water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

DETERMINATION OF WATER RESOURCE CLASSES, RESERVE AND RESOURCE QUALITY OBJECTIVES FOR SECONDARY CATCHMENTS A5-A9 WITHIN THE LIMPOPO WATER MANAGEMENT AREA (WMA 1) AND SECONDARY CATCHMENT B9 IN THE OLIFANTS WATER MANAGEMENT AREA (WMA 2).

BACKGROUND INFORMATION DOCUMENT

PSC no 2: 14 March 2024

INTRODUCTION/BACKGROUND

As part of the mandate of the Department of Water and Sanitation (DWS) to protect water resources as stipulated in Chapter 3 of the National Water Act, the Chief Directorate (CD): Water Ecosystems Management (WEM) initiated the study "Determination of Water Resource Classes, Reserve and Resource Quality Objectives for all significant water resources in the Secondary Catchments (A5-A9) of the Limpopo WMA and B9 in the Olifants WMA" in 2021.

Implementing these Resource Directed Measure (RDM) tools aims to ensure sustainable utilisation of water resources to meet the ecological, social and economic needs of the communities dependent on them and provide a mechanism against which the objectives set can be monitored for compliance.

The Integrated Framework for incorporating the gazetted steps for the Classification, Reserve and RQOs is being used to guide this study (**Figure 1**).

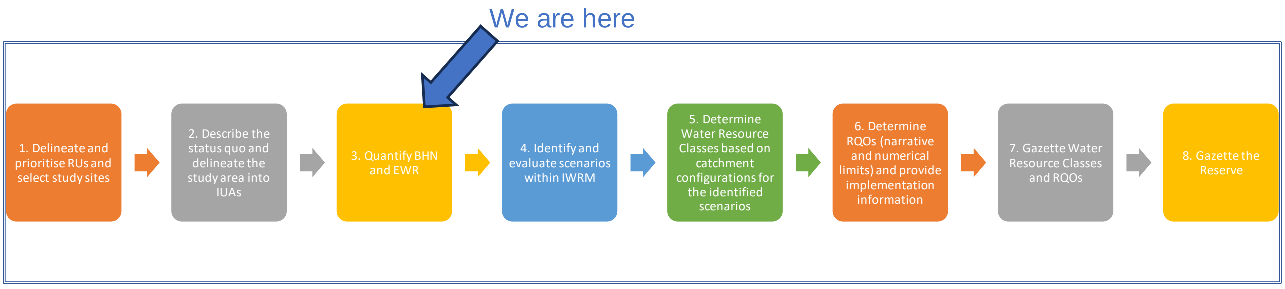

Figure 1. Integrated Framework

The study area comprises secondary catchments A5 (Lephalala), A6 (Mogalakwena), A7 (Sand), A8 (Nzhelele), A9 (Luvuvhu) in the Limpopo WMA (WMA 1), and Secondary Catchment B9 (Shingwedzi) in the Olifants WMA (WMA 2). It is important in terms of its Protected and Conservation areas, Strategic Water Source Areas and Freshwater Ecosystem Priority Areas. Two RAMSAR-declared floodplain wetlands fall within the footprint of the study area. The Nyl River Floodplain, in the upper reaches of the Mokgalakwena catchment and the Makuleke wetlands complex in the Kruger National Park (**Figure 2**).

Surface water resources in the semi-arid study area are limited and unpredictable due to climate variability. Factors such as urbanisation, population growth, industrial growth and agricultural activities contribute to the stress on the limited surface water resources. Groundwater is extensively used and is over exploited in many areas.

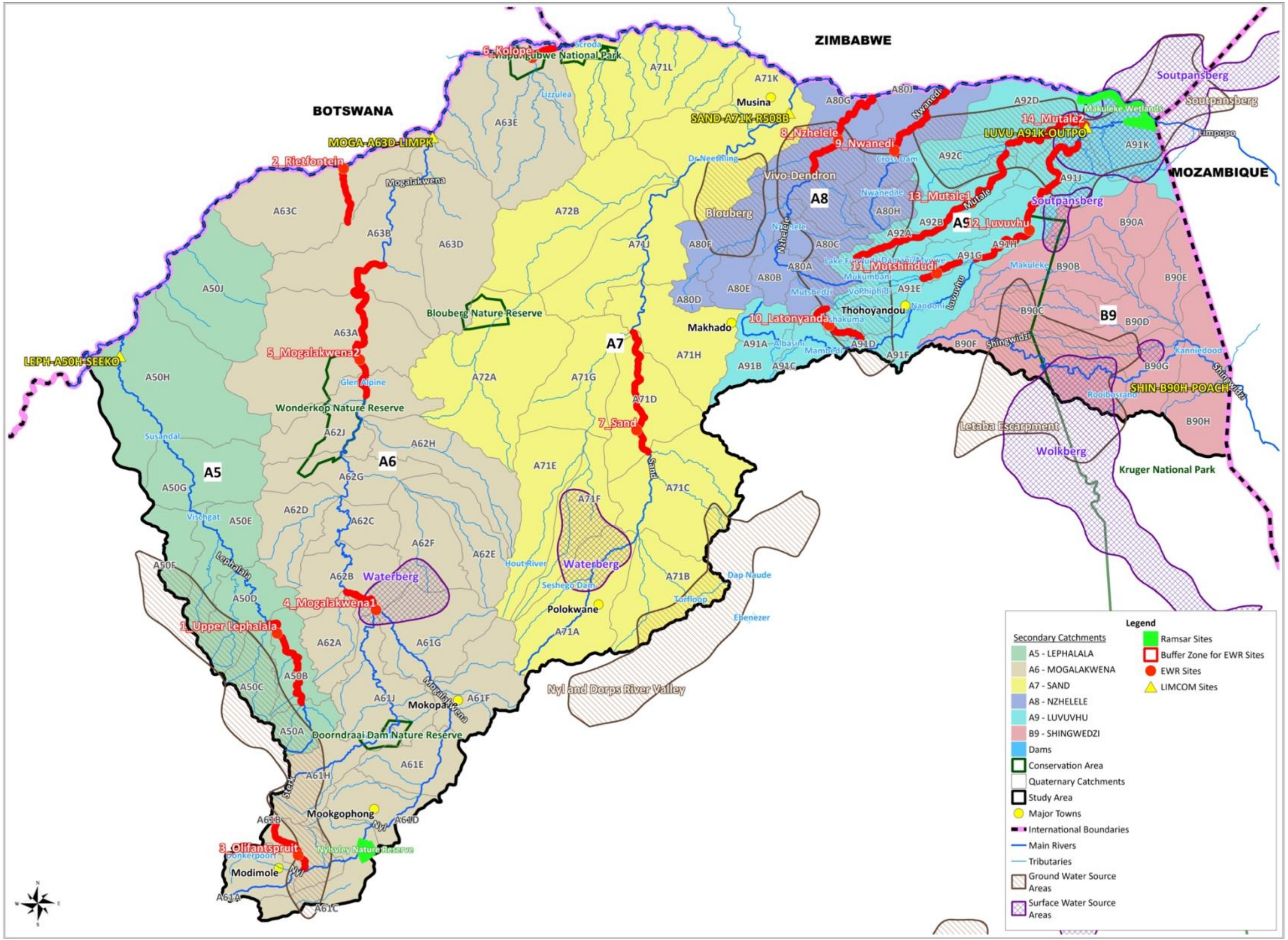

Figure 2. Map of the Study Area, study sites, protected areas and Strategic Water Source Areas

The first two years of this four-year study focused on collating and collecting data to describe the ecological condition (EcoCategorisation) and Ecological Water Requirements (EWR) of key rivers and wetlands, and significant groundwater resources.

WHAT ARE ECOLOGICAL WATER REQUIREMENTS AND WHY DO WE NEED TO DETERMINE THEM?

'Ecological Water Requirements (EWR), also known as Environmental Flows, are flows that are left in, or released into, a water resource to manage some aspect of its condition. Their purpose could be as general as maintaining a "healthy" ecosystem or as specific as enhancing the survival chances of a threatened fish species. They could target the river channel and its surface waters, groundwater, linked wetlands or floodplains, the riparian zone, and/or any of the plant and animal species associated with these system components.' (JM King, et.al., 2008. WRC Report TT 354/08).

WHAT DO WE MEAN BY ECOCATEGORISATION?

As described in the DWS EcoStatus manuals published in 2007, EcoCategorisation refers to determining the Present Ecological Status (PES) that represents the ecological health or integrity of some biophysical attributes of the water resource relative to a reference condition. Components of the water resource were given scores relative to natural (**Table 1**) that show how far away from natural the assessed condition was, with natural being 100%. These scores are grouped into different categories, A-F, based on how far away from natural they are; A is natural, and F is completely unnatural.

The EcoCategorisation process aims to gain insights and understanding into the causes and sources of the deviation of the PES of each attribute from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river.

Table 1. Definitions of the ecological categories (Kleynhans 1996)

Ecological Category	Description of habitat	% of Change from Natural
A	Still in a natural condition.	>92 - 100
A/B		>88 - ≤92
B	Slightly modified. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged from natural.	>82 - ≤88
B/C		>78 - ≤82
C	Moderately modified from natural. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still unchanged.	>62 - ≤78
C/D		>58 - ≤62
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	>42 -≤58
D/E		>38 - ≤42
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 - ≤38
F	Critically/Extremely modified. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

EWR ASSESSMENT METHOD

The seven-step Downstream Response to Imposed Flow Transformation (DRIFT) method (**Figure 3**) was used to organise three main kinds of eco-social information for the rivers study and hydro-ecological information for the two floodplain wetlands: collated and collected data; relevant data in the international scientific literature and project reports, and; expert opinion from the experienced team of river and wetland scientists. This knowledge base was then used to:

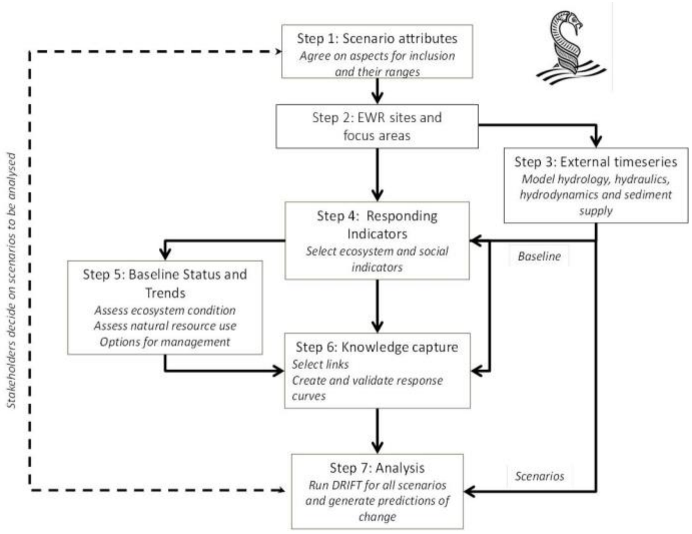

Figure 3. The seven-step DRIFT process

- select the ecosystem indicators that represent the rivers and floodplain wetlands;
- assess the ecological condition and trends of the ecosystem indicators in each of the scenarios, by predicting their change in abundance/area/ concentration (relative to the PES (2022));
- set up DRIFT-Limpopo for the rivers and the DRIFT-Nylsvley and DRIFT-Luvuvhu for the floodplain wetlands;
- predict the overall ecological condition of the river ecosystem and floodplain wetlands under different scenarios.

RESULTS OF THE RIVER ASSESSMENT

Through a process of prioritisation, 19 River EWR sites were selected across the study area; 14 are the focus of work done in this project, and the other five sites are from another project where work was done by the IWMI (International Water Management Institute) for LIMCOM (Limpopo Commission) (**Table 2**). The location of the EWR sites and the LIMCOM sites is shown in **Figure 2**.

The PES, the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Condition (REC) for each EWR site is shown in (**Table 2**).

Table 2. River EWR Sites and their Ecological Condition

NO.	RIVER	EWR Site	Quaternary catchment	PES	EIS	REC
1	Lephalala	1_Lephalala	A50B	C	Moderate	B/C
2	Lephalala	LEPH-A50H-SEEKO*	A50H	C		C
3	Rietfontein	2_Rietfontein	A63C	B/C	Moderate	B/C
4	Olifantspruit	3_Olifantspruit	A61B	C	Moderate	C
5	Mogalakwena	4_Mogalakwena1	A62B	C	Moderate	C
6	Mogalakwena	5_Mogalakwena2	A63A	C	Moderate	C
7	Mogalakwena	MOGA-A63D-LIMPK*	A63D	C		C
8	Kolope	6_Kolope	A63E	C	Moderate	C
9	Sand	7_Sand	A71D	C	Moderate	C
10	Sand	SAND-A71K-R508B*	A71K	C		C
11	Nzhelele	8_Nzhelele	A80G	C	Moderate	C
12	Ṅwanedi	9_Nwanedi	A80J	C	Moderate	C
13	Latonyanda	10_Latonyanda	A91D	C	Moderate	B/C
14	Mutshindudi	11_Mutshindudi	A91G	C	Moderate	C
15	Luvuvhu	12_Luvuvhu	A91H	C	Moderate	C
16	Luvuvhu	LUVU-A91K-OUTPO*	A91K	C		C

NO.	RIVER	EWR Site	Quaternary catchment	PES	EIS	REC
17	Mutale	13_Mutale1	A92B	C	Moderate	B/C
18	Mutale	14_Mutale2	A92D	C	Moderate	B/C
19	Shingwedzi	SHIN-B90H-POACH*	B90H	B/C		B/C

*The EIS was not determined during the LIMCOM study

The DRIFT-Limpopo was set up for the 14 EWR sites and four scenarios were modelled:

- PES (2022), which used the climatic period of 1925-2021 with human influences such as water-resource developments, population and land use at 2022 levels.
- Naturalised, which used the climatic period of 1925-2021 with human influences such as water-resource developments, population and land use at c. 1900 levels.
- Future1, which overlaid planned 2050 water resource developments on PES (2022).
- Future2, which overlaid a dry future climate scenario on Future1.

DRIFT-Limpopo was calibrated against the PES (2022) and Naturalised scenarios. The Future1 and Future2 scenarios were then run through DRIFT-Limpopo to predict the effects of additional planned water-resource development without and with a dry climate, respectively. The water-resource development plans differ between the basins, and in some basins there are no future water developments planned.

The factors considered in the Future1 scenario include increasing return flows from Waste Water Treatment Works (WWTW), raising existing dams or building new dams (increased storage), increasing releases from dams for domestic or agricultural supply, decreasing releases from dams because of increasing demands, increasing flows from inter-basin transfers, and increasing domestic or agricultural water use.

In cases where the predicted Ecological Status under Future1 is poorer than PES, Synthetic Scenarios (SS) were created that allow for development and predict a better Ecological Status than Future1. The Synthetic Scenarios explored scenarios by increasing baseflow in the dry season (mostly) to test whether the predicted Ecological Status could be improved. The increases were unrelated to the planned developments.

Table 3 summarises the EWRs for the 14 study sites. The data provided are:

- Whether future developments are planned or not
- The Recommended Ecological Category (REC)
- The scenario from which the EWRs were derived
- The Ecological Category maintained by the relevant scenario
- Whether additional non-flow related mitigation measures are advised to maintain the REC
- The natural Mean Annual Runoff (nMAR) in units of Million Cubic Metres (MCM)
- The maintenance lowflow requirements in units of MCM and as a percentage of nMAR
- The maintenance highflow requirements in units of MCM and as a percentage of nMAR
- The total maintenance flow requirements in units of MCM and as a percentage of nMAR.

Table 3. Summary of Ecological Water Requirements

Future development?	EWR site	REC	Scenario	Ecological category	Additional mitigation?	Ecological Water Requirements						
						nMAR	Low		High		Total	
Yes / No					Yes / No	MCM	MCM	%nMAR	MCM	%nMAR	MCM	%nMAR
Yes	1_Lephalala	B/C	PES (2022)	C	Yes	66.217	37.824	57.1	7.872	11.9	45.696	69.0
			Future1	C			35.825	54.1	7.773	11.7	43.557	65.8
No	2_Rietfontein	B/C	PES (2022)	B/C	No	0.181	0.057	31.7	0.010	5.3	0.067	40.0
	3_Olifantspruit	C	PES (2022)	C	No	7.815	3.385	43.3	2.616	33.5	6.002	76.8
Yes	4_Mogalakwena1	C	PES (2022)	C	No	71.36	18.217	25.5	5.170	7.3	23.387	32.8
			Future1	B			23.524	33.0	6.314	8.9	29.838	41.8
	5_Mogalakwena2	C	PES (2022)	C	No	188.946	39.096	20.7	4.343	2.3	43.439	23.0
			Future1	C			39.671	21.0	4.755	2.5	44.516	23.6
No	6_Kolope	C	PES (2022)	C	No	1.998	0.349	17.5	0.017	0.9	0.366	18.3
Yes	7_Sand	C	PES (2022)	C	No	23.125	4.125	17.9	1.421	6.1	5.546	24.0
			Future1	B/C			22.276	96.3	6.674	28.9	28.95	125.2
	8_Nzhelele	C	PES (2022)	C	No	98.420	41.595	42.3	8.662	8.8	50.257	51.1
			Future1	D			24.584	25.0	4.951	5.0	29.535	30.0
			Synthetic Scenario1	C/D			27.482	27.9	4.902	5.0	32.383	32.9
	9_Nwanedi	C	PES (2022)	C	No	32.578	11.872	36.4	4.420	13.6	16.292	50.0
			Future1	D			8.517	26.1	3.453	10.6	11.970	36.7
			Synthetic Scenario1	C/D			9.087	27.9	3.432	10.5	12.520	38.4
No	10_Latonyanda	B/C	PES (2022)	C	Yes	61.998	26.567	42.9	8.766	14.1	35.334	57.0
Yes	11_Mutshindudi	C	PES (2022)	C	No	129.309	55.253	42.7	20.618	16.0	75.872	58.7
			Future1	C			47.192	36.5	14.988	11.6	62.180	48.1
	12_Luvuvhu	C	PES (2022)	C		388.014	114.146	29.4	37.773	9.7	151.920	39.1
			Future1	C			87.104	22.5	29.547	7.6	116.651	30.1
	13_Mutale1	B/C	PES (2022)	C	Yes	147.580	66.656	44.5	31.901	26.6	97.556	66.1
			Future1	C/D			48.078	32.6	27.108	18.4	75.185	51.0
			Synthetic Scenario2	C			50.960	34.5	27.055	18.3	78.015	52.9
	14_Mutale2	B/C	PES (2022)	C		153.098	67.063	43.8	36.702	24.0	103.765	67.8
			Future1	C/D			49.569	32.4	32	20.9	81.565	53.3
			Synthetic Scenario1	C			51.662	33.8	31.964	20.9	83.626	54.6

RESULTS OF WETLAND ASSESSMENT

A wetland is defined in the National Water Act (Act 36 of 1998) 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 typically adapted to life in saturated soil.

Wetlands are crucial ecosystems that provide a wide range of ecological, social, and economic benefits. Protecting and preserving wetlands is critical for maintaining biodiversity, ensuring water quality and quantity, and promoting sustainable development.

Wetlands are numerous and scattered throughout the study area. High-priority wetlands were selected based on ecological, socio-cultural and water resource use importance and are often areas of high ecological importance where water resources are stressed or may be stressed in future. The ecological condition of the identified high priority wetlands are provided in **Table 4**.

Table 4. Summary of the ecological condition and REC for all wetlands assessed.

High Priority Wetland	PES Score	PES Category	EI	ES	REC
Luvuvhu Floodplain (Makuleke)	80.0	B/C	Very High	Very High	B/C
Nyl River Floodplain	65.0	C	Very High	Very High	C
Wonderkrater	80.0	B/C	Very High	High	B/C
Nyl Pans	57.0	D	High	Very High	C/D
Maloutswa Floodplain	66.0	C	Very High	Very High	C
Kolope Wetlands	90.0	A/B	Very High	Low	A/B
Lake Fundudzi	78.0	B/C	Very High	Very High	B/C
Mutale Wetlands	62.0	C/D	Very High	Very High	C/D
Mokamole (tributary of the Mogalakwena)	80.0	B/C	High	High	B/C
Malahlapanga	78.0	B/C	Very High	Moderate	B
Bububu wetlands (tributary of the Shingwedzi)	97.0	A	Very High	High	A

Nyl River Floodplain

The Nyl River floodplain (**Figure 5**) is recognized internationally as an important ecological site and conservation area that supports breeding populations of inland water birds and a variety of mammals, reptiles, fish and insects. The ecological functioning of the floodplain is driven by floods that occur in summer every three to five years.

Since there are no water-resource developments planned that are expected to affect water supply to the Nyl River floodplain, the objective of the EWR is to maintain the PES (2022) conditions. The EWRs provided are flood requirements to inundate the floodplains grassland, and inflows from the Nyl and Olifantspruit Rivers.

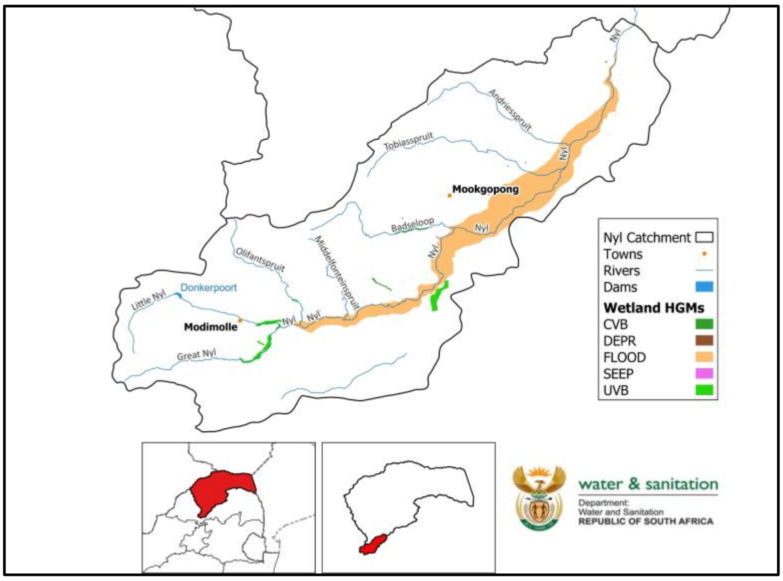

Figure 4. Map of the Nyl Floodplain in relation to its catchment area

The EWRs are:

- Inflows from the Nyl River at the N1 (downstream of the confluence of the Klein Nyl and Groot Nyl rivers) to maintain the PES (2022) of a C for the Nyl River floodplain.
- Inflows from the Olifantspruit to maintain the PES (2022) of a C at the river EWR site 3_Olifantspruit and the PES (2022) of a C for the Nyl River floodplain.

Luvuvhu Floodplain

The Makuleke wetland complex is situated along the Limpopo and Luvuvhu Rivers and is known for its diverse and rich wildlife (Ramsar Information Sheet 2007 and 2017). It was registered as a RAMSAR site in 2007 and comprises riverine forests, riparian floodplain forests, floodplain grasslands, river channels, perennial and seasonal pans that create habitat for a multitude of water birds, and water-dependent reptiles and mammals (**Figure 6**). The Luvuvhu River flows into the Limpopo River and the interactions between the two rivers are hydraulically complex at their confluence and important for the ecological functioning of the Luvuvhu River floodplain, which makes up a large portion of the Makuleke wetland complex.

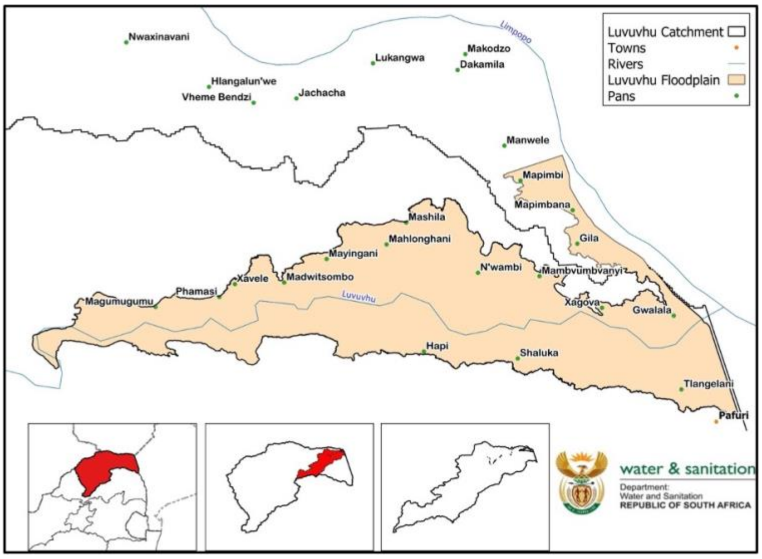

Figure 5. Map showing the pans along the Luvuvhu and Limpopo rivers that are part of the Makuleke Ramsar site, and the floodplain delineation for the study area.

Water resource developments are planned in the Luvuvhu River, and its incremental tributary the Mutale River, upstream of the floodplain. The outcomes of these developments were tested in the DRIFT model under the Future1 and Future2 flow scenarios. The predictions are that the overall integrity of the Luvuvhu River floodplain is expected to drop from a B/C category under the Present Ecological state scenario to a C under the Future1 scenario and a C/D under Future2.

EWRs are provided for the Luvuvhu River floodplain that comprise lowflows, small and large floods in the Luvuvhu River to maintain the PES (2022) B/C category prior to development, derived from the PES (2022) flow scenario, and a C category post-development, derived from the Future1 flow scenario.

GROUNDWATER ASSESSMENT

The study area comprises a nearly 50% split between perennial and ephemeral rivers. The rivers to the west of the study area, the Lephalala and Mogalakwena rivers are perennial systems. East of these rivers is the ephemeral Sand River system, bordered by the perennial Nzhelele, Ṅwanedi̭ and Luvuvhu Rivers. The Shingwedzi River to the east of the study area which flows into the Kruger National Park is an ephemeral system. The importance of groundwater baseflow contribution to managing the ecological condition of the surface water resources in the study area is paramount and an assessment of the groundwater dependent EWR sites was conducted.

The distribution of groundwater contribution to baseflow closely correlates with the distribution of recharge. Rainfall has a dominant control on recharge, and aquifers with high recharge, can also be reasonably expected to have high groundwater discharge, given a state of dynamic equilibrium in the long term.

The EWR sites with a degree of groundwater dependence is listed in **Table 5** and shown in **Figure 6**.

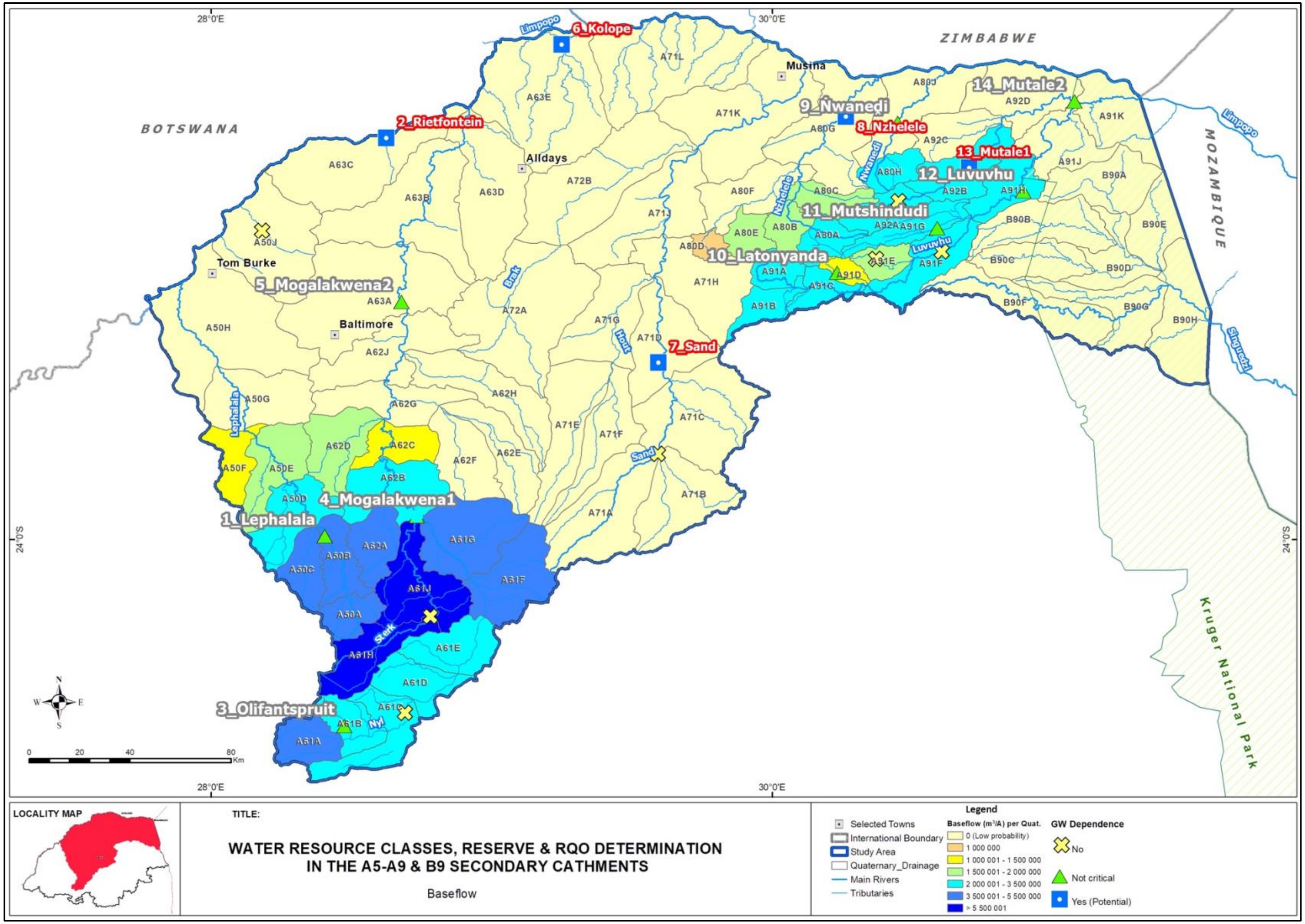

Figure 6 EWR Sites and Groundwater Dependence

Table 5. Groundwater dependent EWR sites.

EWR Site	River	Groundwater Dependence
1_Lephalala	Lephalala	Not critical
2_Rietfontein	Rietfontein	The marginal zone vegetation is a groundwater dependent ecosystem but within a greater riparian channel which will experience intermittent / seasonal flows. A thermal spring feeds the channel.
3_Olifantspruit	Olifantspruit	Not critical
4_Mogalakwena1	Mogalakwena	Not critical
5_Mogalakwena2	Mogalakwena	Not critical
6_Kolope	Kolope	Plants along the channel are phreatophytic so depth to groundwater is important.
7_Sand	Sand	Broad dry riverbed, sandy, with potentially deep sands. Trees along the bank seem to be terrestrial and not phreatophytic.
8_Nzhelele	Nzhelele	Broad macro-channel and sandy. Groundwater important for dry season baseflow
9_Nwanedi	Ṅwanedi	Not critical
10_Latonyanda	Latonyanda	Not critical
11_Mutshindudi	Mutshindudi	Not critical
12_Luvuvhu	Luvuvhu	Not critical
13_Mutale1	Mutale	Extensive seepage wetlands that are therefore partially groundwater dependent
14_Mutale2	Mutale	Not critical

BASIC HUMAN NEEDS RESERVE (BHNR)

Many people rely on informal water sources for domestic water supply, in other words, collecting their own water from rivers or wells. If these sources dry up or their quality becomes compromised, this can incur financial and health costs, driving people further into poverty. The BHNR is needed to ensure that these flows are supplied, over and above the flows needed to maintain ecosystem condition, and without compromising the latter. The BHNR is calculated based on the number of people dependent on these water sources both in the present and projected in the future. It is estimated that some 131 000 of the 851 000 households living in the study area are dependent on informal water sources, with 11.1% reliant on groundwater resources and 4.3% reliant on surface water resources. This equates to an estimated BHNR of 4.3 million m^3 of water per year, with 3.1 million m^3 from groundwater sources and 1.2 million m^3 from surface water sources. These quantities are based on a daily allowance of 25 litres per person per day. The Upper Sand IUA has the highest BHNR of 0.75 million m^3. In the future, it is expected that groundwater dependence will decrease, while surface water dependence is expected to remain relatively stable.

NEXT PHASE – SCENARIO EVALUATION

The determination of the Ecological Reserve comprises a series of steps to evaluate the status of the groundwater, the ecological condition of the study rivers and wetlands, and the assessment of the EWRs[1] needed to support different levels of ecological health in the water resources (Adams et al. 2016). The information from the EWR assessment is used in the implementation of the Water Resources Classification System (WRCS) (**Figure 1**, Step

[1] The quality, quantity and timing of flow to support ecosystem function (Adams *et al*. 2016).

5). This is the stage where stakeholders consider the implication of existing and planned water-resource developments on the water available for the rivers and wetlands and the associated predicted impacts on their ecological category (**Table 1**). In the WRCS, one EWR and its associated ecological category will be chosen for a river reach and this becomes the Ecological Reserve. This is followed by determining the Resource Quality Objectives (RQOs) (**Figure 1**, Step 6). RQOs are numerical and/or descriptive statements of the biological, chemical and physical attributes that characterise a river or wetland for the level of protection defined by the ecological category selected in the WRCS. The Water Resource Classes, Reserve and RQOs will be gazetted for public comment.

For more information on the project you can contact the DWS:

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Information on the project can also be accessed from the project website:

https://www.dws.gov.za/rdm/WRCS/Default.aspx

Photo 1. Luvuvhu River at the Luvuvhu Bridge in the Kruger National Park (Makuleke field survey, October 2022)