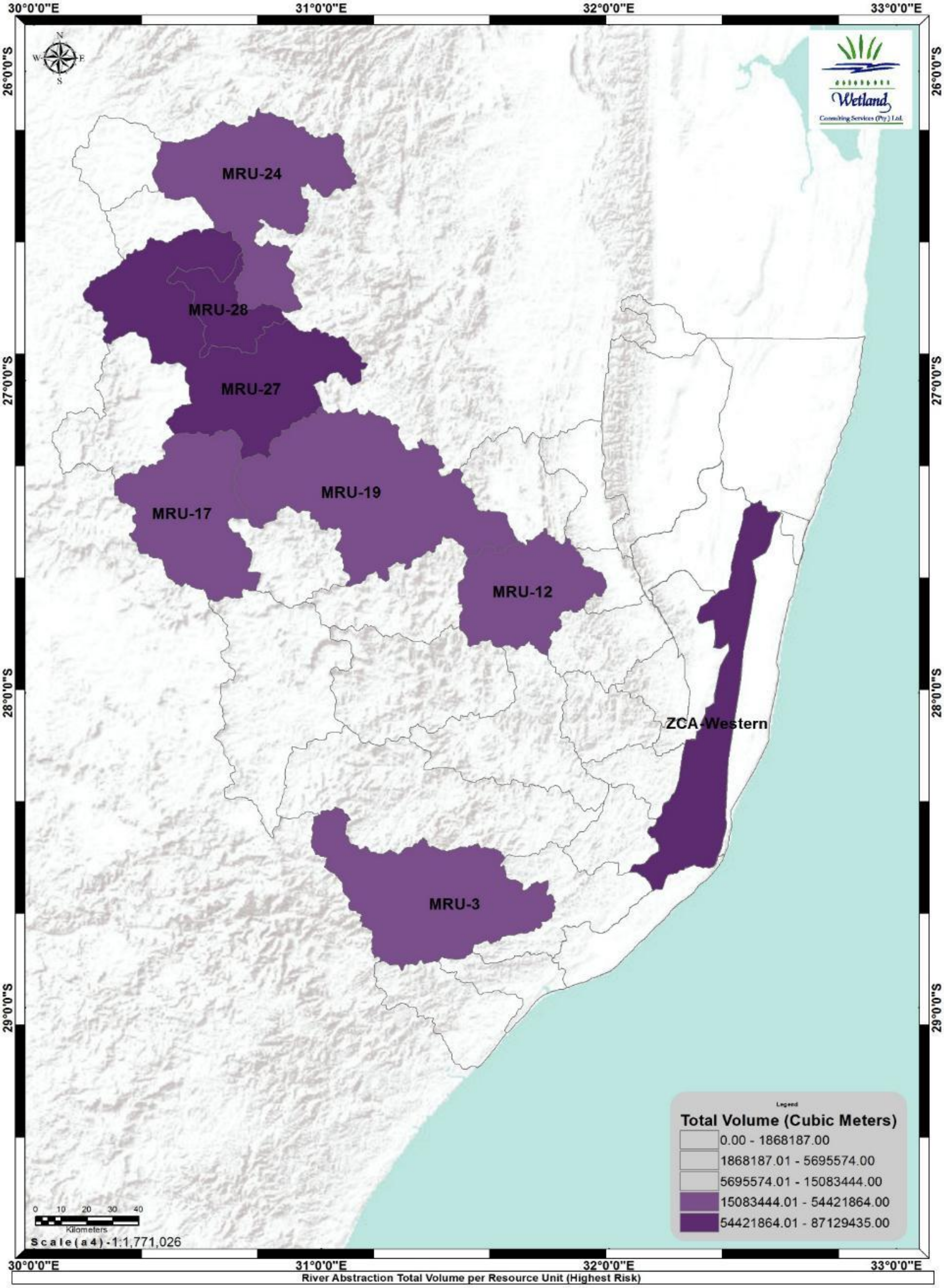


Figure 5-36: Map indicating RUs that already have high abstraction volumes (River) based on WARMS database.

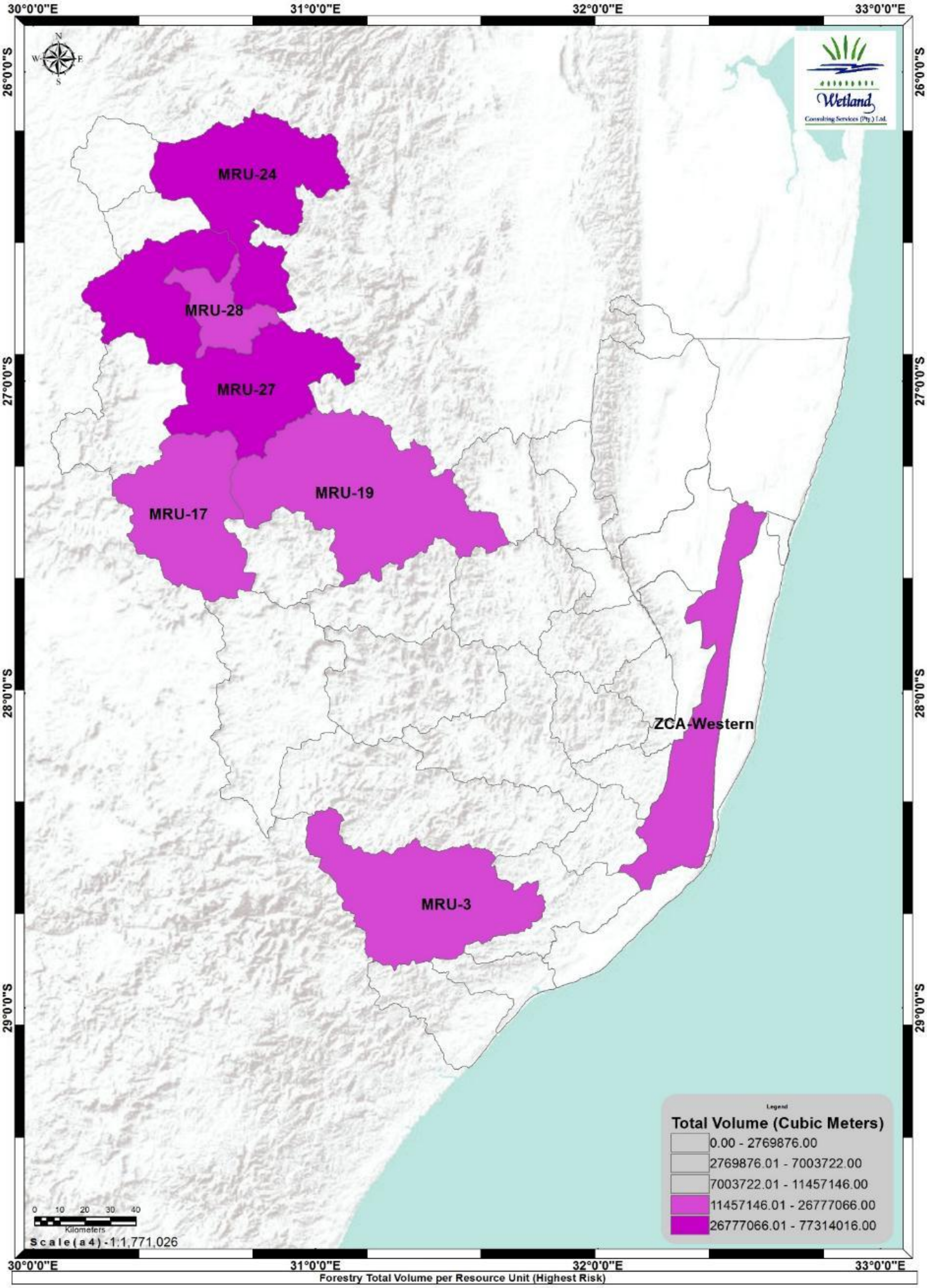


Figure 5-37: Map indicating RUs that already have high abstraction volumes in terms of streamflow reduction activities (Forestry) based on WARMS database.

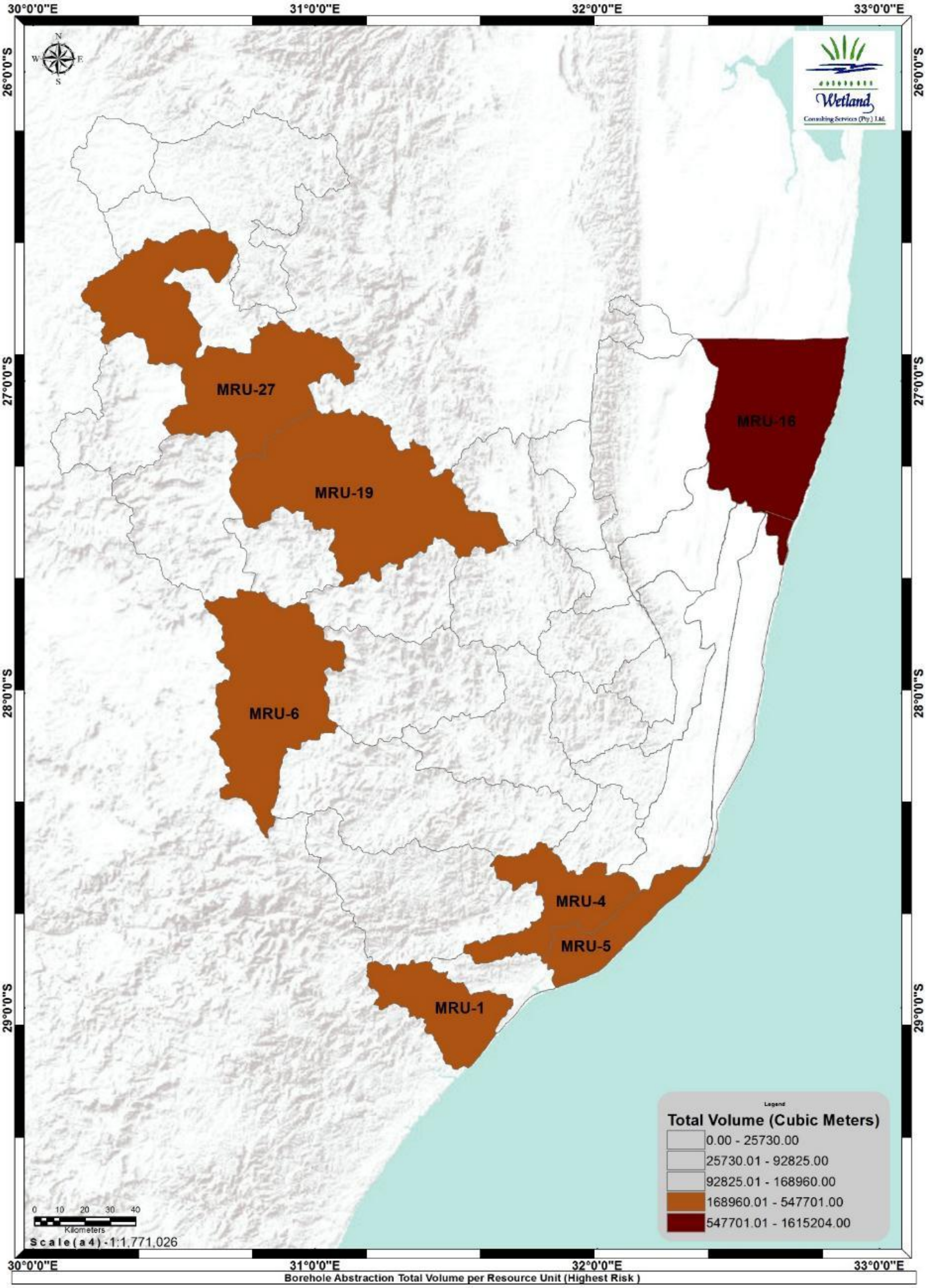


Figure 5-38: Map indicating RUs that already have high abstraction volumes in terms of groundwater (Boreholes abstraction) based on WARMS database.

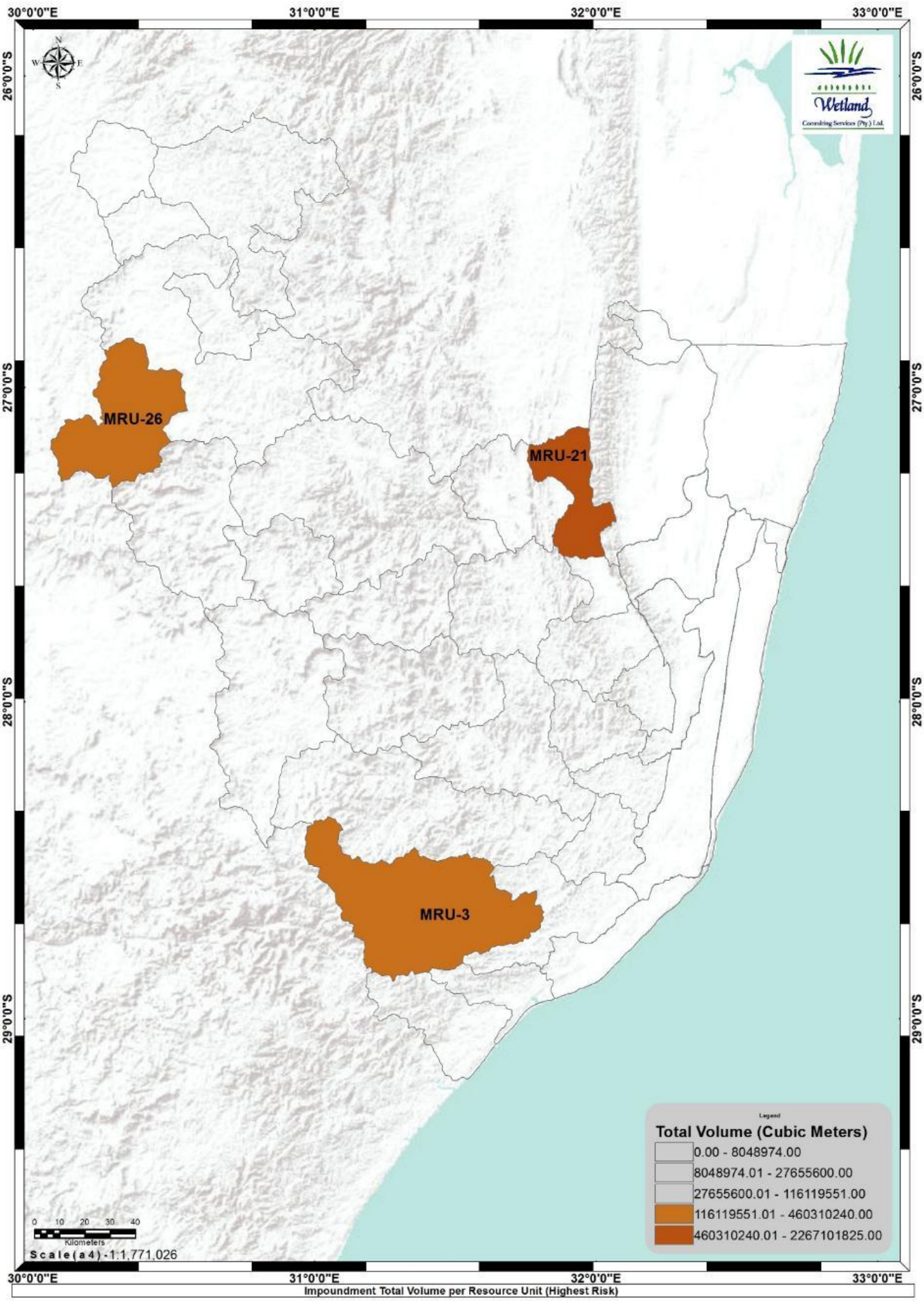


Figure 5-39: Map indicating RUs that already have high volumes of impoundments and dams based on WARMS database.

Based on the analysis of the water uses as indicated above the following threats could be determined, categorized and summarised within the WMA. The wetlands within these RU's are therefore susceptible to the threats as illustrated in the table below. It should be noted that if the extent of these water uses is allowed to increase further in the future without any control measures, the existence of wetlands as they currently occur will be in question as the inputs that sustain these systems will be compromised.

Table 5-2: **Threats analysis per RU based on analysis of available water use information from the WARMS database**

Resource Units	Water Use	Threats
MRU1 MRU4 MRU5 MRU6 MRU16 MRU19 MRU27	Groundwater abstraction	Changes in hydrological regimes and water balance of wetlands. Further increase in groundwater abstraction may cause reduction of inputs to wetlands. Wetlands dry out, leading to a complete loss of wetland habitat.
MRU3 MRU12 MRU17 MRU19 MRU24 MRU27 MRU28 ZCA-WESTERN	Forestry - (streamflow reduction activities) and direct river water abstraction	Changes in hydrological regimes and water balance of wetlands. Increase in extent of forestry and river water abstraction may cause further reduction of stream flow which contributes as water inputs to wetlands. Wetlands dry out, leading to a loss of wetland habitat.
MRU3 MRU21 MRU26	Impoundments, water storages and dams	Changes in hydrological regimes and water balance of wetlands. Further increase of water storage and impoundments may cause reduction of water inputs into wetlands. Wetlands dry out, leading to a loss of wetland habitat. Flooding of wetlands within dam basins also leads to further wetland loss.

In order to develop appropriate management and monitoring guidelines of wetlands within the WMA, it is important to understand the hydrological drivers of the systems as well as the threats to those systems. To this end, a conceptual water balance model of the wetland systems recorded within the water management area are highlighted in the below sections. The concepts indicate and differentiate between systems that are driven by surface water, groundwater and perched groundwater. There are however a number of threats to these systems that require some management and monitoring, particularly to sustain these systems. These threats, particularly with regards to water uses within the WMA, are also discussed and evaluated in detail in the below sections.

5.5 Hydrogeological characterisation and conceptual wetland water balance for the priority wetlands within the Usutu-Mhlatuze WMA

The presence of wetlands in the landscape is largely driven by the underlying hydrogeological conditions of that particular landscape. For example, where the Lake Sibaya and Kosi Bay catchments are situated because of their underlying geological conditions, show that the aquifers are recharged from rainfall. Most of this replenishment is stored within the aquifer and discharges into the lakes, wetlands and to the sea. The wetlands that emerge around these areas are therefore strongly related to the hydrogeological characterization of these systems (Demlie, 2015).

The lithologically controlled aquifers are related to the primary porosity of the underlying sedimentary deposits. The deeper confined aquifer is associated with the weathered, decalcified and locally karst weathered Uloa/Umkwelane Formation deposits which underlie the surficial Pleistocene dune deposits. The shallow unconfined aquifer is associated with the permeable, porous KwaMbonambi Formation dune sands and seasonally is “perched” above the slightly more clay enriched Kosi Bay Formation. Some lateral groundwater seepage along this unconformity results in ponding of water within interdune depressions and watercourses such as the Sihadla (Kosi system), Lake Sibaya drainages and around pans. This shallow aquifer is of extensive occurrence over the higher rainfall eastern and southern portions of the coastal plain, where seepage is the source of the numerous lakes, pans, streams and shallow peat swamps that characterise the surface of the coastal plain (Council of Geosciences, 2012).

In order to develop appropriate management and monitoring guidelines for wetlands within the WMA, it is important to understand the hydrogeological drivers of the systems as well as the threats to those systems. To this end, a conceptual water balance model of the wetland systems recorded within the water management areas are indicated and described in the below sections. The concepts indicate and differentiate between systems that are driven by surface water, groundwater and perched groundwater. There are, however, a number of threats to these systems that require some management and monitoring to sustain these systems. These threats, particularly with regards to water uses within the WMA, are discussed and evaluated in detail in the following sections.

It is however important to note the following (Council of Geoscience, 2012):

1. Within the northern KwaZulu-Natal coastal plain, the importance of groundwater in sustaining the ecological function of the Lake St Lucia estuary/lake cannot be ignored (Council of Geosciences, 2012). The lake level is highly variable due to fluctuations in precipitation, inflow from the rivers and evaporation. Diffuse groundwater seepage along the lake shore and from groundwater fed streams is derived from the dune sand aquifer groundwater “mounds” on the eastern shoreline. A conceptual hydrogeological model simulation conducted for the Eastern Shores, Lake St Lucia showed that the groundwater systems of this coastal lake system are more sensitive to land-use manipulation (such as commercial plantations) than to

any of the climate change scenarios applied. The method shows that the removal of commercial pine over the past decade has resulted in the expansion of wetlands. A secondary effect of fluctuations in the groundwater table is the dynamic effect on the distribution of wetlands on the low relief coastal dune fields.

2. The extensive wetlands and floodplains associated with the lower Mfolozi and Mkhuze River valleys have a profound influence on the hydrology of Lake St Lucia. In the Ozabeni area north of St Lucia there are numerous seasonal wetlands associated with interdune hollows within KwaMbonambi Formation dune fields. Similarly, flooded interdune areas around Lake Sibaya and the Sihadla drainage south of the Kosi lakes are sensitive to development.
3. The Muzi drainage that flows northwards into Mozambique as well as the Musi drainage that feeds the Mkhuze floodplain, are associated with expansive seasonal pans and hygrophilous grasslands. Large areas with low gradients are subject to inundation after high periods of high rainfall through runoff and rising vadose groundwater tables. These wetlands supply the surface water needs of communities and stock during the winter or drought periods when water is still accessible from shallow wells. Despite the low gradients, localised channeling of runoff and flow of water to the Muzi channel can result in destructive flooding that has damaged road infrastructures.
4. The high risk posed by river channels and dams is related to the potential for inundation due to flooding of tributary valleys, floodplains and the sensitive riparian vegetation. The Phongola and Hluhluwe Rivers have been dammed and water releases from the former are planned to reduce the impact on the river ecology. The legacy of channel excavation and diversion on the Mkhuze River floodplain has resulted in significant environmental impacts.

From a hydrological modeling (water balance) perspective, the wetland types that were recorded within the WMA can be represented as follows and these differ depending on the underlying lithology (Copyright CSIR & WCS, 2014).

Legend

GWR – Groundwater recharge
P – Precipitation
ET – Evapotranspiration
OF – Overland flow
CF – Channel flow
FW – Fresh water
SW – Salt water

weathered zone / perched aquifer / soil interflow zone (relative high permeability)

Bedrock with regional groundwater (relative low permeability)

Very low permeable material such as clay or low permeable rock

Wetland soils

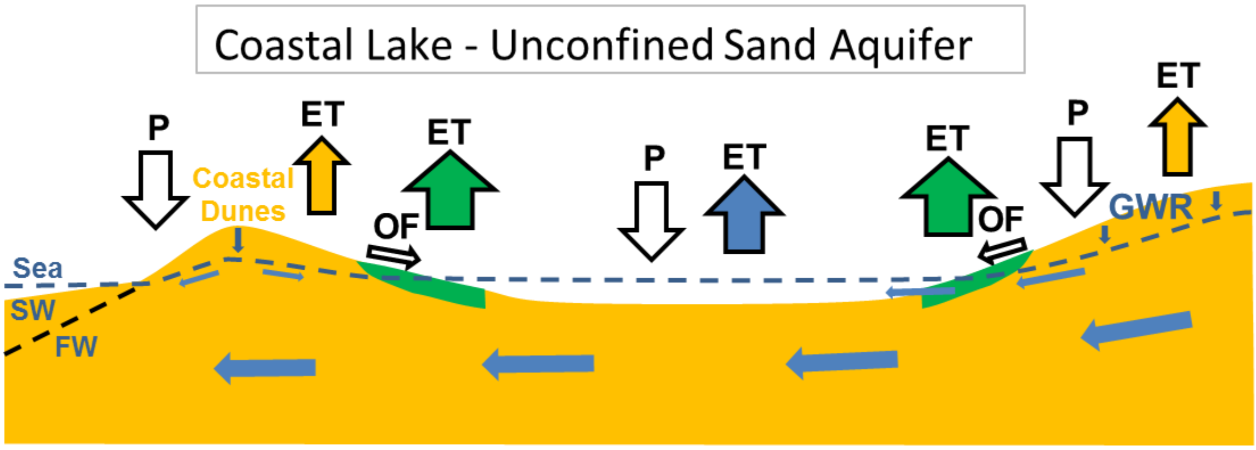
Piezometric head of regional / deep groundwater

Piezometric head of perched / shallow groundwater

Groundwater flow direction

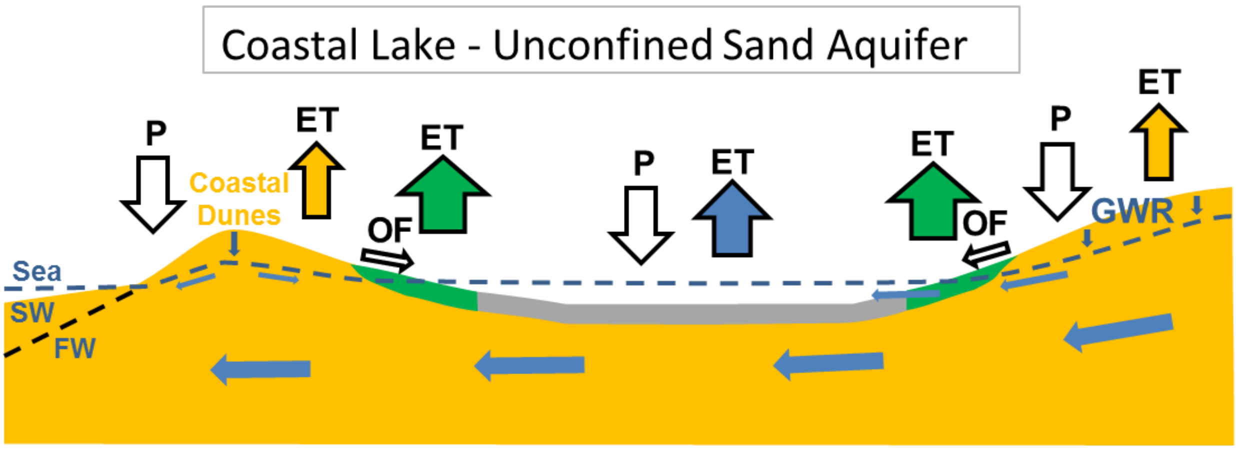
Groundwater recharge (Arrows above groundwater table)

5.5.1 Coastal and Inland systems: Groundwater and surface water driven systems

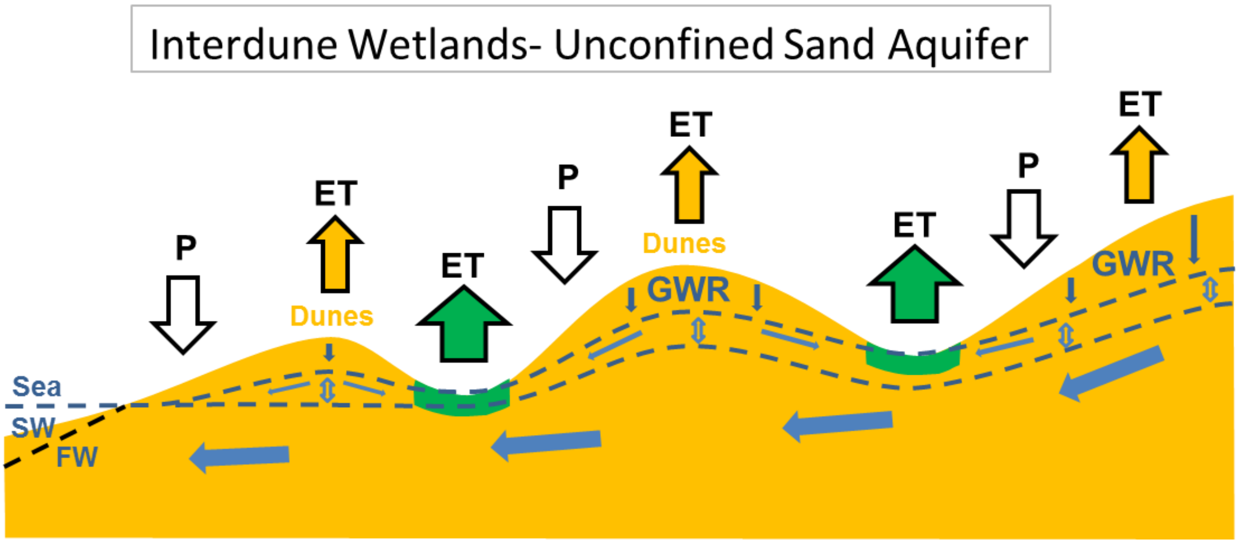


Example: Lake Sibaya

Occurrence: Coastal lakes off the shores of the Indian Ocean between Maputo land and Richard's Bay
Description: The Lake is in direct contact with the regional groundwater. The water level of lake above sea level and the lake floor is below sea level. Lake deposits have formed a confining material (e.g. clays) at the lake floor.

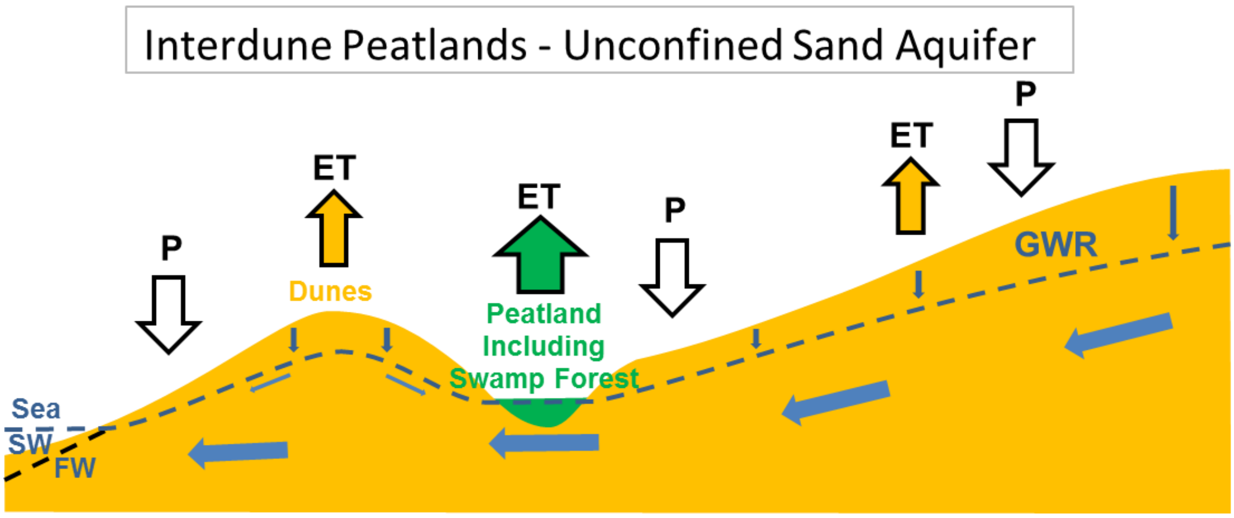


Example: Kosi Lake (Kuhlange)
Occurrence: Coastal lakes off the shores of the Indian Ocean between Maputo land and Richard's Bay
Description: The Lake is in direct contact with the regional groundwater. The water level is above sea level and the lake floor below sea level.



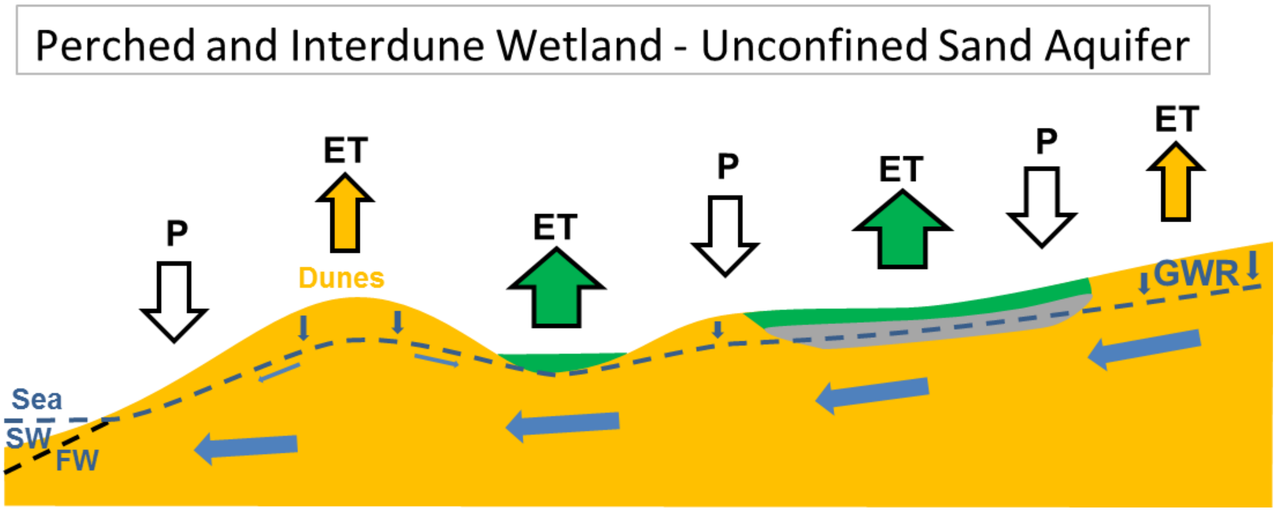
Example: Manguzi area

Occurrence: Interdune wetlands of dunes in close proximity of the shoreline of the Indian Ocean in the Maputo land and further south
Description: The groundwater table is fluctuating seasonally; however the interdune wetlands are in contact with groundwater most of the year.



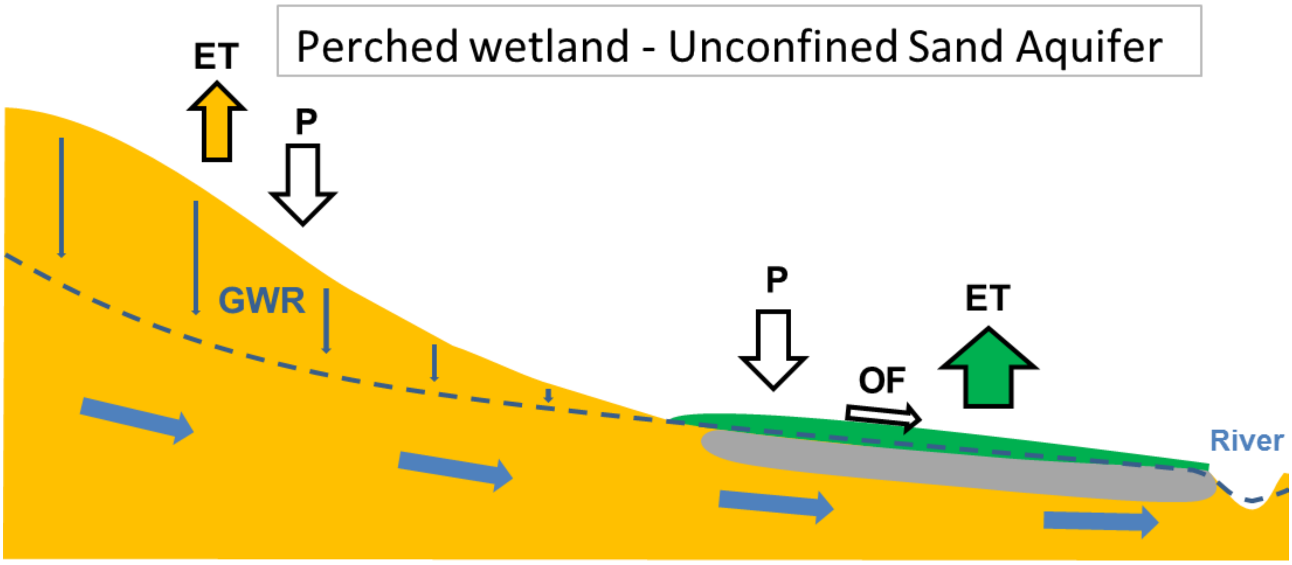
Example: Kosi Bay lake system and coastal forest reserve

Occurrence: In narrow ribbons and patches of low altitude along the Indian Ocean stretching from Maputo land to Port Grosvenor in Pondoland
Description: The peatlands are in contact with perennial groundwater from the unconfined sand aquifer



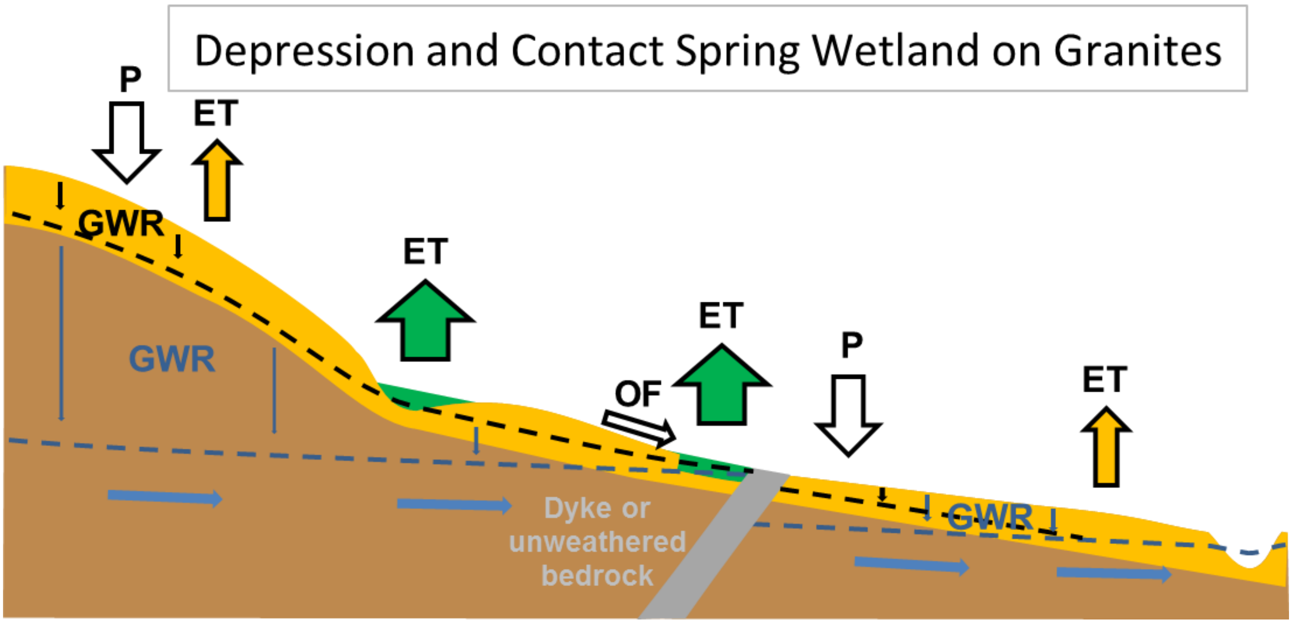
Example: Eastern shores of the Kosi Bay area

Occurrence: Maputo land and further south
Description: Interflow driven hillslope seepage wetlands which are not necessarily linked to the regional groundwater; the interdune wetland is in contact with the regional phreatic aquifer



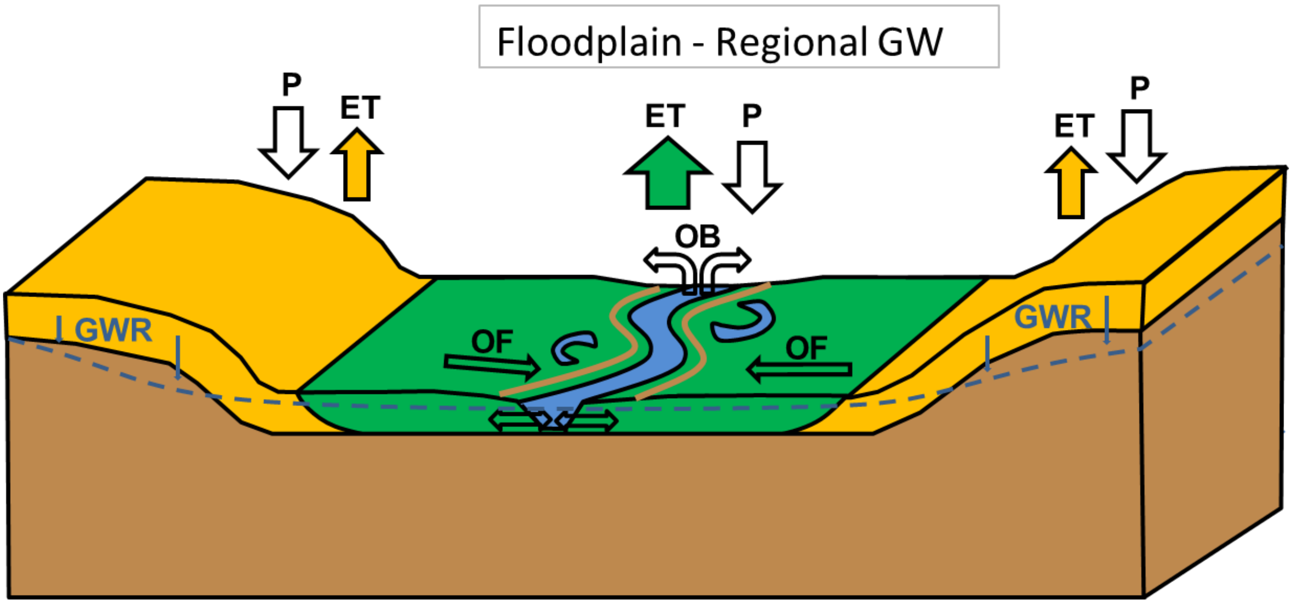
Example: Hillslope seepages in the Richard's bay area

Occurrence: Wider Richard's Bay area
Description: Clay lenses at the bottom slopes cause water to perch in the wetland even when groundwater levels are lower due to seasonal fluctuations



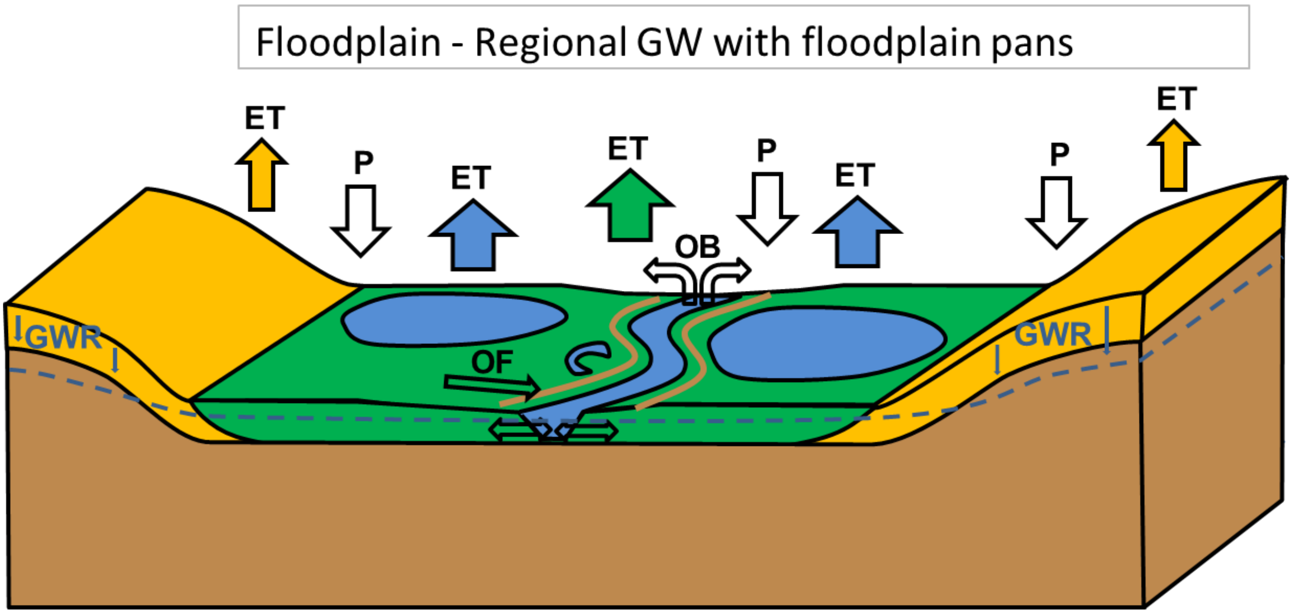
Example: Swazi Era Granites in the Pongola area

Occurrence: In areas where the geology predominantly consists of Swazi Era Granites
Description: Hard rock aquifer with deep groundwater is intercepted by confining material such as unweathered bedrock or intrusive rock such as dolerite dykes causing groundwater to be driven to the surface where it emerges as contact spring or seepage wetland. Perched phreatic groundwater emerges where sediments are shallow or topography causes water to daylight.



Example: Pongola River

Occurrence: Pongola River
Description: Meandering river system with oxbows and overbank during floods. The river is in contact with the regional groundwater table.



Example: Pongola River

Occurrence: Pongola River
Description: The River has formed lakes which are in contact with the river during flooding

The conceptual water balance diagram for the entire St Lucia system is not included in the above diagrams. There is currently a Reserve study being undertaken and the outcome of this study will include a detailed water balance model/diagrams for the system that will enable authorities to set the flow requirements, etc. The outcome of the Reserve study should be included in the list above

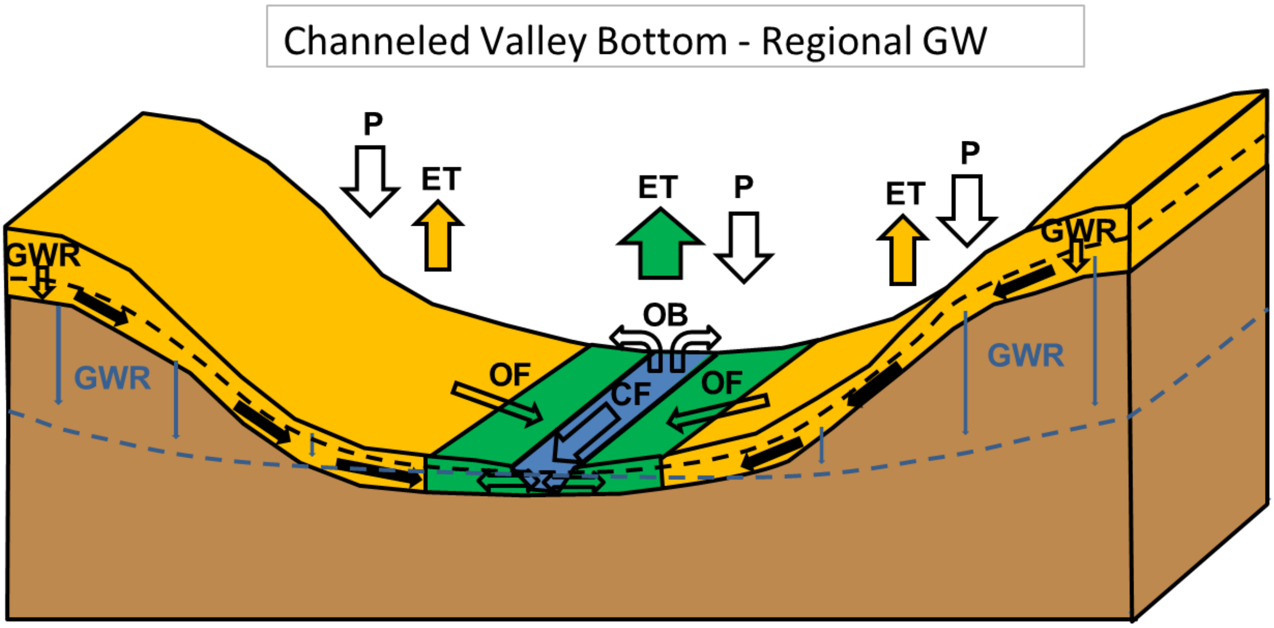
5.5.2 Inlands systems: Perched groundwater and surface water driven systems

Inland wetland systems as prioritised and classified include the following HGM wetland systems. These are described in detail in Appendix 1 and 2. Note: Floodplain systems are not included in the below list as these systems have already been discussed in the above section.

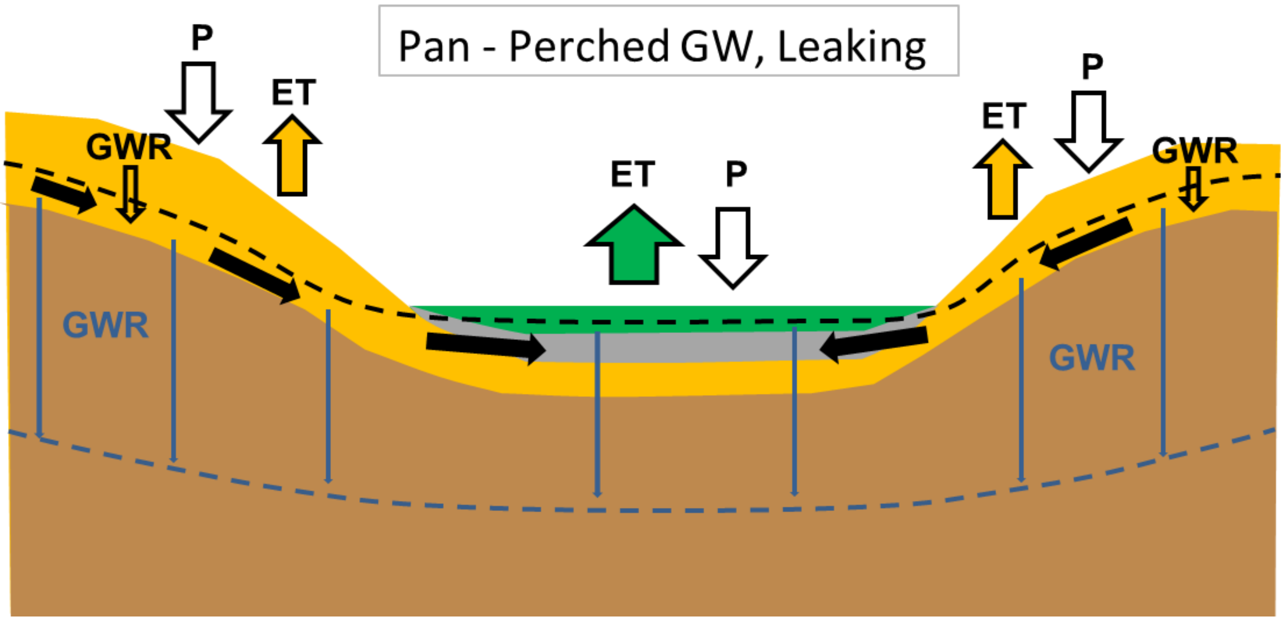
Table 5-3: Table indicating different types of wetland systems within the priority RUs within the WMA

Priority Resource Units	HGM CLASSIFICATION (NCWS_L4)
RU1	Channelled valley-bottom wetland Depression Flat Hillslope Seep Unchannelled valley-bottom wetland Valley head seep
RU4	
RU5	
RU6	
RU16	
RU19	
RU27	

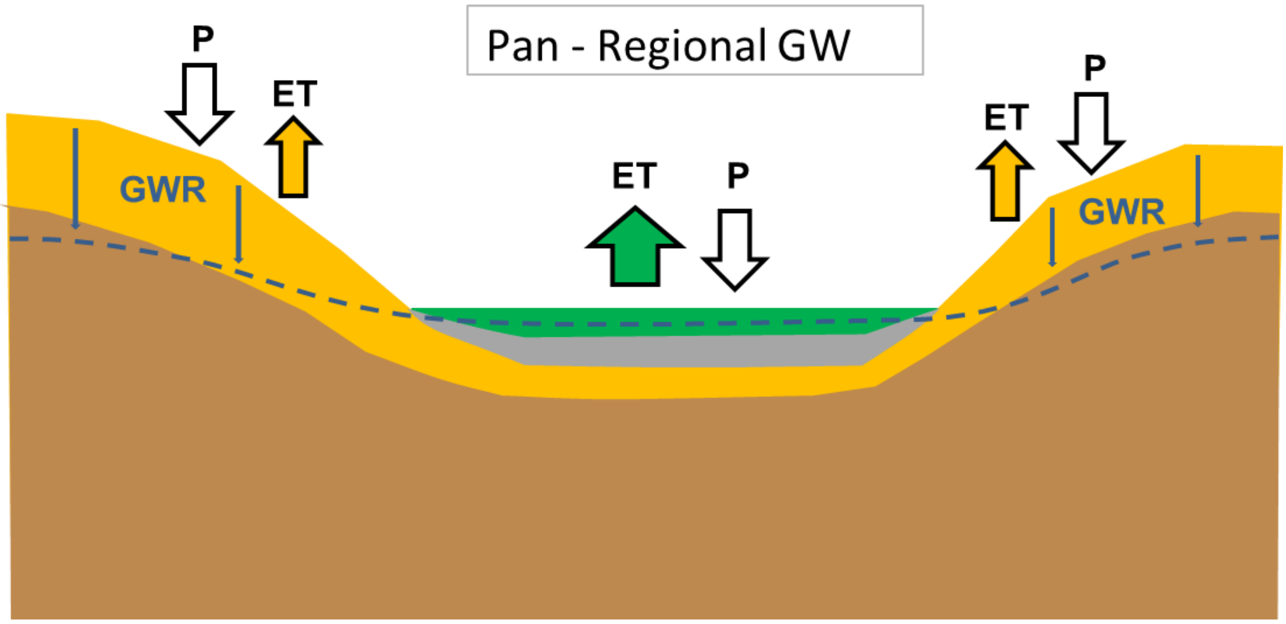
The associated water balance diagrams for these systems is indicated in the below section:



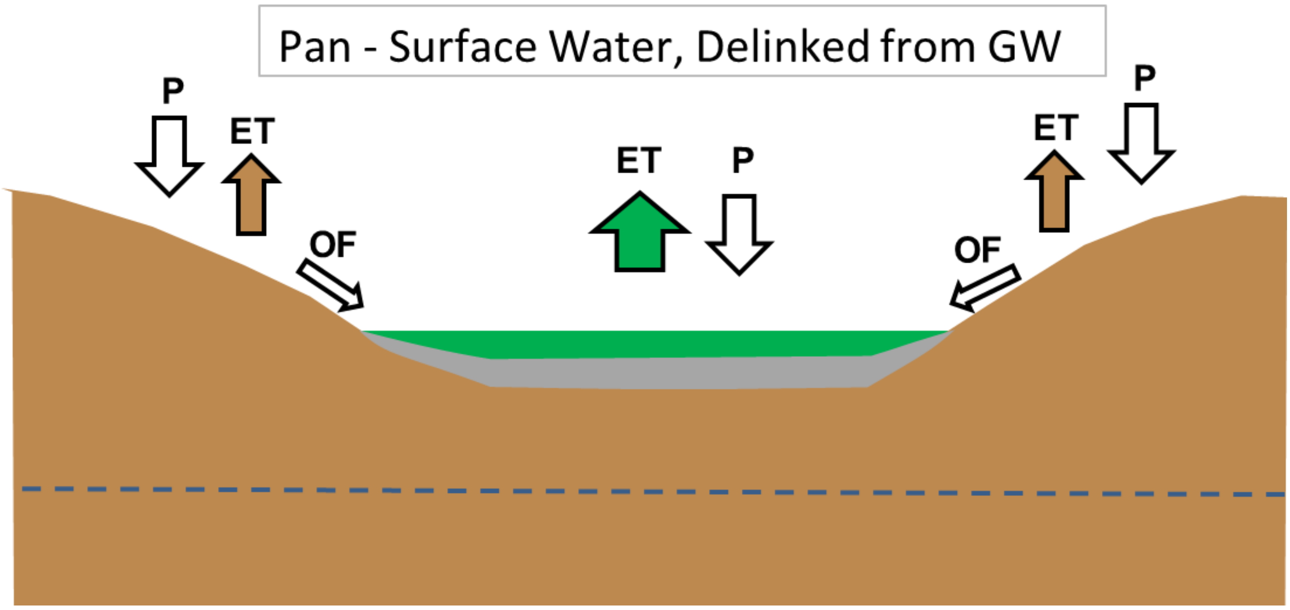
The HGM type of the above example is a channelled valley bottom wetland. Water inputs are mainly from overland flow, rainfall, regional GW and overbanking of the wetland channel. Outflows are mainly overland flow, subsurface flows (towards the rivers) and ET. The regional GW is in contact with the wetland.



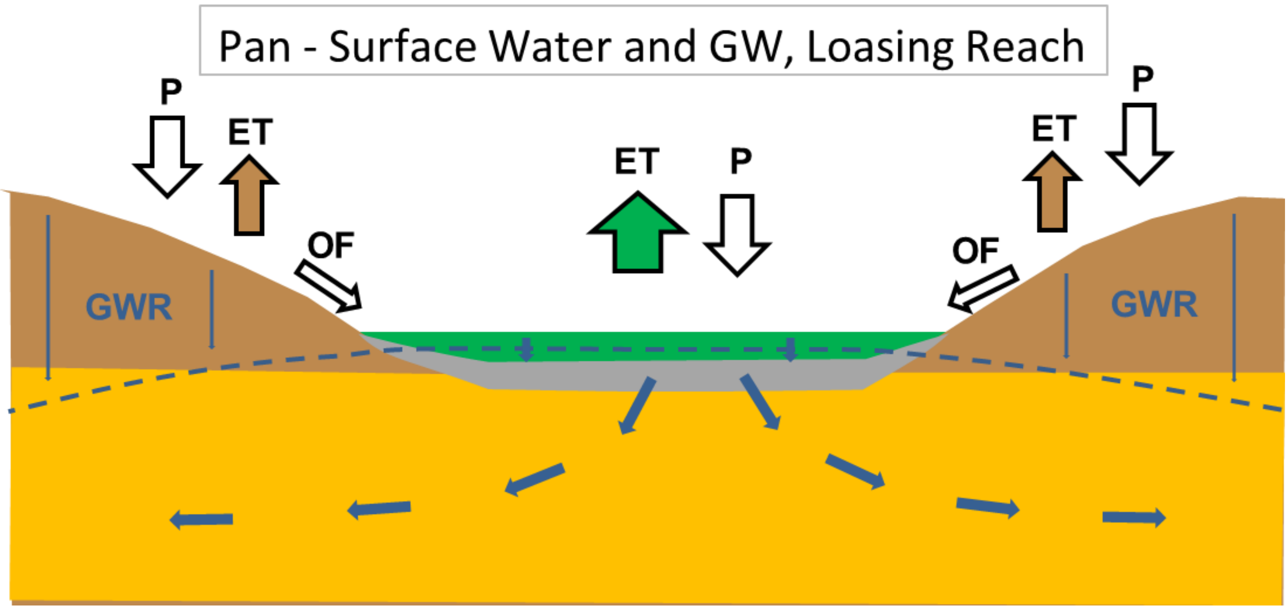
The HGM type of the above example is a pan wetland. Water inputs are mainly from subsurface flow and rainfall. Outflows are mainly ET and drainage into the low permeable rock. The pan water level is a reflection of the shallow perched GW level. Such pans are typically seasonal to perennial depending on the size of the catchment, the permeability of the shallow aquifer and the degree of water percolating into the deeper aquifer.



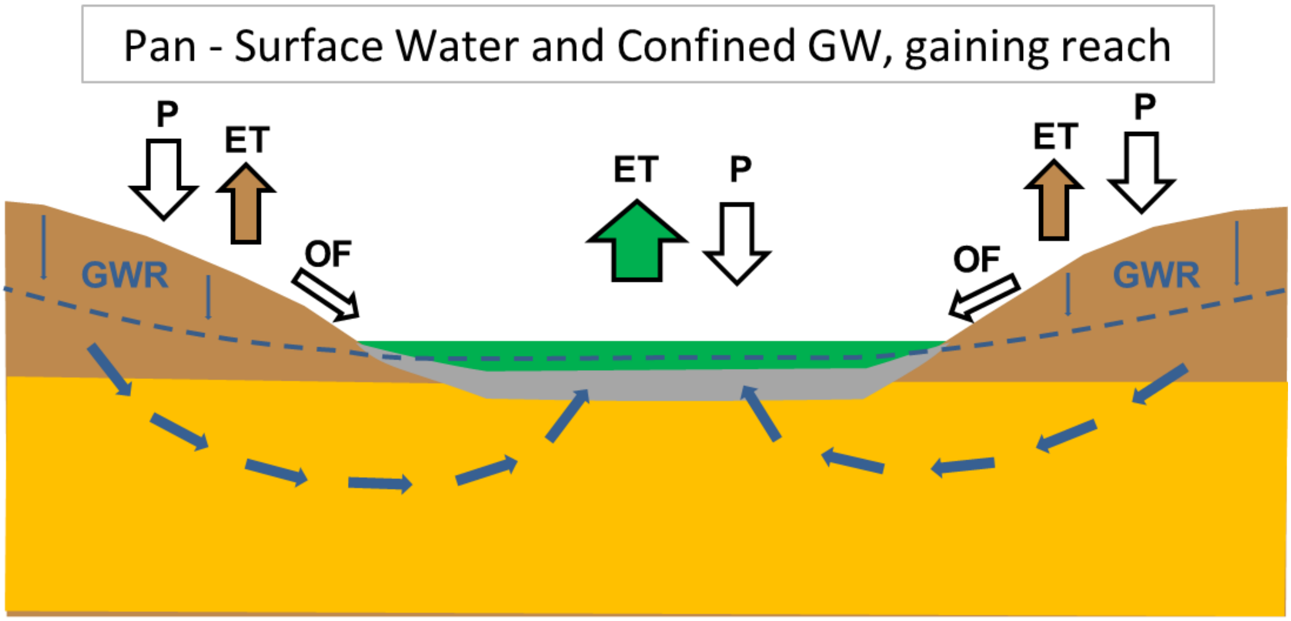
The HGM type of the above example is a pan wetland. Water inputs are mainly from subsurface flow and rainfall. Outflows are mainly ET and, depending on the regional groundwater characteristics to some degree, flows into the aquifer. The pan water level is a reflection of the regional GW level. Such pans are typically seasonal to perennial depending on the size of the catchment, the permeability of the aquifer and the regional setting of the regional groundwater flow characteristics.



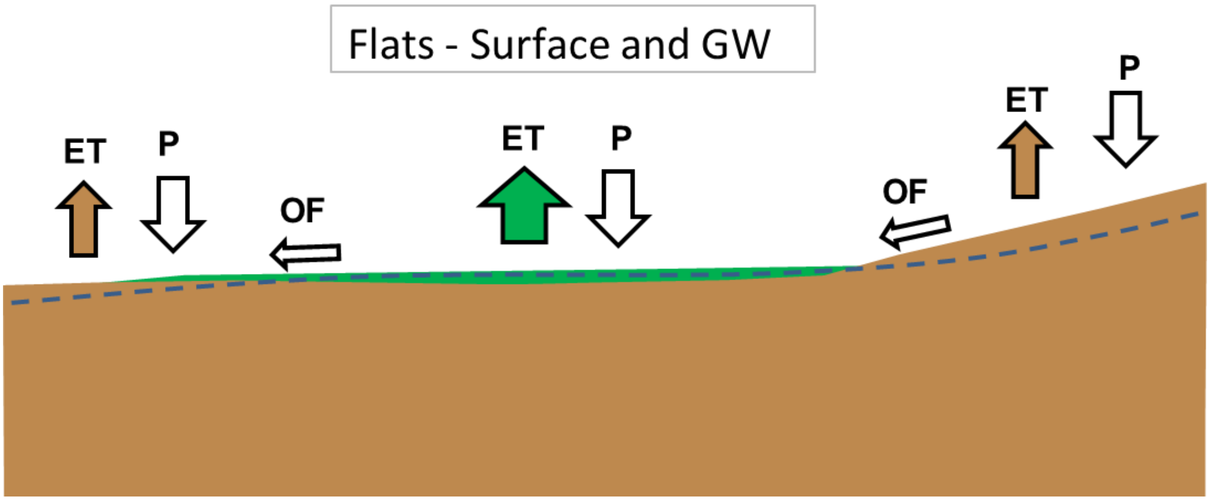
The HGM type of the above example is a pan wetland. Water inputs are mainly from overland flow and rainfall. Outflow is only ET. The pan water level is delinked from any GW. These types of pans are typically ephemeral to seasonal depending on the size of the catchment vs. the size of the pan.



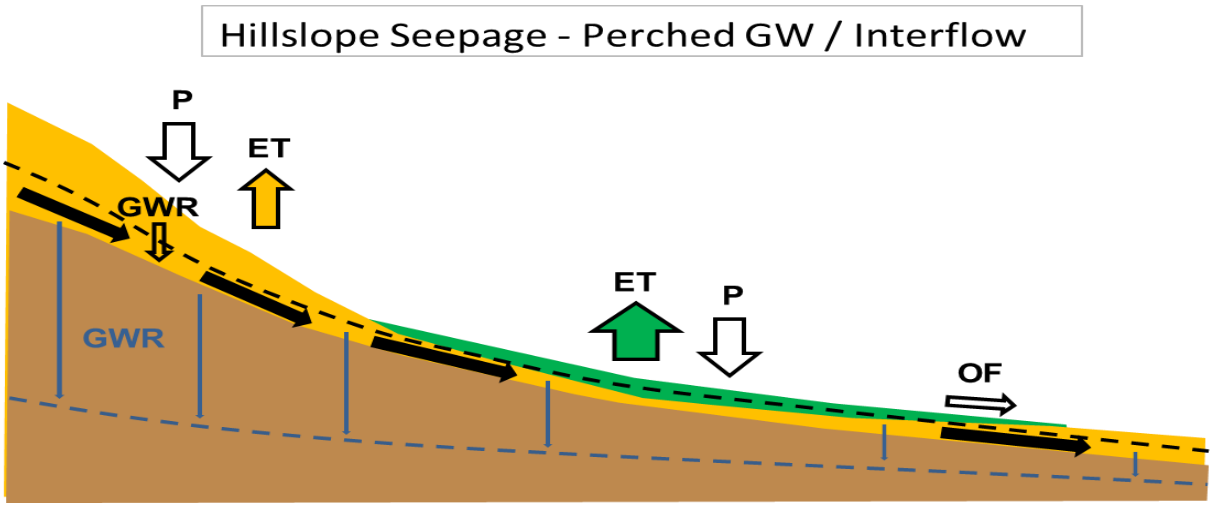
The HGM type of the above example is a pan wetland. Water inputs are mainly from overland flow and rainfall due to the low permeable nature of the pan catchment substrates. The outflows are evaporation and percolation into the lower aquifer. These pans are typically covered with grass and are ephemeral.



The HGM type of the above example is a pan wetland. Water inputs are mainly from groundwater and rainfall due to the artesian nature of the confined underlying aquifer. The outflows are evaporation only. These pans are typically relatively fresh and seasonal to permanent.

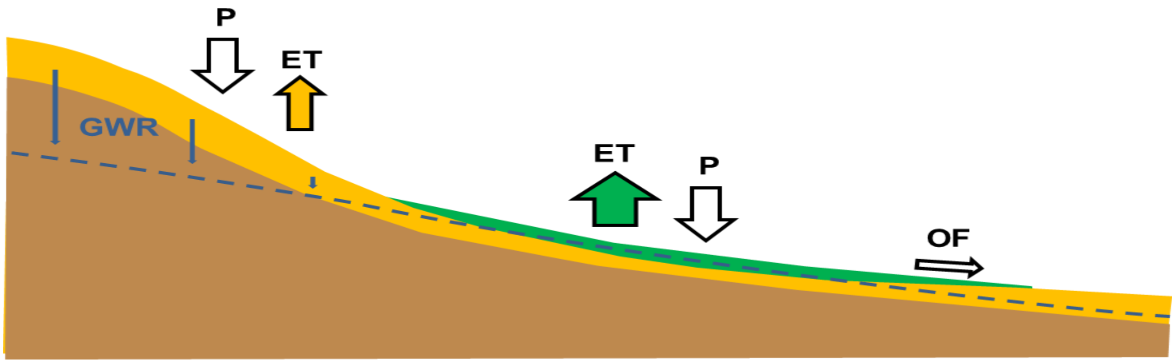


The flat wetland is situated on flat terrain with some catchment above it. Water inputs are mainly from rainfall, overland flow and subsurface flow from regional groundwater. Water losses occur in form of ET and overland flow.



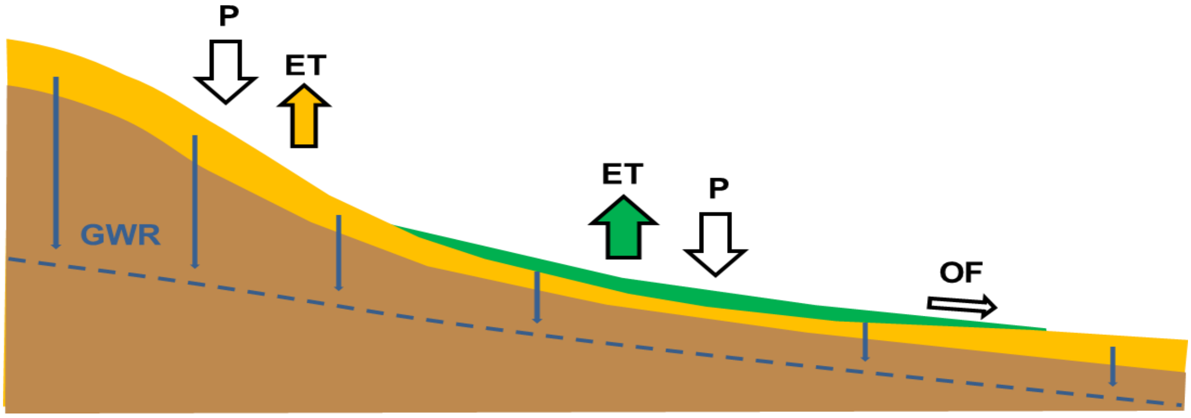
The Hydrogeomorphic (HGM) type according to MM Brinson (1993) is a hillslope seepage wetland potentially linked to a channel. Perched groundwater (GW) typically situated in weathered rock or sand is reaching the rooting zone (wetland soils) due to topographical drivers and changes in thickness of the aquifer along the hillslope. This thinning of the aquifer is typically found in midslopes. The regional GW level is not in contact with the wetland. Water inputs are mainly from rainfall and subsurface flow. Water losses occur in the form of overland flow (sometimes linked to a drainage channel), Evaportranspiration (ET) and subsurface flow.

Hillslope Seepage - Regional GW

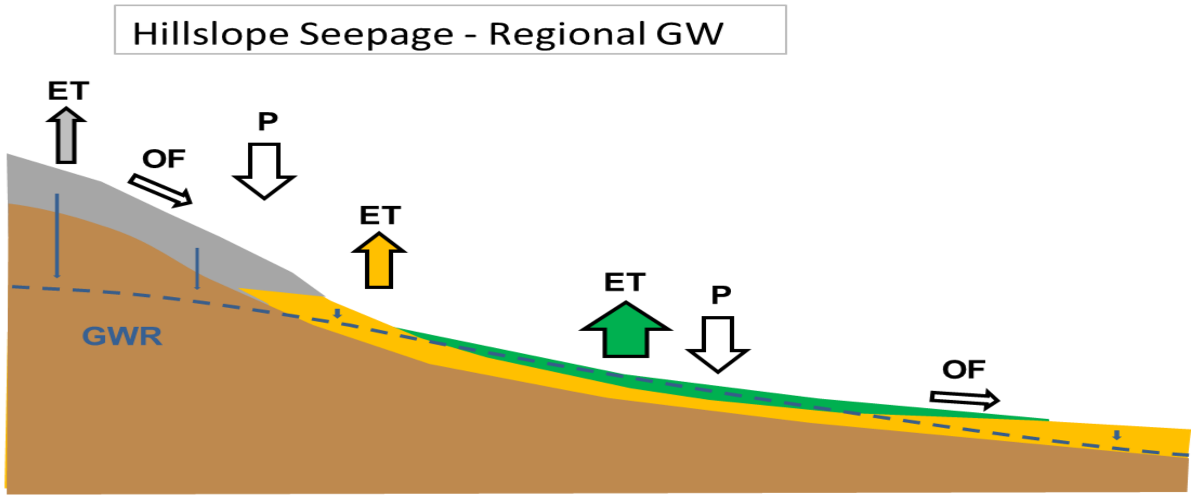


The HGM type of the above example is a hillslope seepage wetland potentially linked to a channel. Water inputs are mainly from rainfall and GW. Water losses occur in the form of overland flow, ET and subsurface flow. The regional GW is recharged by deep soils on the upslopes. Lower permeable conditions in the bedrock cause water to get within the reach of wetland soils. This scenario usually results in a more perennial wetting regime of the wetland.

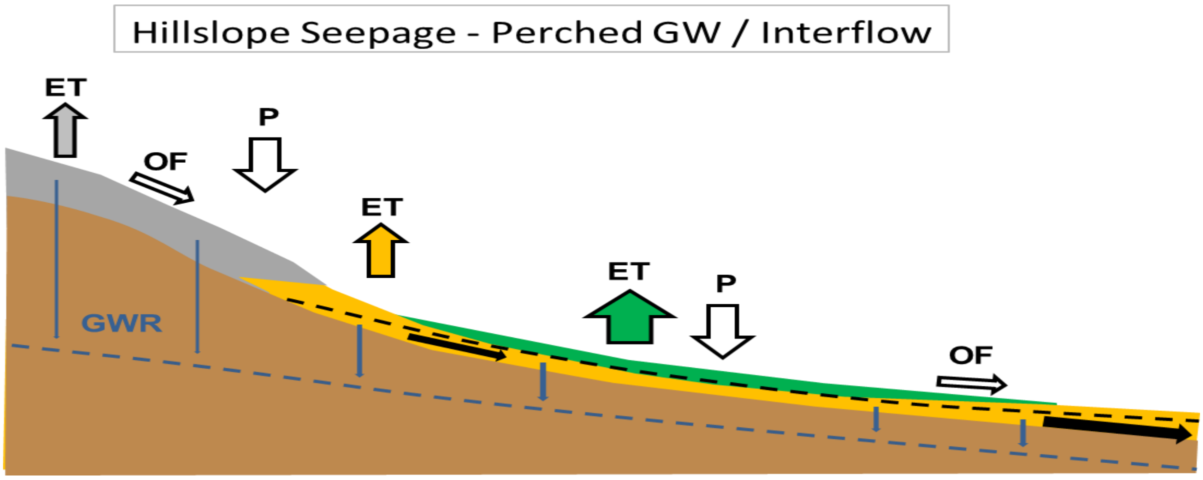
Hillslope Seepage - Rainfed



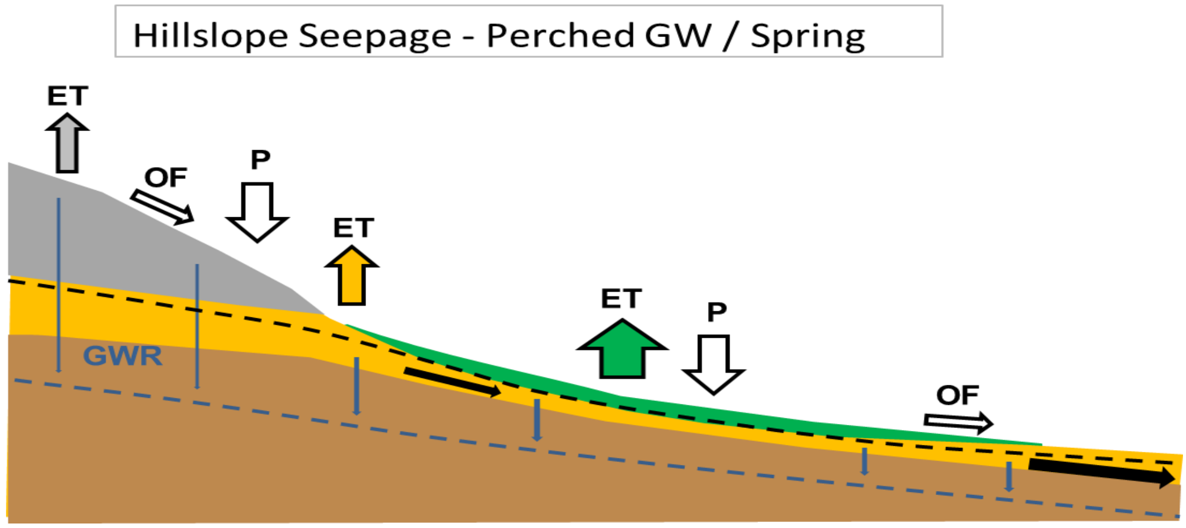
This example does not fit into the HGM type classification. For the purpose of this study, however we have called it a hillslope seepage wetland potentially linked to a channel. Water inputs are from rainfall only. Water losses occur in the form of overland flow, ET and drainage. Permeability's of the weathered and unweathered materials do not allow groundwater water to reach wetland soils. The wetland is only supplied by rainfall which results in a temporary system typically consisting of poor draining soils.



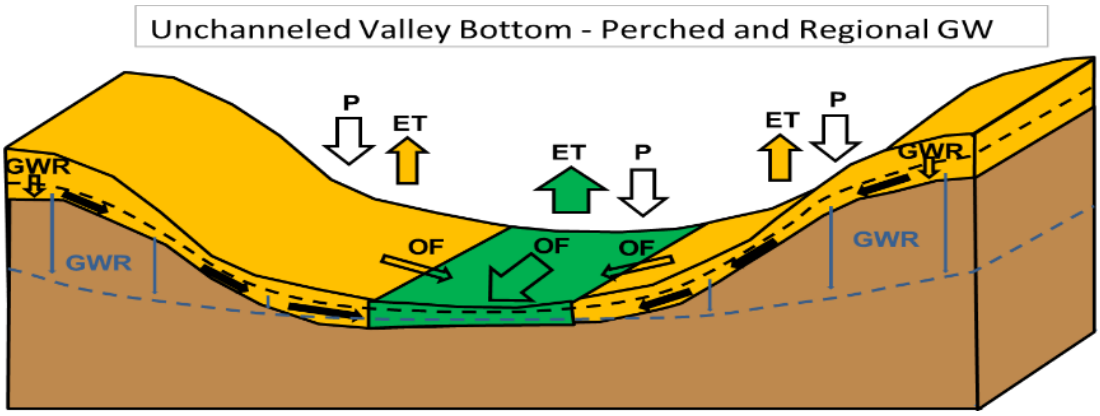
The HGM type of the above example is a hillslope seepage wetland potentially linked to a channel. Water inputs are mainly from rainfall, GW and overland flow. Water losses occur in form of overland flow, ET and subsurface flow. The wetland is supplied by the regional GW which has a semi confined nature due to the low permeable material on the upslopes and crest. Recharge of the aquifer is low at the upslopes and crest.



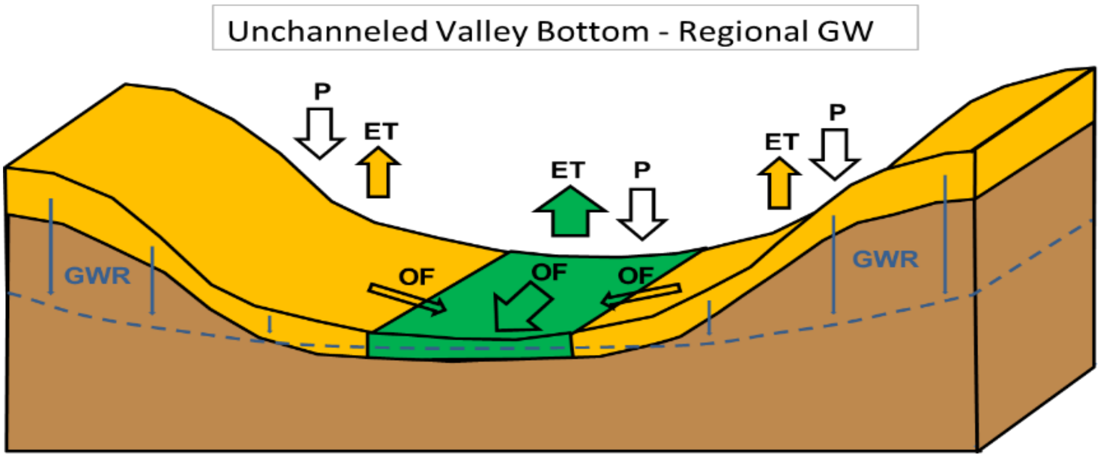
The HGM type of the above example is a hillslope seepage wetland potentially linked to a channel. Water inputs are mainly from rainfall, subsurface flow and overland flow. Water losses occur in form of overland flow, ET and subsurface flow. The regional GW is not in contact with the wetland.



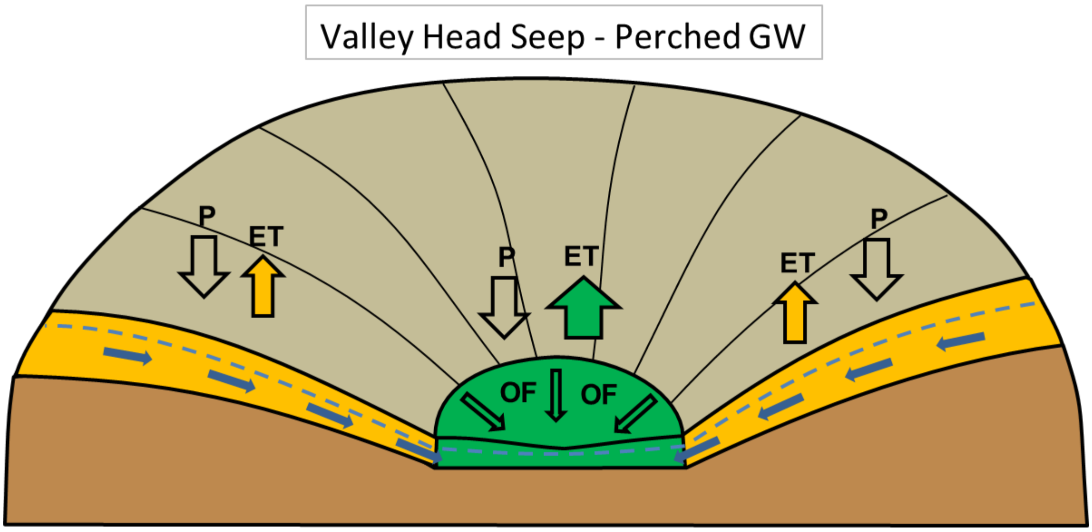
The HGM type of the above example is a hillslope seepage wetland potentially linked to a channel. Water inputs are mainly from rainfall, overland flow, subsurface flow and surface water from a spring. Water losses occur in form of overland flow, ET and subsurface flow. The perched aquifer shows confined characteristics below the low permeable material and becomes phreatic towards the wetland where it emerges in the form of a spring. The regional GW is not in contact with the wetland.



The HGM type of the above example is an unchannelled valley bottom wetland. Water inputs are mainly from overland flow, rainfall, subsurface flow and regional GW. Outflows are primary overland flow and ET. The lowest part of the wetland typically generates lateral overland flow while the higher lying parts generate flows parallel to the hillslopes.



The HGM type of the above example is an unchannelled valley bottom wetland. Water inputs are mainly from overland flow, rainfall and regional GW. Outflows are primary overland flow and ET. The lowest part of the wetland typically generates lateral overland flow while the higher lying areas generate flows parallel to the hillslopes. The regional GW is in contact with the wetland.



The HGM type of the above example is a valley head seep. Water inputs are mainly from subsurface lateral flow from a perched phreatic aquifer, rainfall and overland flow. Outputs are primary interflow and overland flow. These types of wetlands are seasonal to perennial depending on the properties and size of the catchment.

6. PRELIMINARY DETERMINATION OF RESOURCES QUALITY OBJECTIVES (ROQS) OF ALL WETLANDS WITHIN THE WMA

To date, seventeen RUs have provisionally prioritised wetlands/wetland clusters. **Figure 6-24 above indicates** the specific RUs that have selected prioritised wetlands/wetland clusters for which the scenario assessment is undertaken. This includes an assessment of the current water uses and likely changes to the systems as a result of the pressures they are currently experiencing and with increases or changes in these, or the addition of additional threats or pressures, going forward. The idea is to consider the likely trajectory of change from their current state in the context of a decision-support matrix aimed at:

- protecting good condition and important or priority wetlands;
- protecting and improving degraded but important or priority wetlands; and
- Being less protective of degraded and/or less important wetlands.

By adopting this approach, management objectives are set for respective priority and other key wetland systems in each of the prioritised RU's. The idea is that by applying such an approach, one will be able to provide, *albeit* at a very broad and relatively low to medium confidence level, information to help inform what levels of change may or may not be acceptable within a RU in respect of existing wetland resources. Generic resource quality objectives have been determined for the priority and significant water resources, as the means to ensure a desired level of protection. The purpose of the RQOs is to provide limits or boundaries from which it can be deduced whether the resource is being stressed by existing management practices or not. In determining the RQOs, it is important to recognise that different water resources will require different levels of protection. In addition to achieving the water resource management class, the process will allow due consideration of the social and economic needs of competing interests by all who rely on the water resources.

The preliminary RQOs have four critical components to cover each of the aspects of ecological integrity which are necessary for protection of the resource base, namely:

1. Requirements for water quantity, stated as Ecological Water Requirements;
2. Requirements for water quality, which were determined using expert judgment;
3. Requirements for habitat integrity, which encompass the physical structure (morphology) of the water resource, as well as the vegetation aspects; and
4. Objectives for biotic integrity, which reflect the health, community structure and distribution of aquatic biota.

There are currently three sub levels of RQOs proposed to date through various discussion and workshops from different studies given that the methodology to determine wetland RQOs is relatively new. These three sub levels are indicated in Table 6-1 below.

Table 6-1: Table indicating proposed regional sub levels of RQOs determination.

ROQs Levels	Description
Catchment scale wetland RQO's (study area)	This involved developing broad generic RQO's around 'no net loss' principles, conservation plans, wetland types (inferred functionality) and species targets.
RU scale wetland RQO's	This involved developing RQO's based on clusters and wetland types considering development and other risks or impacts that the systems may be exposed to.
Priority wetland RQO's	This involved developing specific RQO's for selected priority wetlands based on expert inputs with specific knowledge of the systems being considered.

It is recommended that only generic regional/catchment scale RQOs for wetlands be considered at this stage for the Usutu to Mhlatuze WMA and the reasons being, though wetland systems have been prioritised this was based on existing information with no specialist onsite assessment using current available and recommended methods/tools and therefore there is no up to date verified ecological integrity and/or health assessment data that could be used as baseline information.

The proposed regional/catchment based RQOs are indicated in Table 7-2 below. It is important to mention that while attempting to reference and/or to implement these RQOs, management and monitoring requirements indicated in section 8 below should be implemented in all respects as part these RQOs.

Table 6-2**: RQOs related to ALL WETLANDS in the Usutu to Mhlatuze WMA**

Wetlands	RU	RQO	Indicator/ measure	Numerical Criteria
All	**All**	There must be no net loss in wetland functioning within the IUA.	Condition of wetlands in the RU. RU level desktop wetland assessment supplemented with a site-level assessment of a subset of indicator wetlands within the RU	• No reduction in hectare equivalents of wetlands in the RU. This include validated FEPA wetlands and other wetland clusters including wetlands with High and Very High EIS. This assessment should be repeated every 3 years. • No reduction in landuse integrity (determined by calculating the Buffer Zone Integrity Score) around validated FEPA wetlands and other wetland clusters. This assessment should be repeated every 3 years. • For a representative sample of Pan Wetland FEPAs and other priority pans, water quality sampling of key cations and anions with chloride levels (concentration) to be set within a 10% variation of the measured value of the chloride concentration over the depth range experienced by the pans. This assessment should be repeated every 3 years.
All	**All**	Validated wetland FEPAs and other priority wetlands as per prioritisation categories in a good condition (equivalent to an A or B ecological category) must at least be maintained whilst wetland FEPAs that are not in a good condition must be improved to their best attainable ecological condition.	Condition of validated wetland FEPAs and other priority wetlands as per categories determined in the RU. RU level desktop assessment of validated wetland FEPAs and other priority wetlands supplemented with a site-level assessment of a subset of these wetlands within the IUA.	
All	**All**	Landuses associated with validated FEPA wetlands and wetland clusters must be controlled to maintain hydrological drivers and linkages (connectivity) between wetlands.	Landuse associated with validated FEPA wetland clusters (determined by calculating the Buffer Zone Integrity Score). Desktop assessment of landuse (Buffer Zone Integrity) within a 500m buffer of validated NFEPA wetlands and other wetland clusters.	
All	**All**	Resource protection measures must be implemented to ensure biodiversity protection, particularly related to validated FEPA wetlands and other prioritised wetland clusters. Such resource protection measures should take into account national and regional wetland conservation targets.	RU level compliance audit of the resource protection measures implemented for the protection of validated FEPA wetlands and other wetland clusters.	
All	**All**	The condition of wetlands with a High and Very High Ecological Importance and Sensitivity must at least be maintained and where possible improved through the implementation of resource protection measures.	RU level compliance audit of the resource protection measures implemented for the protection of wetlands and wetland clusters with High and Very High Ecological Importance and Sensitivities.	
All	**All**	Validated Pan Wetland FEPAs and other important pan habitats, particularly within the Usutu catchment water chemistry must be kept within an acceptable range.	Water quality sampling of key cations and anions.	

7. DEVELOPMENT OF PRELIMINARY MANAGEMENT AND MONITORING REQUIREMENTS FOR THE WETLANDS

7.1 Management and monitoring requirements of priority wetlands and all other wetlands within the Usutu Mhlatuze WMA

While developing management and monitoring requirements for the priority wetlands and associated RUs within the WMA as indicated in Table 8-1 below, it is important to consider the following (Council of Geosciences, 2012):

1. Areas underlain by the KwaMbonambi Formation and Kosi Bay Formation dune sands occurring on the Tshongwe–Sihangwane dune ridge and along the Muzi, Sihadla and Ozabeni wetland areas are prone to the presence of seasonal pans and a rising shallow water table that limits development in these areas where the wetland margins are poorly defined. The high density of communal homesteads suggests that small scale structures are relatively un-impacted by the substrate or terrain.
2. Areas, including the eastern Lebombo foothills, where extensive alluvial gravels occur and the underlying bedrock is the coarser textured basal Cretaceous lithologies, and similarly, large areas underlain by the Vryheid Formation and dolerite in the lower relief parts of the Hluhluwe-iMfolozi Park in the southwest do not pose significant development risk, largely due to their context within a conservation area protected from development. Valley bottoms and deeply weathered tillite within this zone are characterised by hydromorphic and potentially active soils. The extensive carbonaceous shales of the Ecca and the Emakwezini Formations typically weather to produce shallow soils with active clay minerals. Shallow soils on weathered bedrock may pose some unfavourable excavation conditions and mechanical methods of excavation may be required for the installation of foundations and service trenches.
3. Deep sandy soils and the presence of red sand weathering products of the Uloa/Umkwelane Formation sediments are generally associated with low gradient slopes and low ridges raised above areas subject to flooding or shallow water tables. In the southwest the occurrence of siliceous Natal Group rocks or Vryheid Formation sandstones underlying areas of low relief hills are also associated with stable soil substrate

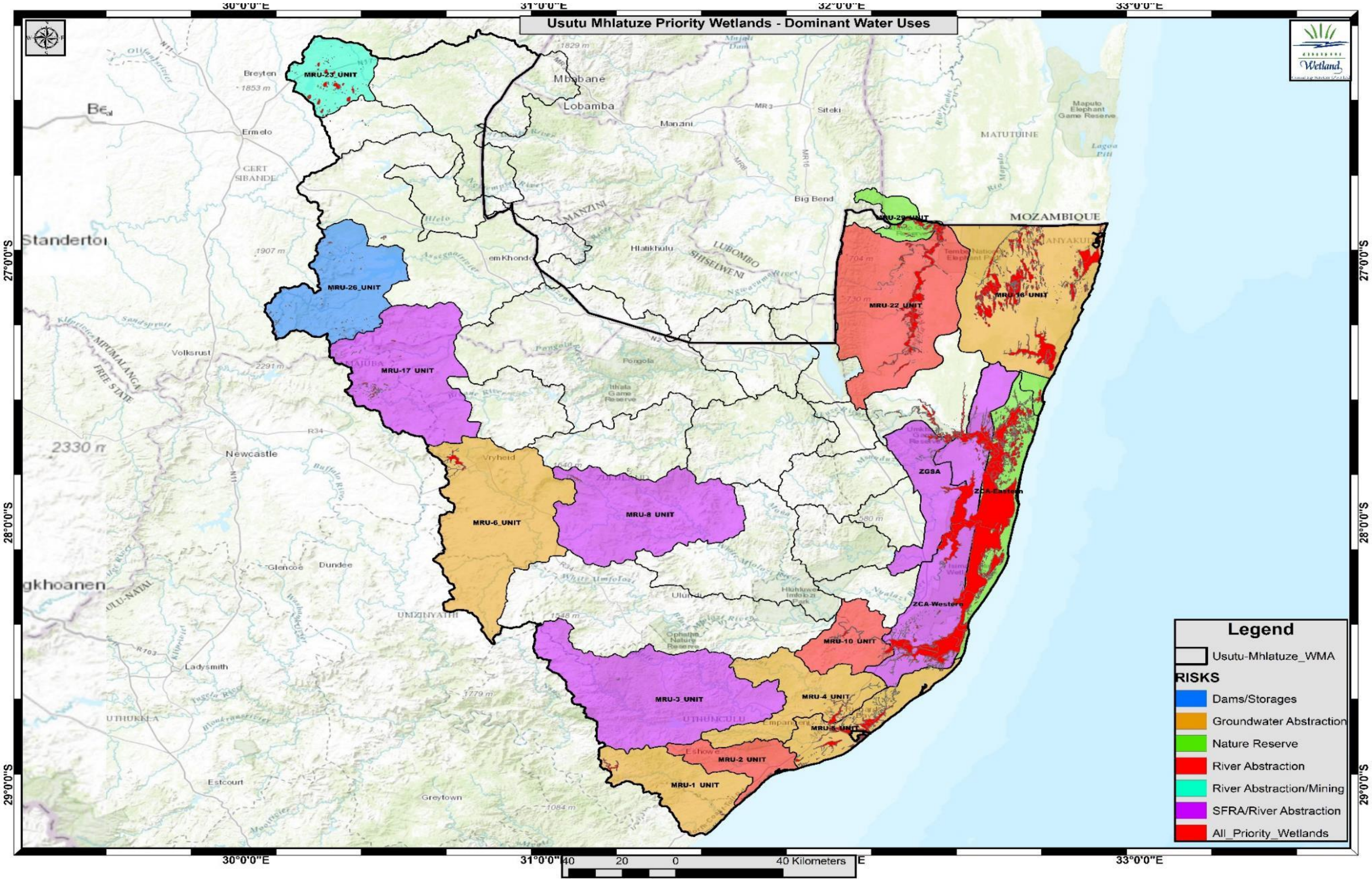


Figure 7-1: Specific RUs associated with priority wetlands with high risks in terms of water use within the WMA.

Table 7-1: Table indicating amamangment and montiring requirements for wetlands within priority RUs

Resource Units	Water Uses - threats	Consequences of Changes	Management Objectives	Managements Measures	Monitoring Measures
MRU1 MRU2 MRU4 MRU5 MRU16	Groundwater abstraction	All the wetland systems are driven largely by groundwater. The wetland systems provide a number of key ecosystem services. • Loss of ecosystem functions; • Changes in salinity; • Reduction in the extent of the lakes and associated wetlands; • Drying out of the swamp forests; • Reduction in the fisheries; • Sea water intrusion and consequential fresh water contamination; and • Loss of tourism opportunities.	• Refer to the relevant Reserve for management objectives for the Kosi Bay and Lake Sibaya. • Abstraction must not exceed the allocable groundwater volume; • Maintain water levels in the wetland to sustain ecological functioning of the system; • The verified PES must be maintained and where possible improved; • Maintain the current groundwater and surface water quality feeding the wetlands.	• Calculate groundwater volumes flowing into the wetland; • Set groundwater level or gradient at a certain distance from the wetland; • Undertake Present Ecological Status (PES) assessment; and • Implement wetland buffer protection measures (hydrological process and ecological buffers)	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; and • Additional monitoring requirements are as indicated in the generic management requirements section below.
ZCA-WESTERN ZCA-EASTERN MRU10 MRU14	River abstraction/ Forestry.	Most of the wetland systems are driven by the combination of groundwater and surface water. The wetland systems provide a number of key ecosystem services. • Loss of ecosystem functions; • Changes in salinity; • Reduction in the extent of the lakes and associated wetlands; • Drying out of the swamp forests; • Reduction in the fisheries; • Sea water intrusion and consequential fresh water contamination; and • Loss of tourism opportunities. • Note: surface water abstraction in these RUs has had a significant impact on the wetlands and is highlighted as a concern.	• Refer to the relevant Reserve for management objectives for Lake St. Lucia. • Abstraction must not exceed the allocable groundwater volume for the groundwater driven systems e.g. • Maintain water levels in the wetlands to sustain ecological functioning; • The verified PES must be maintained and where possible improved; • Maintain the current groundwater and surface water quality feeding the wetlands. • Surface water abstraction must not exceed the allocable volume of water.	• Calculate groundwater volumes flowing into the wetland; • Set groundwater level or gradient at a certain distance from the wetland; • Minimise water loss (implement water conservation measures) • Undertake PES; and • Implement wetland buffer protection measures (hydrological process and ecological buffers)	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; • Success of water conservation measures; and • Additional monitoring requirements are as indicated in the generic management requirements section below.

MRU3	River abstraction	Most of the wetland systems are driven by the combination of surface water and shallow groundwater. The wetland systems provide a number of key ecosystem services. • Loss of ecosystem functions; • Reduction in the extent of the wetlands; • Note: surface water abstraction in these RUs has had a significant impact on the wetlands and is highlighted as a concern.	Refer to the relevant surface water Reserve (2012) for management objectives for the Mhlatuze River system. • Maintain water levels in the wetlands to sustain ecological functioning; • The verified PES must be maintained and where possible improved; • Maintain the current surface water and shallow groundwater quality feeding the wetlands. • Surface water abstraction must not exceed the allocable volume of water.	• Minimise water loss (implement water conservation measures) • Undertake PES; • Implement wetland buffer protection measures (hydrological process and ecological buffers); • Implement current Environmental Water Requirement (EWR);	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; and • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; and • Additional monitoring requirements are as indicated in the generic management requirements section below.
MRU17 MRU19 MRU24 MRU27 MRU28	River abstraction and Forestry	Most of the wetland systems are driven by the combination of mainly surface water and shallow groundwater. The wetlands system provide a number of key ecosystem services. • Loss of ecosystem functions; • Reduction in the extent of the wetlands; • Note: Forest plantations and surface water abstraction in these RUs has had a significant impact on the wetlands and is highlighted as a concern.	Maintain water levels in the wetlands to sustain ecological functioning; The verified PES must be maintained and where possible improved; Maintain the current surface water and shallow groundwater quality feeding the wetlands. Surface water abstraction must not exceed the allocable volume.	• Minimise water loss (implement water conservation measures) • Undertake PES; and • Implement wetland buffer protection measures (hydrological process and ecological buffers).	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; and • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; and • Additional monitoring requirements are as indicated in the generic management requirements section below.
MRU22 (Phongola FP)	River abstraction	The wetland system and associated pans are driven by the combination of surface water and shallow groundwater. The wetland systems provide a number of key ecosystem services. • Loss of ecosystem functions (livelihood and system dependent by local communities); • Reduction in the extent of the wetlands; • Note: surface water abstraction in these RUs has had a significant impact on the wetlands and is highlighted as a concern.	Refer to the relevant surface water Reserve (2012) for management objectives for the Phongola floodplain system. • Maintain water levels in the wetlands to sustain ecological functioning; • The verified PES must be maintained and where possible improved; • Maintain the current surface water and shallow groundwater quality feeding the wetlands. • Surface water abstraction must not exceed the allocable volume of water.	• Minimise water loss (implement water conservation measures) • Undertake PES; • Implement wetland buffer protection measures (hydrological process and ecological buffers); • Implement current EWR.	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; and • Additional monitoring requirements are as indicated in the generic management requirements section below.

MRU3 MRU21 MRU26	Impoundments/dams	Most of the wetland systems are driven by the combination of mainly surface water and shallow groundwater. The wetland systems provide a number of key ecosystem services. • Loss of ecosystem functions; • Reduction in the extent of the wetlands due to loss of supply of water to wetlands; • Loss of wetlands and supporting biodiversity and • Reduction of supply of base and natural flow to rivers downstream and thus to all the users of surface waters especially during periods of low rainfall/flows. • Note: Impoundments of water in terms of total volumes in these RUs has had a significant impact on the wetlands and is highlighted as a concern.	• Maintain water levels in the wetlands to sustain ecological functioning; • The verified PES must be maintained and where possible improved; • Maintain the current surface water and shallow groundwater quality feeding the wetlands. • Surface water abstraction must not exceed the allocable volume. • Volumes of impoundments must not exceed the allocable volume of water.	• Minimise water loss (implement water conservation measures) • Undertake PES; • Implement wetland buffer protection measures (hydrological process and ecological buffers); and • Minimise additional water storage within these RUs.	Monitor: • Water abstraction volumes against Reserve requirements; • Water levels; • Water quality in terms of water quality eco-specifications; and • Present Ecological Status (PES) - the system should not be allowed to deteriorate but should be maintained at the current status or improved; and • Additional monitoring requirements are as indicated in the generic management requirements section below.

Table 8-2 below provides risks analysis and consequences of change as described in the above table on the integrity of the priority wetlands onsite. Best Attainable Status (BAS) Ecological Integrity of wetlands with implementation RQOs - it should be noted from below table that with implementation of RQOs including management and monitoring measures you likely to meet the REC of the wetlands

7.2 Management and monitoring requirements for specific wetlands where peat occurs and was sampled within the Usutu Mhlatuze WMA

Based on the study entitled "Mapping and characterisation of Highveld peatlands resources" Grundling and Marneweck, 1999, Figure 8-2 below indicated RUs and specific wetlands that peat was sampled and confirmed onsite as part of the above mentioned study. Table 8-2 indicates RUs where peat was sampled and confirmed as well as major water uses within these RUs which may cause threads to Peatlands. Due to the presence of within these RUs, specific management and monitoring requirements are needed to be implemented.

Table 7-2: **Major water uses within the RUs were peat was sampled and associated threads that may require to be management and monitored**

Resource Units	Water Use	Threats
MRU1 MRU2 MRU4 MRU5 MRU16	Groundwater abstraction	Changes in hydrological regimes and water balance of wetlands. Further increase in groundwater abstraction may cause reduction of inputs to wetlands. Wetlands dry out, leading to a complete loss of wetland habitat.
MRU14 ZCA-EASTERN ZCA-WESTERN	Forestry - (SFRA) and direct river water abstraction	Changes in hydrological regimes and water balance of wetlands. Increase in extent of forestry and river water abstraction may cause further reduction of stream flow which contributes as water inputs to wetlands. Wetlands dry out, leading to a loss of wetland habitat.

The management and monitoring requirements as indicated in Table 8-1 associated with the water uses as indicated above must be applicable in these RUs as these interventions will ensure existence and management of Peatlands. In addition to the proposed management and monitoring requirements based on water uses above, general land use management is required and the management practices must be applicable where possible:

8.2.1 Management of land use and agricultural lands

Adjacent lands to Peatlands used for agricultural activities (including use of herbicides, pesticides and fertilizers in the vicinity of the wetland) should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetlands. Expansion of cultivation gardens must be restricted to areas inundated with water and where peat layer is thicker than 0.5m. A vegetated buffer of at least 50m should be maintained between any agricultural lands, afforestation and wetland areas so as to limit impacts associated with sedimentation and pollutant runoff. This should also be extended to as much as 50m where steep slopes occur or where intensive cultivation is undertaken. Cultivation techniques must also employ measures to limit erosion and sediment loss from the cultivated fields, i.e. contour ploughing etc. Existing disturbed areas should be used in preference to undisturbed areas Mininise the level of drainage in the peatlands and this can be done by selecting appropriate crops that are tolerant to waterlogging to avoid active draining by furrows. The wettest areas must be left under natural vegetation as far as possible to further limit any possible drainage in the peatlands.it is important to minimize frequency of disturbances as far possible and this can be done by ensure that perennial crops are selected as options as these limit consistence disturbances of the peatlands. Rehabilitation of degraded peatlands is recommended and this may include plugging of drains and removal impediment structures and alien vegetation invasive as these practices may improve integrity of the peatland.

8.2.2 Fire management

With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm per annum), an area of wetland should be burnt every 4 to 5 years. Where possible, burning should be undertaken on a rotational basis. Cool and patchy burns should be promoted where possible by burning when relative humidity is high and air temperatures are low, preferably after rain. Mosaic burning in wet years during wet cycles must be allowed and it must be ensured that peat is inundated during burning period. The peatland must be monitored after fires to detect any peat fires. Further reference to this must be according to the recent published SANBI Grazing & Burning Guidelines (SANBI, 2014). A burning management strategy should be included in the Wetland Management Plan for this purpose.

8.2.3 Control of alien invasive plants

Alien invasive plants (particularly Pinus ssp., Poplars, Black wattle, Eucalyptus and Willows) occurring within the wetlands and sub-catchments pose a threat to wetland functioning and should ideally to be removed as part of rehabilitation activities. This should be considered for future rehabilitation planning cycles. Possible introduction of biological control to control spreading of this weed must be investigated and included as part of alien vegetation control programme to be instituted where possible in specific areas.

8.2.4 Livestock management

The majority of rural communal lands are utilised for agricultural activities, Department of agriculture must assist communities and ensure that livestock numbers are maintained within acceptable carrying capacities to ensure that species composition is not compromised and trampling does not lead to further erosion of wetland areas. If necessary, the Department of Agriculture should be called upon to determine the grazing capacity for the bioclimatic region in which the wetland is located. Where important biota occur, further advice should be sought by an Agricultural Extension Officer. Where cattle trampling is causing significant disturbance near drinking points, alternative water sources should be provided or the area hardened to reduce the potential for erosion. A livestock management and grazing plan should be included in the specific Wetland Management Plan for this purpose.

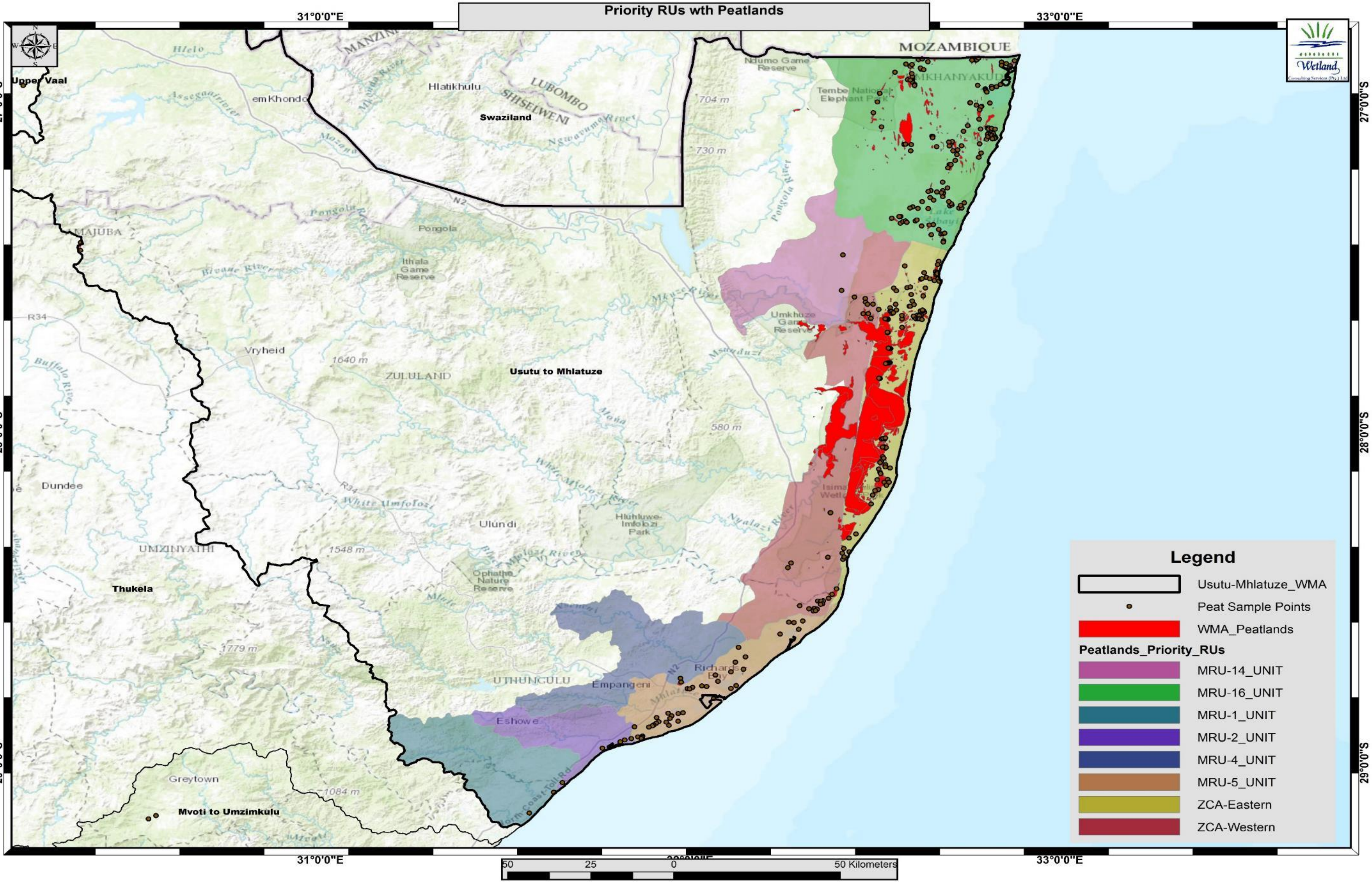


Figure 7-2: Priority wetlands where peatlands occurred including sample points within the WMA.

7.3 Generic management requirements for all the wetlands within the WMA for any water use licence application

7.3.4 Urban developments and associated infrastructures

7.3.4.1 General requirements

The ecological functioning of wetland systems is influenced by both flow and non-flow related issues. The correct management of these issues has the potential to improve the ecological functioning of the systems and therefore the goods and services they provide. The recommendations included below should therefore be incorporated into any Water Use License Application that may affect these systems.

Impacts on wetlands outside the immediate boundaries of the proposed activity's footprint due to the construction of housing and urban infrastructures should be managed and strictly controlled to minimize damage to the wetlands and therefore to their functioning. This should include the following mitigation requirements:

- Operation and storage of equipment in wetlands is to be prevented, unless authorised;
- Crossings by construction vehicles and/or any other vehicles should use existing roads where possible, and disturbance and trampling of wetlands should be minimized as far as is reasonably possible;
- Where applicable, disturbed zones (i.e. for those areas that will not form part of the development operational footprint but were disturbed as part of the construction activities) should be rehabilitated and re-vegetated using site-appropriate indigenous vegetation and/or seed mixes;
- Alien vegetation should not be allowed to (re)colonize the disturbed wetland areas;
- Rehabilitation of disturbed wetland habitat should commence during and immediately after construction is completed. A wetland specialist should oversee or audit this process;
- No construction camps should be allowed in or within 30m of the edge of the wetland area;
- No stockpile areas should be located in or within 30m of the edge of the wetland area;
- Where construction is proposed to take place within a wetland or its immediate catchment, this should take place during the low flow (winter) months where possible, in order to minimise the risk to the hydrology of the systems as well as to prevent excessive sediment and debris being washed into wetland areas;
- Areas in and around the wetland should not be cleaned, graded and ditched/trenched more than a week before construction activities commence. The aim is to prevent erosion and sedimentation and the collection of run-off trench water which has high sediment content;

- As noted above, stockpiling of soil and the construction camps must be stored clearly away (at least 30m where possible) from the wetland edge to prevent soil being washed into the wetland;
- During the construction and operation phase erosion and siltation measures should be implemented (e.g. the use of temporary silt traps or sediment fences downstream of construction);
- The use of machinery within the wetland may lead to compaction of soils and vegetation. This will lead to decreased infiltration of rain water, increased run-off and will limit re-vegetation. It is thus recommended that all compacted areas or areas where flow has been diverted or drained for construction purposes (that do not form part of the actual infrastructure footprint) be rehabilitated. Compacted areas should be ripped and disked or landscaped (where necessary) to approximate the natural slope of the area followed by re-seeding (where appropriate). Method statements should be developed indicating how this rehabilitation will be done.
- Slope, bank, channel, and/or drainage stabilization measures as well as measures to reinstate the pre-development hydrology (including both surface and sub-surface hydrology) should be implemented as far as is reasonably possible as part of wetland mitigation measures; No threatened flora should be collected or harvested;
- No fauna, especially threatened fauna, should be hunted or poached; and
- No flora, especially threatened flora, should be collected or used.

7.3.4.2 Measures to prevent net loss of, and improve current, wetland functioning

Measures must be put in place to prevent any further net loss of wetland functioning and improve the current functioning of the remaining wetlands within and adjacent to the proposed activity operation. In cases where there will be a residual loss of wetland area, no net loss of wetland functioning can be achieved through the rehabilitation, protection and management of the remaining wetlands to achieve a net gain in functional hectare equivalents. The rehabilitation activities should be targeted to achieve a net gain in functional hectare equivalents so as to meet the regional RQO of no net loss of wetland functioning in the affected RU's. It is therefore recommended that:

- A rehabilitation, management and monitoring strategy/plan should be developed and implemented to protect the remaining wetlands within and adjacent to the footprint of the proposed development area and this should include measures to improve the functionality of the wetlands in terms of ecosystem services including, but not necessarily restricted to, water supply, water quality enhancement and biodiversity support.

7.3.4.3 Specific requirements

In areas where rehabilitation measures will be implemented, or where activities will take place close to or in wetlands, the wetland management plan and biodiversity action plan should form the basis for best management practices.

7.3.5 Linear infrastructures and associated crossing

All the conditions as mentioned above should be applied as detailed, in addition the following for linear infrastructure:

- Where conveyors, pipelines, culverts, roads, railway lines, powerlines, drains or any other infrastructure or servitude crosses or impacts a wetland, crossing method statements should be developed indicating how impacts during the construction period will be minimised and managed.

7.3.6 Mining and associated activities

All the conditions as mentioned above should be applied as detailed and it must also be noted that it is currently impossible to effectively mitigate all the impacts resulting from possible Acid Mine Drainage (AMD). The following mitigation is however recommended:

- It is recommended that prior to any new mining activities taking place, suitable clean and dirty water diversion/separation and storage facilities be put in place to deal with possible AMD and prevent contamination of the wetlands adjacent to and downstream of any mining operation;
- Suitably designed berms/drainage channels should be constructed both below and above stockpiles and discard facilities to enable the separation of clean and contaminated water;
- Water quality in the system should be regularly monitored according to an appropriate protocol that will need to be put in place according to a regular schedule and for recommended variables including the water quality Ecospecs and appropriate and timeous remedial interventions made in the case of non-compliance;
- Water treatment, which could include the passive treatment/management of water quality as and when the technology allows and if proven to be feasible, must form part of the mining operation to deal with existing and possible future sources of contamination from mining. It is important to ensure financial and logistical capacity for long-term maintenance of treatment or infrastructural requirements to protect the adjacent and downstream wetland and river systems from water quality impacts resulting from mine water contamination.
- As a minimum, any discharge water should meet the catchment standards as indicated in the EMP and other relevant authorizations;
- Where clean water is discharged into the environment from water treatment or from infrastructure such as detention facilities, anti-erosion measures should be put in place;

- The risk to the receiving environment in terms of water quality, flow modification, erosion and biological effects must be established and assessed and appropriate mitigation put in place to deal with these;
- If proposed mining operations are located in the headwaters (watershed) of rivers, water of an appropriate quality should be put back into the rivers to supplement the water lost from dewatering;
- The decant of treated water back into the rivers should be done in such a way that it mimics how water would naturally enter the system as far as is reasonably possible, and suitable protection measures must be put in place along the stream channels to prevent erosion and sedimentation of the channels and modification of the channel/river morphology;
- Methods should be investigated and implemented for supplementing/supplying treated water to those wetlands outside development areas. The method of introduction of the treated water must mimic the natural flow as far as is reasonably possible. These should include ways of introducing the treated water back into the wetlands in as diffuse a manner as possible in order to replicate the pre-development hydrological characteristics; and
- Methods should be put in place to limit the amount of water entering the voids thus further reducing the risks of long-term decant into adjacent and downstream/affected wetlands.

7.3.7 Monitoring requirements

A monitoring programme should be developed to monitor the implementation and success of the protection measures for the rivers and rehabilitation and protection of the remaining wetlands. The feasibility of installing piezometers to monitor the wetting regimes (water balance) in the wetlands that form part of any mitigation and/or rehabilitation strategy should also be considered.

7.3.7.1 Wetland condition monitoring

A monitoring programme must be developed to monitor the condition/health/state of the wetlands associated with the affected sub-catchments of the RUs. This must be done in order to determine whether or not the Recommended Ecological Category (REC) for each of the wetlands is being met or maintained as required. The monitoring strategy must be developed by a suitably qualified wetland specialist and submitted to the DWS for review and approval. The use of appropriate wetland assessment tools should form part of the monitoring method. The results of the monitoring (monitoring reports) must form part of the reporting requirements in the WUL.

7.3.7.2 River water quality

Water quality monitoring must be undertaken in all the affected rivers including the tributaries affected by the proposed development/operation. The frequency, location of monitoring sites, and variables to be monitored must be determined by a suitably qualified water quality specialist. An independent SANAS accredited water laboratory should be used to analyse the variables sampled. These must include, but are not restricted to, the following:

- pH, Electrical Conductivity; Total Suspended Solids; Calcium, Magnesium; Sulphate; Iron; Manganese; Aluminium; Ammonia; Nitrate; Total Alkalinity; Chloride; Fluoride and Orthophosphate.

Records should be maintained for inspection by the DWS. If any measured value exceeds the RWQOs (95th percentile) included in the Water Use License, then the Regional Office of the DWS shall be informed together with an indication of the probable cause and time span of the exceedance. Mitigation measures will also need to be indicated in order to remedy the situation in the case of exceedance or non-compliance. The results of the monitoring (monitoring reports) must form part of the reporting requirements in the WUL.

7.3.7.3 Monitoring of important biota

- Where endangered faunal species occur in the wetland, records should ideally be kept of sightings in order to help establish whether or not the wetland management practices and rehabilitation efforts are having a positive impact on these species; and
- Where appropriate, the local district conservation officer should be contacted to obtain further information on monitoring of important species.

8. SCENARIO ASSESSMENT AND RELATED RECOMMENDATIONS PER RU

Inherent in trying to assess the possible effects of different water use scenarios on wetlands is understanding the underlying drivers of the different wetland types that occur. For example, wetlands such as hillslope seepage systems that are maintained by interflow can be expected to respond separately to water use scenarios that may affect the river in the same catchment. Wetlands maintained by regional groundwater such as peatlands in certain of the RUs, would also less likely be affected by surface water use scenarios, but certainly would be affected by future groundwater use scenarios. Floodplains will be more affected by changes to high flows or floods in most cases, but under certain circumstances elevated baseflows too may have an effect through causing channel erosion which reduces the frequency of bank overtopping and hence leaving the floodplain drier for longer. **Table 9.1** REC and BAS of priority wetlands considering the high water use risks within RUs and provided that recommendations for management and monitoring as discussed above including generic recommendations for mitigation are applied with specific water use applications.

Table 8-1: Table indicating risk and consequences of change on ecological integrity of prioritised wetlands under different management scenarios as indicated above

Tertiary catchment	Resource Units	Wetland Name	Type	Actual PES*(Lakes and Estuaries)	Actual PES** Other wetlands	NFEPA WETC0N***	Modelled PES**** (Landuse based State)	River Condition used by NFEPA	PES Range (Wetland)	EIS*****	Water Use risk Assessment	Provisional REC	BAS
Usutu River	MRU26	Assegai River headwaters	Hillslope seepage wetlands	-	-	A/B	C	B	A/B - C	High	Dams/Storages	B	B/C
Usutu River	MRU23	Chrissiesmeer Pan Cluster	Pans	-	B - C	A/B - D	C/D	B	A/B to D	High	River Abstraction/Mining	A/B - D	-
Usutu River	MRU26	Hlelo River floodplain	Floodplain	-	C	C	D	B	C - D	High	Dams/Storages	B	B/C
Usutu River	MRU26	Hlelo River headwaters	Hillslope seepage wetlands	-	C	A/B	B	B	A/B - B	High	Dams/Storages	A/B	B
Usutu River	MRU26	Mawandlane River headwaters	Hillslope seepage wetlands	-	-	A/B	C/D	-	A/B - C/D	High	Dams/Storages	A/B	B
Umkuze River	ZCA-Eastern	Lake Bhangazi North	Lake	-	-	A/B	B	-	A/B	High	Groundwater Abstraction	A/B	A/B
Umkuze River	ZCA-Eastern	Lake Bhangazi South	Lake	-	-	A/B	B	-	A/B	High	Protected area	A/B	A/B
Umkuze River	ZCA-Eastern	Lake St Lucia	Lake	D	-	-	D/E	-	C/D	High	SFRA/River Abstraction	A	B
Umkuze River	ZCA-Eastern	Mbazwana/Siphudwini swamp	Unchannelled valley bottom	-	-	A/B - C	C/D	-	A/B - D	High	Groundwater Abstraction	A/B	B/C
Umkuze River	ZCA-Eastern	Mfabeni Swamp/Mire	Unchannelled valley bottom	-	B	A/B	-	-	A/B	High	Protected area	A	A/B
Umkuze River	ZCA-Eastern	Mgobezeleni Lake and swamps	Lake	-	-	A/B - D	D/E		A/B - D	High	Groundwater Abstraction	A/B	B/C
Umkuze River	ZCA-Western	Mkuze flooplain	Floodplain	-	D	A/B	D/E	A - B	A/B - D	Moderate	SFRA/River Abstraction	A/B	B
Umkuze River	ZCA-Western	Mpempe pan	Pans	-	-	A/B	D/E	A	A/B	High	SFRA/River Abstraction	A/B	B
Umkuze River	ZGSA	Msunduzi floodplain	Floodplain	-	-	A/B	B	-	A/B	Moderate	SFRA/River Abstraction	A/B	B
Umkuze River	MRU14	Muzi pan	Pans	-	D	A/B	D/E	-	A/B -C	High	SFRA/River Abstraction	B	B/C
Umkuze River	ZGSA	Mzinene floodplain	Floodplain	-	D	A/B	D/E	-	A/B - D	Moderate	SFRA/River Abstraction	A/B - D	C
Umkuze River	ZGSA	Mzinene Lake	Lake	-	D	A/B	D/E	-	A/B - D	Moderate	SFRA/River Abstraction	A/B - D	C
Umkuze River	MRU14	Neshe pan	Pans	-	D	A/B	C/D	-	A/B - C	Moderate	SFRA/River Abstraction	A/B	B
Umkuze River	ZGSA	Nsumo pan	Pans	-	C	A/B	C	-	A/B	High	SFRA/River Abstraction	A/B	B
Umkuze River	ZCA-Western	Ntshangwe pan	Pans	-	-	A/B	C/D	-	A/B - C	High	SFRA/River Abstraction	A/B	B
Umhlatuze River	MRU5	Lake Cubhu	Lake	-	D	A/B - C	D/E	-	C	Moderate	Groundwater Abstraction	A/B	C
Umhlatuze River	MRU5	Lake Mzingazi	Lake	-	D	A/B - C	D/E	-	C	Moderate	Groundwater Abstraction	A/B	C
Umhlatuze River	MRU4	Lake Nsezi	Lake	-	D	C	D/E	-	C/D	Moderate	Groundwater Abstraction	C	C
Umhlatuze River	MRU1	Amatikulu Estuary	Estuary	B	-	-	D/E	-	B	Moderate	Groundwater Abstraction	A/B	A/B
Umhlatuze River	MRU1	Mbongolwane Wetland	Valle bottom wetlands	-	-	-	D/E	-	D/E	Moderate	Groundwater Abstraction	C	C
Umhlatuze River	MRU5	Mhlatuze Estuary	Estuary	B	-	-	D	-	B	Moderate	Groundwater Abstraction	A	A/B
Umhlatuze River	MRU5	Mhlatuze Floodplain	Floodplain	-	E	D	D	-	D - E	Moderate	Groundwater Abstraction	C	C/D
Umhlatuze River	MRU2	Mlalazi Estuary	Estuary	B	-	-	D/E	-	B	High	River Abstraction	A	A/B
Umhlatuze River	MRU5	Nhlabane Lake	Lake	-	D	A/B - C	D	-	B/C	Moderate	Groundwater Abstraction	B	B
Umhlatuze River	MRU1	Nyoni River Estuary	Estuary	B	-	-	B	-	B	Moderate	Groundwater Abstraction	A/B	B
Umhlatuze River	MRU2	Siyaya River	Valley bottom wetlands	-	-	-	B	-	B	High	River Abstraction	-	B
Umfolozi River	MRU8	Aloeboom Vlei	Valley bottom wetlands	-	-	C	D/E	B	C	Moderate	SFRA/River Abstraction	B	B/C
Umfolozi River	MRU10	Lake Teza	Lake	-	D	C	D/E	-	C/D	Moderate	SFRA/River Abstraction	C	C
Umfolozi River	MRU10	Mbukwini Lake	Lake	-	D	A/B	C/D	-	B/C	Moderate	River Abstraction	B	B
Umfolozi River	ZCA-Western	Mfolozi Swamp	Unchannelled valley bottom	-	D	C	C/D	-	C/D	High	SFRA/River Abstraction	B/C	C
Umfolozi River	ZCA-Western	Mfutululu Lake and Peatland/Mire	Lake	-	C	C	D/E	-	C/D	Moderate	SFRA/River Abstraction	B/C	C
Umfolozi River	MRU10	Mvamanzi Pan and Wetlands	Pans	-	D	C	D/E	-	C/D	Moderate	River Abstraction	B/C	C

Tertiary catchment	Resource Units	Wetland Name	Type	Actual PES*(Lakes and Estuaries)	Actual PES** Other wetlands	NFEPA WETCON***	Modelled PES**** (Landuse based State)	River Condition used by NFEPA	PES Range (Wetland)	EIS*****	Water Use risk Assessment	Provisional REC	BAS
Umfolozi River	MRU10	Nkatha Pan	Pans	-	C	A/B	C/D	-	B/C	Moderate	River Abstraction	B/C	C
Umfolozi River	MRU10	Ntweni Pans	Pans	-	C	C	C/D	-	C	Moderate	River Abstraction	B/C	C
Umfolozi River	MRU6	Stilwater Vlei	Channelled valley bottom	-	C	C	D/E	-	C/D	Moderate	Groundwater Abstraction	B/C	C
Usutu River	MRU29	Banzi Pan Ndumo	Pans	-	D/E	AB	B/C	-	D/E	Moderate	Nature Reserve	A/B	B
Phongola River	MRU29	Nyamithi Pan Ndumo	Pans	-	B	A/B	B/C	-	B	Moderate	Nature Reserve	A/B	A/B
Phongola River	MRU22	Phongola floodplain	Floodplain	-	D/E	A/B - C	C/D	C	D/E	High	Rivers Abstraction	C/D	C/D
Phongola River	MRU17	Phongola River headwaters	Hillslope seepage wetlands	-	-	AB	B	A	B	High	SFRA/River Abstraction	B	B
Phongola River	MRU17	Pivaanswaterval floodplain	Floodplain	-	-	AB	C	B	B	High	SFRA/River Abstraction	B	B
Phongola River	MRU17	Waterval headwaters	Hillslope seepage wetlands	-	B	AB	D/E	-	B - D	High	SFRA/River Abstraction	B	B/C
Lake Sibaya & Kosi Bay	MRU16	Kosi Bay System	Lake	A/B	-	A/B		-	A/B	High	Groundwater Abstraction	A	A
Lake Sibaya & Kosi Bay	MRU16	KuMvushana Wetland System	Unchannelled valley bottom	-	C	A/B - C	C	-	B/C	High	Groundwater Abstraction	B	B/C
Lake Sibaya & Kosi Bay	MRU16	KuMzingwane Pan	Pans	-	C	AB	C	-	B/C	High	Groundwater Abstraction	B	B/C
Lake Sibaya & Kosi Bay	MRU16	KuShengeza Pan	Pans	-	C	AB	C	-	B/C	High	Groundwater Abstraction	B	B/C
Lake Sibaya & Kosi Bay	MRU16	Lake Sibaya	Lake	B/C	-	AB	D/E	-	B/C	High	Groundwater Abstraction	B/C	B
Lake Sibaya & Kosi Bay	MRU16	Muzi Swamps	Unchannelled valley bottom	-	D	AB	D/E	-	C	Moderate	Groundwater Abstraction	B	B/C

* Actual PES - PES assessment based on rivers and estuaries specialists as part of Reserve Determination Studies

**Actual PES - PES assessment based on area weighted impacts recorded and assessed onsite

***NFEPA WETCON - Wetland condition assessment based on NFEPA datasets

****Modelled PES - PES assessment based on surrounding landuses particular for systems that were not onsite assessed

*****EIS - EIS assessment based on existing information from previous studies, peatlands studies, regional conservation plans, NFEPA, WARMS datasets

9. REFERENCES

Begg, G. (1986). The Wetlands of Natal (Part 1). An overview of their extent, role and present status. Natal Town and Regional Planning Report Volume 68, Pietermaritzburg, South Africa.

Begg, G. (1988). The Wetlands of Natal (Part 2). The distribution, extent and status of wetlands in the Mfolozi catchment. Natal Town and Regional Planning Report Volume 71, Pietermaritzburg, South Africa.

Begg, G. (1989). The Wetlands of Natal (Part 3). The location status and function of the priority wetlands of Natal. Natal Town and Regional Planning Report Volume 73, Pietermaritzburg, South Africa.

Brinson, M. M. 1993. *A hydrogeomorphic classification for wetlands*. Wetlands Research Program Technical Report WRP-DE-4. U.S. Army Corps of Engineers, Waterway Experiment Station. Vicksburg, MS: Bridgham and Richardson.

Cowan GI (ed) 1995. Wetlands of South Africa. Department of Environmental Affairs and Tourism, Pretoria. South Africa

Cowardin LM, Carter V, Golet FC and LaRoe ET (1979). Classification of Wetlands and Deepwater Habitats of the United States. FWS-OBS-79-31. US Fish and Wildlife Service, Washington, DC.

Council of Geosciences, 2012. Geological, Geohydrological and Development potential zonation influences; environmental management framework for umkhanyakude district, kwazulu-natal. Pietermaritzburg. South Africa.

Davis TJ (ed.) (1994). The Ramsar Convention Manual: A Guide to the Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar Convention Bureau, Gland, Switzerland.

Department of Agriculture, Environmental Affairs and Rural Development. 2010. KwaZulu-Natal State of the Environment 2004: Inland Aquatic Environment Specialist Report. KwaZulu-Natal Provincial Government, Pietermaritzburg.

Department of Water Affairs 2010. *The nature, distribution and value of aquatic ecosystem services of the Olifants, Inkomati and Usutu to Mhlatuze Water Management Areas.* Contract Report by Anchor Environmental Consultants for Department: Water Affairs, 362pp.

Driver, A., Maze, K., Rouget, M., Lombard, A.T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K. and Strauss, T. (2005). National spatial biodiversity assessment 2004: Priorities for biodiversity conservation in South Africa. Strelitzia vol. 17.

DWAF. (2004c). Usutu-Mhlathuze Water Management Area: Internal Strategic Perspective. Prepared by Tlou and Matji (Pty) ltd in association with WRP (Pty) ltd, CPH2O and Dirk Versveld cc on behalf of the Directorate: National Water Resource Planning. DWAF Report No P WMA 04/000/00/0304.

DWAF. (2005). A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

DWAF. (2009a). Groundwater Reserve Determination Study in the Umhlathuze Catchment. Prepared by Institute for Groundwater Studies on behalf of the Chief Directorate: Resource Directed Measures. DWAF Report No: RDM/WMA6/02/CON/ INT_COMP/ 0109.

DWAF. (2009b). Groundwater Reserve Determination Study – St Lucia System Assessment Report. Prepared by Parsons and Associates and Geo-hydrological and Spatial Solution International (Pty) Ltd. on behalf of the Chief Directorate: Resource Directed Measures. DWAF Report No: RDM/W32H/02/CON/COMP/0109.

EKZNW. (2007). Freshwater Systematic Conservation Plan: Best Selected Surface (Marxan). Unpublished GIS Coverage [Freshwater_cons_plan_2007], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

EKZNW. (2010). Terrestrial Systematic Conservation Plan: Minimum Selection Surface (MINSET). Unpublished GIS Coverage [tscp_minset_dist_2010_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

Ferrar, A. A., and Lotter, M. C. (2006). Mpumalanga Biodiversity Conservation Plan Handbook. Mpumalanga Tourism and Parks Agency, Nelspruit.

Grundling, P-L., Mazus, H., and L. Baartman. (1998). Peat resources in northern Kwazulu-Natal wetlands: Maputaland. Department of Environmental Affairs and Tourism, Pretoria.

Grundling, P., Price, J.S. , Grootjans, A.P. and Ellery, W.N. (2013) The capability of the Mfabeni Peatland to respond to climatic and land-use stresses, and its role in sustaining discharge to downstream and adjacent ecosystems. WRC Report No. 1857/1/12.

Grundling, A.T., Van den Berg, E.C. and Pretorius, M.L. (2014) Influence of regional environmental factors on the distribution, characteristics and functioning of hydrogeomorphic wetland types on the Maputaland Coastal Plain, KwaZulu-Natal, South Africa. WRC Report No. 1923/1/13.

Grundling, A.T. (2014). Remote sensing and biophysical monitoring of vegetation, terrain attributes and hydrology to map, characterise and classify wetlands of the Maputaland Coastal Plain, KwaZulu-Natal, South Africa. PhD Thesis. University of Waterloo, Canada.

GRÜNDLING P.L. & G.C. MARNEWEC K (1999): Mapping and characterisation of Highveld peatland re - sources. Wetland Consulting Services. Report No. 28/99. Report for Agricultural Research Council and Directorate of Land and Resource Management, Department of Agriculture, Pretoria.

Kotze, D.C, Marneweck, G.C., Batchelor, A.L., Lindley, D. and Collins, N. 2008. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report TT339/09, Pretoria, South Africa

Mucina, L., and M. C. Rutherford (Eds). (2006). The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Nel, J.L., Murray, K.M., Maherry, A.M, Petersen, C.P., Roux, D.J, Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L.and Nienaber, S (2011). Technical Report for the National Freshwater Ecosystem Priority Areas Project. Water Research Commission (WRC) Report No. 1801/1/11, Pretoria, South Africa.

Nel J.L. and Driver A. (2012). South African National Biodiversity Assessment 2011: Technical Report. Volume 2: Freshwater Component. CSIR Report Number CSIR/NRE/ECO/IR/2012/0022/A, Council for Scientific and Industrial Research, Stellenbosch

Ollis, D. J., Snaddon, C. D., Job, N. M., and N. Mbona. (2013). Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. *SANBI Biodiversity Series* 22. South African National Biodiversity Institute, Pretoria.

Nel, J. L., Driver, A., Strydom, W. F., Maherry, A., Petersen, C., Hill, L., Roux, D. J., Nienaber, H., van Deventer, H., Swartz, E., and L. B. Smith-Adao. (2011). Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. WRC Report No. TT500/11.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. and Goge, C.(2008). WET-Health: A technique for rapidly assessing wetland health. Water Research Commission Report TT340/08, Pretoria, South Africa.

McCarthy T., Cairncross B., Huizenga J.M. & Bachelor A. (2007). Conservation of the Mpumalanga Lakes District. Unpublished report. Johannesburg.

Mitsch, W.T., and Gosselink, J.G., 2000. Wetlands – Third Edition. John Wiley & Sons, Incorporated. Columbus Ohio. United State of America.

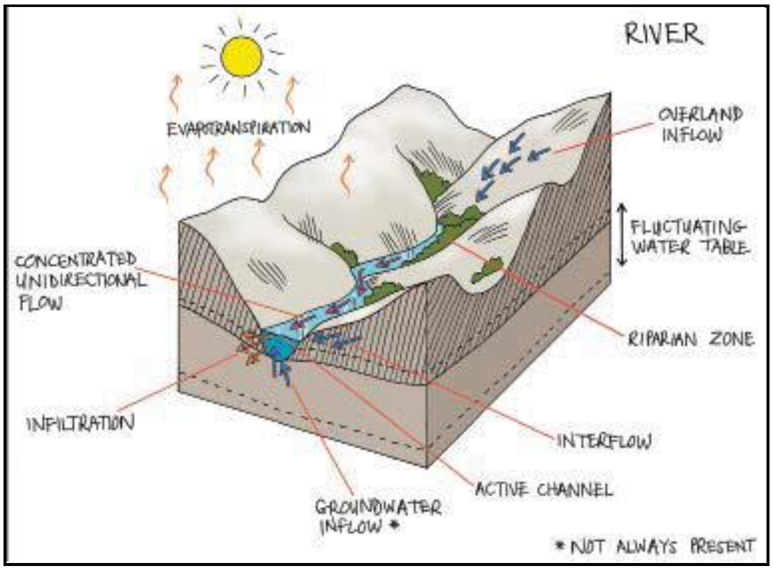
SANBI. (2009). Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

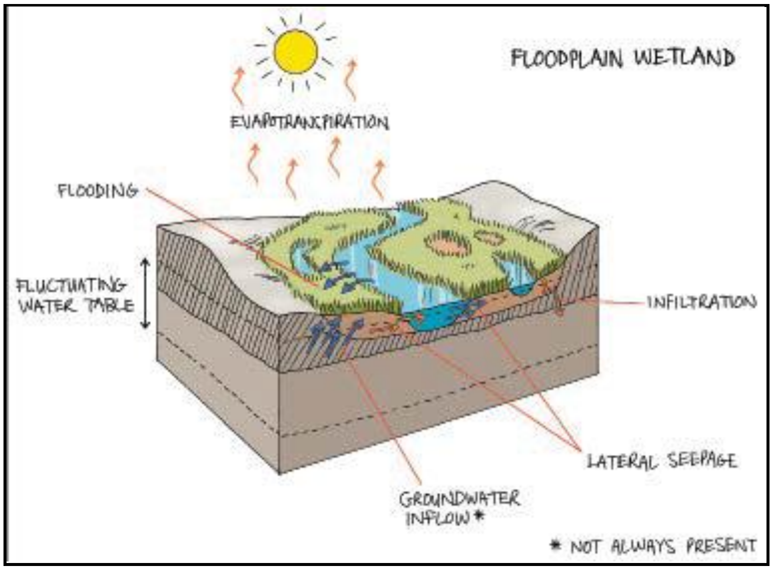
Scott-Shaw, C.R and Escott, B.J. (Eds) (2011) KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map – 2011. Unpublished GIS Coverage [kznveg05v2_1_11_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

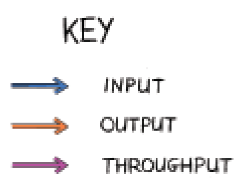
South Africa. 1998. National Water Act 38 of 1998. Pretoria: Government Printer

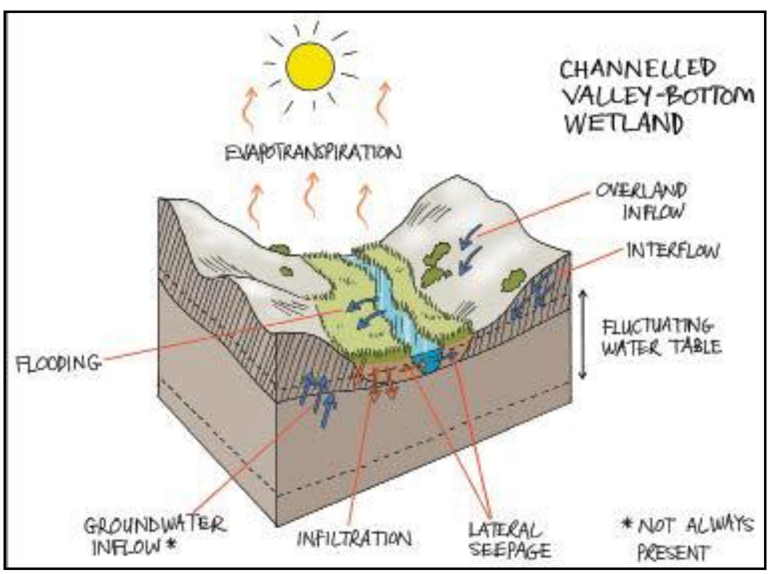
Thompson, M., Marneweck, G., Bell, S., Kotze, D., Muller, J., Cox, D. and R. Clark. (2002). A pilot project for the determination of methods for the National Wetland Inventory. Wetland Inventory Consortium (Geospace, Wetland Consulting Services, INR and CSIR) for the Department of Environmental Affairs and Tourism, Pretoria.

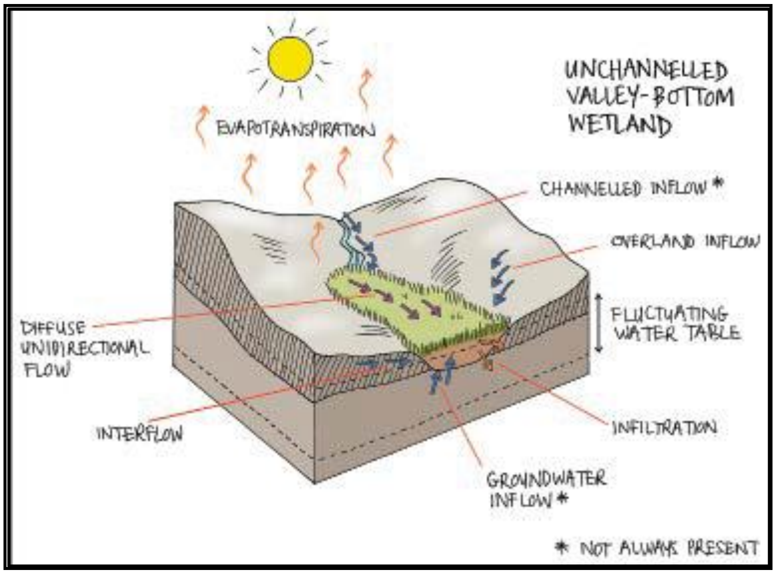
10. APPENDIX 1 (HGM DIAGRAMS – TAKEN FROM OLLIS *ET AL.*, 2013

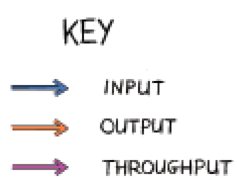


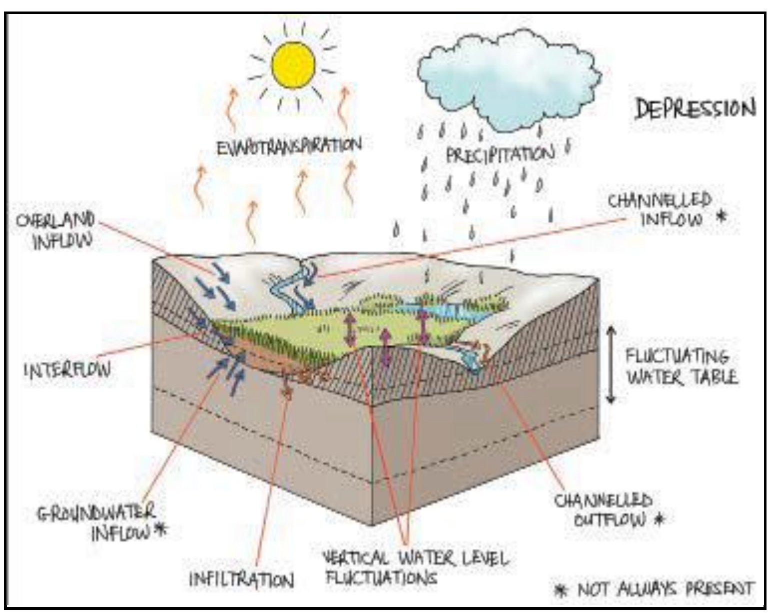

FLOODPLAIN WETLAND
EVAPOTRANSPIRATION
FLOODING
FLUCTUATING WATER TABLE
INFILTRATION
LATERAL SEEPAGE
GROUNDWATER INFLOW *
* NOT ALWAYS PRESENT

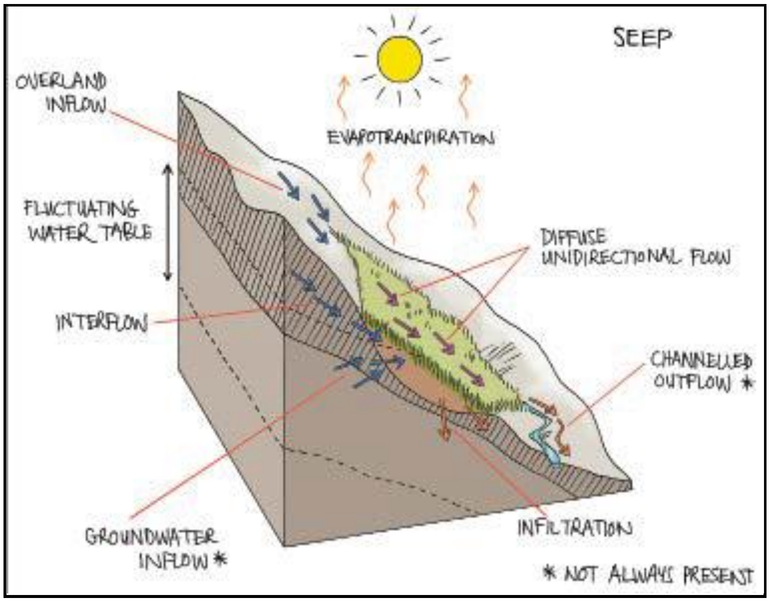

KEY
INPUT
OUTPUT
THROUGHPUT

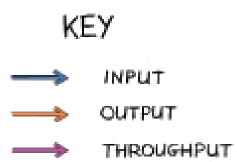

CHANNELLED VALLEY-BOTTOM WETLAND
EVAPOTRANSPIRATION
OVERLAND INFLOW
INTERFLOW
FLUCTUATING WATER TABLE
FLOODING
GROUNDWATER INFLOW *
INFILTRATION
LATERAL SEEPAGE
* NOT ALWAYS PRESENT

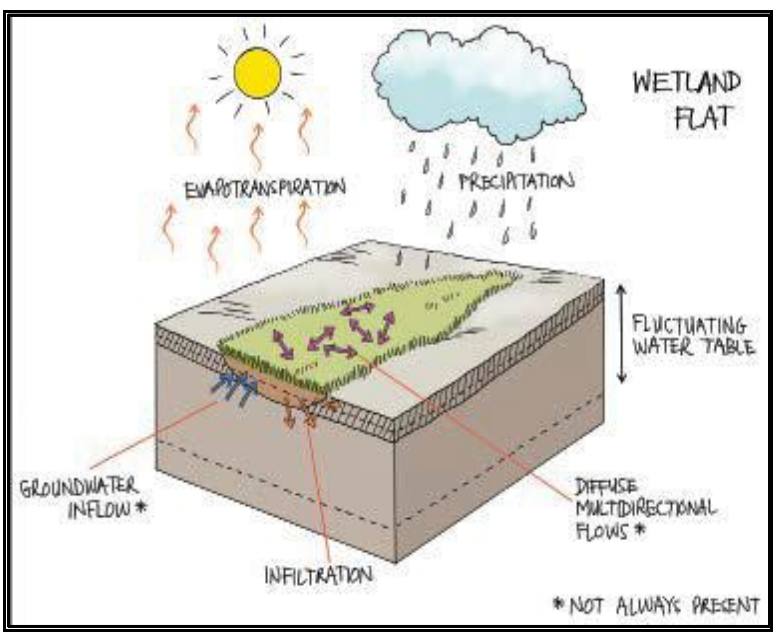

UNCHANNELLED VALLEY-BOTTOM WETLAND
EVAPOTRANSPIRATION
CHANNELLED INFLOW *
OVERLAND INFLOW
DIFFUSE UNIDIRECTIONAL FLOW
FLUCTUATING WATER TABLE
INTERFLOW
INFILTRATION
GROUNDWATER INFLOW *
* NOT ALWAYS PRESENT

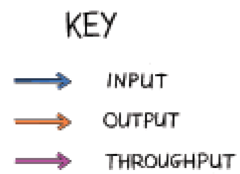

KEY
INPUT
OUTPUT
THROUGHPUT


DEPRESSION
EVAPOTRANSPIRATION
PRECIPITATION
CHANNELLED INFLOW *
OVERLAND INFLOW
INTERFLOW
FLUCTUATING WATER TABLE
GROUNDWATER INFLOW *
CHANNELLED OUTFLOW *
VERTICAL WATER LEVEL FLUCTUATIONS
INFILTRATION
* NOT ALWAYS PRESENT


SEEP
OVERLAND INFLOW
EVAPOTRANSPIRATION
FLUCTUATING WATER TABLE
DIFFUSE UNIDIRECTIONAL FLOW
INTERFLOW
CHANNELLED OUTFLOW *
GROUNDWATER INFLOW *
INFILTRATION
* NOT ALWAYS PRESENT


KEY
INPUT
OUTPUT
THROUGHPUT


WETLAND FLAT
EVAPOTRANSPIRATION
PRECIPITATION
FLUCTUATING WATER TABLE
GROUNDWATER INFLOW *
DIFFUSE MULTIDIRECTIONAL FLOWS *
INFILTRATION
* NOT ALWAYS PRESENT


KEY
INPUT
OUTPUT
THROUGHPUT

12. APPENDIX 2 – WETLAND CATEGORISATION & TYPING - TABLES

Primary (Level 4A) HGM Type*	Secondary (Level 4B) HGM Units (Longitudinal Zonation / Landform)	Landscape setting/s	Dominant hydrological characteristics			Dominant hydrodynamics
			Inputs	Throughputs	Outputs	
CHANNEL	Mountain Headwater Stream	Slope	Overland flow from catchment runoff, concentrated surface flow from upstream channels and tributaries, diffuse surface flow from an unchannelled upstream drainage line (i.e. an unchannelled valley-bottom wetland), seepage from adjacent hillslope or valley head seeps, and/or groundwater (e.g. via in- channel springs)	Concentrated surface flow	Concentrated surface flow, generally, but can be diffuse surface flow (e.g. where a channelled valley- bottom wetland becomes an unchannelled valley- bottom wetland because of a change in gradient or geological control)	Horizontal: unidirectional
	Mountain Stream	Slope / Valley floor				
	Transitional River	Slope / Valley floor				
	Upper Foothill River	Valley floor				
	Lower Foothill River	Valley floor				
	Lowland River	Valley floor / Plain				
	Rejuvenated Bedrock Fall (gorge)	Slope / Valley floor				
	Rejuvenated Foothill River	Slope / Valley floor				
	Upland Floodplain River	Valley floor / Plain (specifically a plateau)				
CHANNELLED VALLEY- BOTTOM WETLAND	Valley-bottom flat	Valley floor	Overland flow from adjacent valley-side slopes, lateral seepage (interflow) from adjacent hillslope seeps, channel overspill during flooding	Diffuse surface flow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during flooding events	Diffuse surface flow and interflow into adjacent channel, infiltration and evaporation (particularly from depressional areas)	Horizontal: bidirectional; limited vertical: bidirectional (mostly in depressions)
	Valley-bottom depression	Valley floor				
UNCHANNELLED VALLEY- BOTTOM WETLAND	Valley-bottom flat	Valley floor / Plain	Concentrated or diffuse surface flow from upstream channels and tributaries; overland flow from adjacent valley-side slopes (if present); lateral seepage from adjacent hillslope seeps (if present); groundwater	Diffuse surface flow, interflow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during high-flow events	Diffuse or concentrated surface flow, infiltration and evaporation (particularly from depressional areas)	Horizontal: unidirectional; limited vertical: bidirectional (mostly in depressions)
	Valley-bottom depression	Valley floor / Plain				
FLOODPLAIN WETLAND	Floodplain flat	Valley floor / Plain	Channel overspill during flooding (predominantly), but there could also be some overland flow from adjacent valley-side slopes (if present) and lateral seepage from adjacent hillslope seeps (if present)	Diffuse surface flow, interflow, temporary containment and storage of water in depressional areas, possible short-lived concentrated flows during high-flow events	Diffuse surface flow and interflow into adjacent channel, infiltration and evaporation (particularly from depressional areas)	Horizontal: bidirectional; limited vertical: bidirectional (mostly in depressions)
	Floodplain depression	Valley floor / Plain				
DEPRESSION (EXORHEIC, without channelled inflow)	n/a	Slope / Valley floor / Plain / Bench	Precipitation, concentrated and (possibly) diffuse surface flow, interflow, groundwater	Containment and storage of water, slow through-flow	Concentrated surface flow	Horizontal: unidirectional; vertical: bidirectional
DEPRESSION (EXORHEIC, without channelled inflow)	n/a	Slope / Valley floor / Plain / Bench	Precipitation, diffuse surface flow, interflow, groundwater	Containment and storage of water, slow through-flow	Concentrated surface flow	Horizontal: unidirectional; vertical: bidirectional
DEPRESSION	n/a	Slope / Valley	Precipitation, concentrated and (possibly) diffuse surface	Containment and storage of water	Evaporation, infiltration	Vertical: bidirectional

Primary (Level 4A)	Secondary (Level	Landscape	Dominant hydrological characteristics			Dominant
(ENDORHEIC, with channelled inflow)		floor / Plain / Bench	flow, interflow, groundwater			
DEPRESSION (ENDORHEIC, without channelled inflow)	n/a	Slope / Valley floor / Plain / Bench	Precipitation, diffuse surface flow, interflow, groundwater	Containment and storage of water	Evaporation, infiltration	Vertical: bidirectional
FLAT	n/a	Plain / Bench	Precipitation, groundwater	Containment of water, some diffuse surface flow and/or interflow	Evaporation, infiltration	Vertical: bidirectional; limited horizontal: multidirectional
HILLSLOPE SEEP (with channelled outflow)	n/a	Slope	Groundwater, precipitation (perched)	Diffuse surface flow, interflow	Concentrated surface flow	Horizontal: unidirectional
HILLSLOPE SEEP (without channelled outflow)	n/a	Slope	Groundwater, precipitation (perched)	Diffuse surface flow, interflow	Diffuse surface flow, interflow, evaporation, infiltration	Horizontal: unidirectional
VALLEYHEAD SEEP	n/a	Valley floor	Groundwater, diffuse surface flow, precipitation	Diffuse surface flow, interflow	Concentrated surface flow	Horizontal: unidirectional