IMPLEMENTATION OF THE WATER RESOURCES CLASSIFICATION SYSTEM AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES FOR SIGNIFICANT WATER RESOURCES IN THE LETABA CATCHMENT

PROJECT NUMBER: WP 10640

RESOURCE QUALITY OBJECTIVES

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DEPARTMENT OF WATER AFFAIRS

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES IN THE LETABA CATCHMENT

RESOURCE QUALITY OBJECTIVES

Report Number: RDM/WMA02/00/CON/CLA/0314

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DOCUMENT INDEX

INDEX NUMBER	DWA REPORT NUMBER	REPORT TITLE
R 1	*RDM/WMA02/00/CON/CLA/0112*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Inception report**
R 2	*RDM/WMA02/00/CON/CLA/0113*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Status quo assessment, IUA and biophysical node delineation and identification**
R 7	*RDM/WMA02/00/CON/CLA/0213*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Catchment visioning**
R 3	*RDM/WMA02/00/CON/CLA/0313*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Ecological Water Requirements**
R 4.1	*RDM/WMA02/00/CON/CLA/0114*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment: Consequences and Management Class*
R 4.2	*RDM/WMA02/00/CON/CLA/0214*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Consequences and Management Class: Supporting information on ecological consequences of operational scenarios**
R 5	**RDM/WMA02/00/CON/CLA/0314**	**Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment: Resource Quality Objectives**
R 6	*RDM/WMA02/00/CON/CLA/0414*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Main report**
R 8	*RDM/WMA02/00/CON/CLA/0514*	*Classification of Water Resources and Determination of the Resource Quality Objectives in the Letaba Catchment:* **Closing report**

DEPARTMENT OF WATER AFFAIRS
CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

CLASSIFICATION OF WATER RESOURCES AND DETERMINATION OF THE RESOURCE QUALITY OBJECTIVES IN THE LETABA CATCHMENT

RESOURCE QUALITY OBJECTIVES

Report Number: RDM/WMA02/00/CON/CLA/0314

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EXECUTIVE SUMMARY

INTRODUCTION

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

*This task forms **part** of Step 6, i.e. the development of draft RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented.*

SUMMARY OF RQO RESULTS

RQOs are set for the draft Management Class associated with the recommended scenario to be implemented in the catchment. The RQOs are summarised in a set of tables below.

Table 1 provides an indication of the hydrological RQOs for Rivers expressed in terms of flow at biophysical nodes and Ecological Water Requirement (EWR) sites. These summarised statistics are representative of the required flow regime in the river where the variability is dependent on the seasonal and temporal pattern of natural flow conditions. The mean monthly flows represent low flow requirements of a representative wet (April) and dry (October) month. High flow releases are required for EWR sites 3, 4 and 7 in January, February and March.

Table 11 Summary of key hydrological RQOs for RIVERS for the Letaba River catchment

Biophysical node	River	Target EC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[2]	October (m^3/s)		April (m^3/s)	
						Mean of monthly flows at the indicated frequency.[4]			
						90%	60%	90%	60%
IUA 1: LETABA RIVER UPSTREAM OF TZANEEN DAM									
81A-00242	*Broederstroom*	*C*	*23.8*	*13.9*	*21.9*	*0.066*	*0.069*	*0.112*	*0.137*
B81A-00256	*Unnamed*	*D*	*16.34*	*15.3*	*21.9*	*0.061*	*0.064*	*0.078*	*0.087*
B81A-00263	*Unnamed*	*D*	*5.75*	*15.1*	*21.9*	*0.012*	*0.021*	*0.030*	*0.032*
B81A-00270	*Broederstroom*	*C*	*44.47*	*19*	*27.1*	*0.112*	*0.159*	*0.213*	*0.250*
B81B-00233	*Mahitse*	*C*	*2.69*	*18.6*	*27.4*	*0.004*	*0.010*	*0.009*	*0.016*
B81B-00234	*Mahitse*	*C*	*10.13*	*21.2*	*29.8*	*0.023*	*0.040*	*0.025*	*0.065*
B81B-00246	*Politsi*	*C*	*36.26*	*10*	*17.7*	*0.007*	*0.011*	*0.041*	*0.088*
B81B-00251	*Unnamed*	*D*	*1.34*	*7*	*15.4*	*0.000*	*0.000*	*0.001*	*0.005*
B81B-00269	*Morudi*	*B*	*1.95*	*23.9*	*34.6*	*0.002*	*0.005*	*0.005*	*0.013*
B81B-00227	*Mahitse*	*D*	*13.6*	*14.8*	*22.1*	*0.031*	*0.036*	*0.051*	*0.066*
B81B-00240	*Politsi*	*C*	*38.98*	*11.4*	*19.1*	*0.011*	*0.022*	*0.070*	*0.117*
EWR 1	*Great Letaba*	*C*	*99.84*	*11.8*	*21*	*0.125*	*0.198*	*0.155*	*0.352*
IUA 2: LETSITELE AND THABINA RIVERS									
B81D-00277	*Thabina*	*D*	*25.28*	*4.2*	*13*	*0*	*0.021*	*0.012*	*0.042*
B81D-00280	*Bobs*	*B*	*18.5*	*19.7*	*29.3*	*0.023*	*0.04*	*0.076*	*0.094*
B81D-00296	*Mothlaka-Semeetse*	*B*	*10.53*	*25*	*34.6*	*0.022*	*0.033*	*0.049*	*0.078*
EWR 2	*Letsitele*	*D*	*116.55*	*15.3*	*23.7*	*0.042*	*0.100*	*0.131*	*0.753*

Biophysical node	River	Target EC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[2]	October (m^3/s)		April (m^3/s)	
						Mean of monthly flows at the indicated frequency.[4]			
						90%	60%	90%	60%
B81D-00272	Letsitele	C	91.27	14.6	22	0.068	0.105	0.232	0.369
IUA 3: LETABA RIVER DOWNSTREAM OF TZANELEEN DAM TO THE PROPOSED NWAMITWA DAM									
B81E-00213	Nwanedzi	D	17.28	1.7	8.1	Minimal base (low) flows - seasonal system..			
IUA 4: LETABA FROM PROPOSED NWAMITWA DAM TO KLEIN LETABA CONFLUENCE									
EWR 3[(3)]	Groot Letaba	C	394.91	-	43.91	1.092	1.222	1.318	2.500
EWR 4[(3)]	Groot Letaba	C	441.39	-	42.53	0.523	0.554	0.679	1.517
IUA 5: SOUTHERN TRIBUTARIES TO LETABA IN IUA 4									
B81F-00228	Reshwele	B	3.53	0.8	9.1	Minimal base (low) flows - seasonal system..			0.004
B81F-00232	Makwena	B	2.75	3.4	12.6	Minimal base (low) flows - seasonal system..			
IUA 6: NORTHERN TRIBUTARIES TO THE LETABA RIVER									
B81F-00189	Merekome	C	4.75	1.3	7.1	Minimal base (low) flows - seasonal system.			
B81F-00203	Lerwatlou	C	3.74	1.9	8.8				
B81G-00164	Molototsi	D	16.72	0.4	6.6				
B81H-00162	Metsemola	C	0.64	1.8	9.8				
B81H-00171	Molototsi	D	25.84	1.0	6.5				
B81J-00187	Mbhawula	C	2.53	0.5	9.8				
IUA 7: UPPER MIDDEL LETABA RIVER AND TRIBUTARIES UPSTREAM OF MIDDLE LETABA DAM									
B82A-00168	Middel Letaba	C	31.12	13.9	24.3	0.007	0.068	0.055	0.073
B82B-00173	Koedoes	D	23.13	6	12.3	0.007	0.012	0.015	0.035
B82D-00163	Lebjelebore	C	4.9	16.7	25.8	0.004	0.012	0.008	0.020
B82D-00154	Middel Letaba	D	40.53	8.7	17.3	0.015	0.071	0.042	0.064
B82D-00166	Mosukodutsi	D	42.25	4.2	10.2	0.000	0.004	0.000	0.027
IUA 8: KLEIN LETABA RIVER UPSTREAM FROM THE MIDDLE LETABA DAM									
B82E-00149	Khwali	B	4.51	2.8	13.9	Minimal base (low) flows - seasonal system..			0.001
B82E-00150	Klein Letaba	C	3.48	1.1	16	Minimal base (low) flows - seasonal system..			
B82F-00141	Soeketse	C	7.32	1.6	12.8	Minimal base (low) flows - seasonal system..		0.001	0.005
B82F-00128	Klein Letaba	C	32.13	5	15.4	0.001	0.006	0.007	0.017
B82F-00137	Klein Letaba	D	13.64	0.5	9.7	Minimal base (low) flows - seasonal system..		0.001	0.002
IUA 9: KLEIN LETABA DS FROM THE MIDDLE LETABA DAM									
EWR 5	Klein Letaba	C/D	99.84	--	55.94	0.015	0.030	0.034	0.069
IUA 10: LOWER KLEIN LETABA TRIBUTARIES									
B82H-00127	Nsama	C	6.91	1.0	10.6	Minimal base (low) flows - seasonal system..			
B82H-	Magobe	B	3.1	0.7	14.9	Minimal base (low) flows -			

Biophysical node	River	Target EC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[2]	October (m^3/s)		April (m^3/s)	
						Mean of monthly flows at the indicated frequency.[4]			
						90%	60%	90%	60%
00139						*seasonal system..*			
B82H-00157	*Nsama*	*B*	*11.72*	*1.7*	*14.4*	*Minimal base (low) flows - seasonal system..*			
B82J-00197	*Ka-Malilibone*	*B*	*0.66*	*3.6*	*13.7*	*Minimal base (low) flows - seasonal system..*			
IUA 11: LETABA MAIN STEM IN THE KNP									
EWR 7(3)	*Letaba*	*C*	*646*	*-*	*49.34*	*0.523*	*0.554*	*0.696*	*1.549*

Note (1): nMAR is the natural Mean Annual Runoff in million cubic meters per annum.
Note (2): %nMAR is flow required at the nodes expressed as a percentage of the natural Mean Annual Runoff, Low flows and Total flows.
Note (3): The monthly flow requirements for EWR 3, 4, 5 and 7 represent the total flow defined by the selected Operational Scenario where the Present Ecological State low flows and releases for water users defines the minimum requirements for the respective EWR sites.
Note (4): Percentage points on the monthly low flow frequency distribution continuum at the nodes, expressed as the percentage of the months (90% and 60%) that the flow should equal or exceed the indicated minimum values.

Table 2 provides the habitat, biota and water quality RQOs for each IUA for moderate priority Resource Units. The RQOs are grouped together where possible for all the different RUs for the key indicator. The target Ecological Category is provided for each Resource Unit.

Table 22 Summary of key RQOs for BIOTA, HABITAT and WATER QUALITY in RIVERS in MODERATE priority RUs in the Letaba Catchment

Biophysical node (RU)	Target EC	Indicator	RQO
IUA 1: LETABA RIVER UPSTREAM OF TZANEEN DAM			
B81A-00242	**B**	*Riparian vegetation*	*No encroachment of forestry in riparian zone. Alien species aerial cover to conform to EC*. Longitudinal fragmentation should not increase. Natal ghost frog, mountain wagtail, half collared kingfisher, population (sensitive) must be maintained*
B81A-00256	**D**		
B81A-00263	**D**		
B81A-00270	**C**		
B81B-00233	**C**	*Fish*	*Maintain PES, species richness, suitable flow for primary indicators (AURA, CPRE, BNEE, LMOL, BMAR). Trout not to spread and to be removed if possible*
B81B-00246	**C**		
B81B-00269	**B**		
B81B-00227	**D**	*Inverts*	*Maintain suitable velocities in SIC habitat and marginal vegetation for indicator species*
B81B-00240	**C**		
IUA 2: LETSITELE AND THABINA RIVERS			
B81D-00277 B82D-00272	**C**	*Riparian vegetation*	*Perennial alien species aerial cover must confirm to EC*. No encroachment of agriculture in rip zone. Vegetation cover on banks to be maintained to prevent erosion*
		Fish	*Maintain PES, species richness, Suitable flow for primary indicators (AURA, CPRE).*
		Invertebrates	*Maintain suitable velocities in SIC habitat and marginal*

			vegetation for indicator species
B81D-00277 (Thabina)		*Water quality*	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Agriculture - irrigation: driver).*
			Meet faecal and *E. coli* coliform targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
B82D-00272 (Letsitele)		*Water quality*	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Agriculture - irrigation: driver).*
			Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996) and DWAF (2008).
IUA 3: LETABA RIVER DOWNSTREAM OF TZANELEEN DAM TO THE PROPOSED NWAMITWA DAM			
B81E-00213 (Nwanedzi)	**C**	*Riparian vegetation*	*Perennial alien species aerial cover must confirm to EC*. No encroachment of agriculture in rip zone.*
		Fish	*Maintain PES, species richness, Suitable flow for primary indicators (BMAR).*
		Invertebrates	*Maintain suitable velocities in SIC habitat and suitable water quality for key taxa*
		Water quality	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Agriculture - irrigation: driver).*
			Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996) and DWAF (2008).
IUA 6: NORTHERN TRIBUTARIES TO THE LETABA RIVER			
B81G-00164 (Molototsi)	*n/a*	*Water quality*	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystem: driver).*
			Meet faecal coliform and *E. coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
B81H-00171 (Molototsi)	**C**	*Riparian vegetation*	*Vegetation cover on banks to be maintained to prevent erosion and provide bank stability*
IUA 7: UPPER MIDDEL LETABA RIVER AND TRIBUTARIES UPSTREAM OF MIDDLE LETABA DAM			
B82B-00173 (Koedoes), B82D-00166 (Mosukodutsi)	**D**	*Riparian vegetation*	*No encroachment of agric in rip zone. Vegetation cover to be maintained to prevent erosion*
		Fish	*Maintain PES, species richness, suitable flow for primary indicators (BVIV, BTOP).*
		Water quality	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems / Agriculture - Irrigation: drivers).*
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).

B82D-00146 (Middel Letaba)	*n/a*	*Water quality*	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems / Agriculture - Irrigation: drivers).*
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
B82C-00175 (Brandboontjies)	*n/a*	*Water quality*	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.125 mg/L PO_4-P (Aquatic ecosystems / Agriculture - Irrigation: drivers). 50th percentile of the data must be less than or equal to 1.0 mg/L TIN-N (Aquatic ecosystems: driver).*
			Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
			Meet faecal coliform and *E. coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
IUA 8: KLEIN LETABA RIVER UPSTREAM FROM THE MIDDLE LETABA DAM			
B82F-00128 B82F-00137	**B82F-00128 C** / **B82F-00137 D**	*Riparian vegetation*	*Riparian zone fragmentation should not increase No encroachment of agriculture in rip zone. Vegetation cover on banks to be maintained for bank stability and to prevent erosion*
		Fish	*Maintain PES, species richness, suitable flow for primary indicators (BMAR).*
	n/a	*Water quality: Also includes B82G-00135 up to Giyani*	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).*
			Meet faecal coliform and *E.coli* targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
			Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events. (Aquatic ecosystems: driver).
			Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
IUA 10: LOWER KLEIN LETABA TRIBUTARIES			
B82H-00127I B82H-00157	**B82H-00127 C** / **B82H-00157 B**	*Riparian vegetation*	*No encroachment of agriculture in rip zone. Riparian zone fragmentation should not increase Vegetation cover on banks to be maintained for bank stability and to prevent erosion*

** A/B: < 10; B: 10 - 20; C: 20 - 30; D: 30 - 50% cover of perennial exotics or alien vegetation.*

Table 3 provides the habitat, biota and water quality RQOs for each IUA for HIGH priority Resource Units. RQOs and the target Ecological Category is provided for each component and/or indicator.

Table 33 RQOs for RIVERS for water quality, geomorphology, riparian vegetation, macro-invertebrates and fish in HIGH priority RUs in the Letaba Catchment.

TWQR = Target Water Quality Range (DWAF 1996a)

Component/ Indicator	Target EC	RQO
RESOURCE UNIT RU EWR 1 (Letaba River, B81B-00264, B81B-00247)		
Geomorphology	**C/D**	*Maintain the current EC and geomorphological structure*
Fish	**C**	*Do not reduce current 22 species. Indicator of fast flowing habitats is the stargazer.*
Invertebrates	**C**	*Community representative of small foothill stream assemblage. Maintain the C, good SIC and marginal vegetation.*
Riparian vegetation	**C**	*Maintain C. Keep aliens in check (not more than 20-30% cover of perennial aliens). Maintain viable populations of matumi, leadwood, apple leaf.*
Water quality	**B**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).*
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
RESOURCE UNIT RU EWR 2 (Letsitele River, B81D-00271)		
Geomorphology	**D**	*Maintain the current EC and geomorphological structure*
Fish	**C/D**	*Do not reduce current 24 species. Indicator of fast flowing habitats is the stargazer.*
Invertebrates	**C**	*Community representative of small foothill stream assemblage. Maintain the C good SIC and marginal vegetation.*
Riparian vegetation	**D**	*Maintain C. Keep aliens in check check (not more than 30-50% cover of perennial aliens). Maintain viable populations of matumi, leadwood, apple leaf.*
Water quality	**C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Agriculture - irrigation: driver).*
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Aquatic ecosystems: driver).
		Meet faecal coliform and E.coli targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a)
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
RESOURCE UNIT RU EWR 3 (Letaba River, B81F-00200; B81C-00245; B81E-00244; B81F-00212; B81F-00215; B81F-00218; B81F-00231)		
Geomorphology	**D**	*Maintain the current EC and geomorphological structure*
Fish	**C**	*Do not reduce current 30 species. Indicator of fast flowing habitats is the shortspine suckermouth.*
Invertebrates	**C**	*Community representative of Lowveld river in the middle with seasonal traits. Maintain the C diversity and integrity.*
Riparian vegetation	**C**	*Maintain C. Keep aliens in check. Maintain viable populations of matumi, leadwood, apple leaf.*
Water quality	**B**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic*

		ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver).
		Ensure that pH stays within Ideal limits: 5th and 95th percentiles of pH data must be between 6.5 and 8.0 (Aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
RESOURCE UNIT RU EWR 4 (Letaba River, B81J-00219; B81J-00209)		
Geomorphology	**D**	Maintain the geomorphological characteristics associated with a D
Fish	**C**	Do not reduce current 26 species. Indicator of fast flowing habitats is the shortspine suckermouth.
Invertebrates	**C/D**	Community representative of Lowveld river in the middle with seasonal traits. Maintain the C/D diversity and integrity.
Riparian vegetation	**C**	Maintain C. Keep aliens in check check (not more than 20- 30% cover of perennial aliens). Maintain viable populations of matumi, leadwood, apple leaf.
Water quality	**B/C**	Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).
		Ensure that electrical conductivity (salt) levels are within Ideal limits: 95th percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver).
		Ensure that pH stays within Acceptable limits: 5th and 95th percentiles of pH data must be between 6.5 and 8.4 (Industry Cat 3: driver).
		Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events. (Aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).
RESOURCE UNIT RU EWR 5 (Klein Letaba River, B82G-00135; B82J-00165; B82J-00178; B82J-00201; B82J-00207)		
Geomorphology	**D**	Maintain the geomorphological characteristics associated with a D
Fish	**C**	Do not reduce current 23 species. Indicator of fast flowing habitats is the sawfin suckermouth.
Invertebrates	**D**	Community representative of Lowveld river assemblage with seasonal traits (for a D)
Riparian vegetation	**C/D**	Keep aliens in check (not more than 30%- 50% cover of perennial aliens). Agricultural activities should not encroach. Maintain viable populations of matumi, leadwood, apple leaf.
Water quality: Includes B82G-00135 downstream of Giyani	**C**	Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (Aquatic ecosystems: driver).
		Meet faecal coliform and E. coli targets for recreational (full contact) use: Meet the TWQR of 0-130 counts per 100 ml (DWAF, 1996a).
		Ensure that turbidity or clarity levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity during runoff events. (Aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).

RESOURCE UNIT RU EWR 7 (Letaba River, B83D-00255; B83A-00220; B83A-00230; B83A-0235; B83A 00252; B83E-00265)		
Geomorphology	**C**	*Maintain the geomorphological characteristics associated with a D*
Fish	**C/D**	*Do not reduce current 29 species. Maintain present FROC for a C and, once Sc 11 is implemented, the FROC for a C/D. Indicator of fast flowing habitats is the sawfin suckermouth and largescale yellowfish.*
Invertebrates	**C/D**	*Community representative of a Lowveld River assemblage. Maintain rare SIC habitat and marginal vegetation.*
Riparian vegetation	**C**	*Maintain C. No increase in alien vegetation. Maintain viable populations of matumi, leadwood, apple leaf, torch wood.*
Water quality	**B**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (Aquatic ecosystems: driver).*
		Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 55 mS/m (Aquatic ecosystems: driver).
		Ensure that turbidity or clarity levels stay within Ideal limits: A small change from natural state (Aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories: 95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).

Table 4 provides the habitat and biota RQOs for HIGH priority wetlands in each IUA. The locality of the wetlands is linked to the river RU and biophysical nodes. The target Ecological Category is provided for the relevant wetlands in the Resource Unit.

Table 44 Summary of key RQOs for BIOTA and HABITAT in WETLANDS in priority RUs in the Letaba Catchment

Biophysical node/RU	Target EC	Indicator	RQO
IUA 1: LETABA RIVER UPSTREAM OF TZANEEN DAM			
B81A-00270	**C**	*Riparian vegetation*	*No increase in wetland fragmentation. No construction of furrows, canals, and excavations; no dredging. Maintain species composition and vegetative cover. No increase in the cover or abundance of woody invasive alien species. Forestry activities should not expand or intensify towards or into wetlands.*
		Biota	*No decline in populations of Gunnera perpensa (IUCN threat status of "Declining"). No decline in dark-footed forest shrews, Angoni vlei rats, vlei rats or water rats; herons, ducks, moorhens, greenshank or sandpiper; Natal ghost frog, green and brown water snakes. Periodic flooding of wetlands should support fish breeding/productivity.*
IUA 2: LETSITELE AND THABINA RIVERS			
B81D-00277	**D**	*Riparian vegetation*	*No increase in wetland fragmentation. No construction of furrows, canals, and excavations; no dredging. Maintain species composition and vegetative cover. Allow periodic flooding to maintain wetland EC. No increase in the cover or abundance of woody invasive alien species. Forestry activities should not expand or intensify towards or*

Biophysical node/RU	Target EC	Indicator	RQO
			into wetlands.
		Biota	*No decline in populations of G. perpensa (IUCN threat status of "Declining").* *No decline in herons, ducks, moorhens; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
IUA 3: LETABA RIVER DOWNSTREAM OF TZANELEEN DAM TO THE PROPOSED NWAMITWA DAM			
B81C-00245	**D**	*Riparian vegetation*	*No increase in wetland fragmentation.* *No construction of furrows, canals, and excavations; no dredging.* *Maintain species composition and vegetative cover.* *Allow periodic flooding to maintain wetland EC.* *No increase in the cover or abundance of woody invasive alien species.* *Forestry activities should not expand or intensify towards or into wetlands.*
		Biota	*No decline in populations of G. perpensa (IUCN threat status of "Declining").* *No decline in herons, ducks, moorhens; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
IUA 4: LETABA FROM PROPOSED NWAMITWA DAM TO KLEIN LETABA CONFLUENCE			
B81F-00231	**C/D**	*Riparian vegetation*	*No increase in wetland fragmentation.* *No construction of furrows, canals, and excavations; no dredging.* *Maintain species composition and vegetative cover.* *Allow periodic flooding to maintain wetland EC.* *No increase in the cover or abundance of woody invasive alien species.* *Forestry activities should not expand or intensify towards or into wetlands.*
		Biota	*No decline in Angoni vlei rats or vlei rats; herons, ducks, moorhens, greenshank or sandpiper; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
B81F-00200 (EWR 3)	**C**	*Riparian vegetation*	*No increase in wetland fragmentation.* *No construction of furrows, canals, and excavations; no dredging.* *Maintain species composition and vegetative cover.* *Allow periodic flooding to maintain wetland EC.* *No increase in the cover or abundance of woody invasive alien species.* *Forestry activities should not expand or intensify towards or into wetlands.*
		Biota	*No decline in Angoni vlei rats or vlei rats; herons, ducks, moorhens, greenshank or sandpiper; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
IUA 7: UPPER MIDDEL LETABA RIVER AND TRIBUTARIES UPSTREAM OF MIDDLE LETABA DAM			
B82B-00173	**D**	*Riparian*	*No increase in wetland fragmentation.*

Biophysical node/RU	Target EC	Indicator	RQO
		vegetation	*No construction of furrows, canals, and excavations; no dredging.* *No encroachment of agricultural activities into the wetland.* *Allow periodic flooding to maintain wetland EC.*
		Biota	*No decline in populations of G. perpensa (IUCN threat status of "Declining").* *No decline in herons, ducks, moorhens; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
B82C-00175	**D**	*Riparian vegetation*	*No increase in wetland fragmentation.* *No construction of furrows, canals, and excavations; no dredging.* *No encroachment of agricultural activities into the wetland.* *Allow periodic flooding to maintain wetland EC.*
		Biota	*No decline in populations of G. perpensa (IUCN threat status of "Declining").* *No decline in herons, ducks, moorhens; Natal ghost frog, green and brown water snakes.* *Periodic flooding of wetlands should support fish breeding/productivity.*
IUA 9: KLEIN LETABA DS FROM THE MIDDLE LETABA DAM			
B82G-00135 (EWR 5)	**C/D**	*Riparian vegetation*	*No encroachment of agricultural activities into the wetland.* *No construction of furrows, canals, and excavations; no dredging.* *Maintain species composition and vegetative cover.*

Table 5 provides an indication of the narrative and numberical RQOs for groundwater expressed in terms of guidelines and limitations of groundwater abstractions. The groundwater assessment is undertaken on a quaternary catchment scale which has been grouped within the relevant IUAs.

Table 55 Summary of RQOs for GROUNDWATER in the Letaba Catchment.

IUA	Quat	Groundwater narrative RQO	Groundwater numerical RQO
1	*B81A* *B81B*	*Groundwater is underutilised. Abstraction impacts significantly on baseflow and this region is one of the most significant sources of baseflow in the Letaba system. Hence further investigations as to the impact of abstraction and SFR activities are required before any significant increase takes place.*	*Groundwater abstraction can be increased from 2.79 Mm^3/a to 10.44 Mm^3/a, with a 4.76 Mm^3 reduction in baseflow.*
2	*B81D*	*Groundwater is moderately utilised. Abstraction impacts significantly on baseflow and this region is a significant source of baseflow in the Letaba system. Further investigations as to the impact of abstraction and SFR activities are required before any additional abstraction takes place.*	*Groundwater abstraction can be increased from 4.13 Mm^3/a to 7.77 Mm^3/a, with a 1.60 Mm^3 reduction in baseflow.*
3	*B81C*	*Groundwater is heavily utilised. Abstraction impacts significantly on baseflow and this region is a significant source of baseflow in the Letaba system. Further investigations as to the impact of*	*Groundwater abstraction exceeds the Harvest Potential but not the simulated aquifer recharge. No further abstraction should take place without a review of the harvest*

		abstraction and SFR activities are required before any additional abstraction takes	*potential.*
	B81E	*Groundwater is over exploited and has resulted in significant baseflow depletion from the catchment. No further groundwater abstraction should be permitted.*	*Groundwater abstraction exceeds the Harvest Potential but not the simulated aquifer recharge. No further abstraction should take place without a review of the harvest potential.*
4, 5, 6	*B81F*	*Groundwater is significantly utilised. Abstraction can be marginally increased up to the Harvest Potential with little to no impact on baseflow*	*Groundwater abstraction can be increased from 7.94 Mm^3/a to 14.40 Mm^3/a, with no further reduction in baseflow.*
	B81J	*Groundwater is underutilised and can be utilised up to the Harvest Potential with little to no impact on baseflow*	*Groundwater abstraction can be increased to 6.46 Mm^3/a, with a 0.06 Mm^3 reduction in baseflow.*
6	*B81G*	*Groundwater is moderately utilised. Abstraction can be increased up to the Harvest Potential with little or no impact on baseflow.*	*Groundwater abstraction can be increased from 5.06 Mm^3/a to 6.78 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.*
	B81H	*Groundwater use is low and can be utilised up to the Harvest Potential with little to no impact on baseflow*	*Groundwater abstraction can be increased from 2.62 Mm^3/a to 7.97 Mm^3/a, with no reduction in baseflow.*
7	*B82A, B82D*	*Groundwater is moderately utilised. Abstraction impacts signifcantly on baseflow locally and on inflows into the middle Letaba dam. Increases in abstraction should consider the impacts on the yield of the middle letaba dam.*	*Groundwater abstraction can be increased from 7.45 Mm^3/a to 17.47 Mm^3/a, with a 5.27 Mm^3/a reduction in baseflow. An investigation of the baseflow reduction on the yield of the middle Letaba dam is required*
	B82B, B82C	*Groundwater is over exploited and has resulted in significant reduction in inflows into the Middle letaba dam. No further groundwater abstraction should be permitted.*	*Groundwater abstraction exceeds the Harvest Potential and the simulated aquifer recharge. No further abstraction should take place.*
8	*B82E B82F*	*Groundwater is underutilised. Abstraction impacts signifcantly on baseflow, however the impact is local as the region is not a significant source of baseflow to the Letaba system. Abstraction can be increased depending on low flow requirements in the Klein Letaba*	*Groundwater abstraction can be increased from 2.88 Mm^3/a to 18.46 Mm^3/a, with a 1.1 Mm^3/a reduction in baseflow.*
9	*B82G*	*Groundwater use is low and can be utilised up to the Harvest Potential with little to no impact on baseflow*	*Groundwater abstraction can be increased from 0.6 Mm^3/a to 11.02 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.*
9, 10	*B82H B82J*	*Groundwater is underutilised and can be utilised up to the Harvest Potential with little to no impact on baseflow*	*Groundwater abstraction can be increased from 0.16 Mm^3/a to 14.89 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ASPT	*Average Score Per Taxon*
CD: RDM	*Chief Directorate: Resource Directed Measures*
CEV	*Chronic Effects Value*
DSS	*Decision Support System*
DWA	*Department of Water Affairs*
EC	*Ecological Category*
EcoSpecs	*Ecological Specifications*
EWR	*Ecological Water Requirement*
EI	*Environmental Importance*
EIS	*Ecological Importance and Sensitivity*
FRAI	*Fish Response Assessment Index*
FROC	*Frequency of Occurrence*
GRA2	*Groundwater Resource Assessment Phase II*
GRUs	*Hydrogeological regions*
IHI	*Integrated Habitat Integrity*
IUA	*Integrated Unit of Analysis*
KNP	*Kruger National Park*
MIRAI	*Macro Invertebrate Response Assessment index*
MAR	*Mean Annual Runoff*
mbgl	*metres below ground level*
MCM	*Million Cubic Metres*
NFEPA	*National Freshwater Ecosystem Priority Areas*
NWRS	*National Water Resource Strategy*
nMAR	*Natural Mean Annual Runoff*
PAI	*Physico-chemical Driver Assessment Index*
pMAR	*Present Day Mean Annual Runoff*
PES	*Present Ecological State*
PESEIS	*Present Ecological State and Ecological Importance -Ecological Sensitivity*
PSP	*Professional Service Provider*
RHAM	*Rapid Habitat Assessment Method*
REC	*Recommended Ecological State*
RQOs	*Resource Quality Objectives*
RQOs	*Resource Quality Objectives*
RU	*Resource Unit*
RDRM	*Revised Desktop Reserve Model*
Sc	*Scenario*
SCI	*Socio-Cultural Importance*
SASS 5	*South African Scoring System version 5*
SIC	*Stones in Current*
SQ	*Sub Quaternary*
TWQR	*Target Water Quality Range*
TPCs	*Thresholds of Potential Concern*
TEACHA	*Tool for Ecological Aquatic Chemical Habitat Assessment*
TDS	*Total Dissolved Salts*
TIN	*Total Inorganic Nitrogen*
VEGRAI	*Vegetation Response Assessment Index*
WWTW	*Waste Water Treatment Works*
WRCS	*Water Resources Classification System*

Fish and Macro-invertebrate Habitats

FD	*Fast Deep*

FS	*Fast Shallow*
MV	*Marginal Vegetation*
SD	*Slow Deep*
SS	*Slow Shallow*

Fish species name abbreviations

AMOS	*Anguilla mossambica*
AURA	*Amphilius uranoscopus*
BANN	*Barbus annectens*
BEUT	*Barbus eutaenia*
BIMB	*Brycinus imberi*
BLIN	*Barbus lineomaculatus*
BMAR	*Labeobarbus marequensis*
BNEE	*Barbus neefi*
BPAU	*Barbus paludinosus*
BRAD	*Barbus radiatus*
BTOP	*Barbus toppini*
BUNI	*Barbus unitaeniatus*
BVIV	*Barbus viviparus*
CPAR	*Chiloglanis paratus*
CPRE	*Chiloglanis pretoriae*
CSWI	*Chiloglanis swierstrai*
HVIT	*Hydrocynus vittatus*
LCYL	*Labeo cylindricus*
LMOL	*Labeo molybdinus*
LROS	*Labeo rosae*
LRUD	*Labeo ruddi*
MBRE	*Mesobola brevianalis*
MMAC	*Marcusenius macrolepidotus*
PCAT	*Petrocephalus wesselsi*
PPHI	*Pseudocrenilabrus philander*
SINT	*Schilbe intermedius*
SZAM	*Synodontis zambezensis*
TREN	*Tilapia rendalli*
TSPA	*Tilapia sparrmanii*

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study.

1.2 STUDY AREA AND INTEGRATED UNITS OF ANALYSIS

The study area is the catchment of the Letaba River (Figure 1.1). Twelve Integrated Units of Analasis (IUAs) were identified (DWA, 2013a).

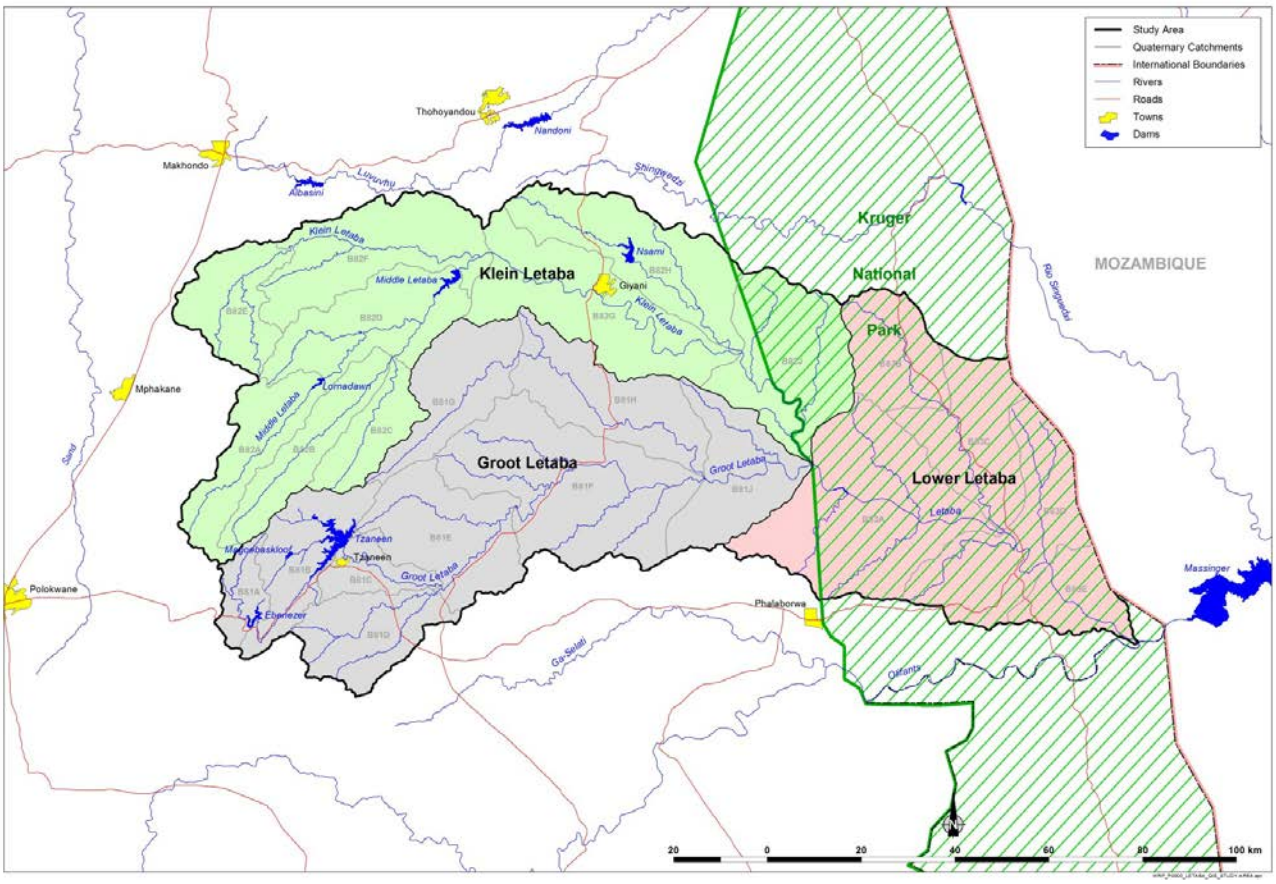


Figure 1.1 Study area: Letaba River Catchment

1.3 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs (DWA, 2012a) are supplied in Table 1.1.

Table 1.1 Integrated study steps

Step	Description
1	*Delineate the units of analysis and Resource Units, and describe the status quo of the water resource(s) (completed).*
2	*Initiation of stakeholder process and catchment visioning (on-going).*
3	*Quantify the Ecological Water Requirements and changes in non-water quality ecosystem.*
4	*Identification and evaluate scenarios within the Integrated Water Resource Management process.*

Step	Description
5	*Evaluate the scenarios with stakeholders and determine Management Classes.*
6	**Develop draft RQOs and numerical limits.**
7	*Gazette and implement the class configuration and RQOs.*

*This task forms **part** of Step 6, i.e. the development of RQOs and provision of numerical limits. This step is closely linked to the next step where the class configuration and RQOs are gazetted and implemented. The results of Step 6 are documented in this report. The information generated during Step 1, 3, 4 and 5 forms the basis of the RQOs.*

1.4 INTRODUCTION TO RQOs

RQOs are numerical and/or descriptive statements about the biological, chemical and physical attributes that characterise a resource for the level of protection defined by its Class. The National Water Resource Strategy (NWRS) therefore stipulates that "Resource Quality Objectives might describe, among other things, the quantity, pattern and timing of instream flow; water quality; the character and condition of riparian habitat, and the characteristics and condition of the aquatic biota".

The 7 steps to be applied during the determination of RQOs and guidelines to determine RQOs are provided in DWA 2011. Habitat and Biota RQOs (referred to as Ecological Specifications (EcoSpecs) and Thresholds of Potential Concern (TPC)) are according to DWAF 2010b.

1.5 TASK D6: RQO STEPS AND INTEGRATION

As there are significant overlap in the RQO steps with the Classification and Reserve steps, integrated steps have been designed which incorporates the RQO steps in an iterative manner and used during this study. The 7 steps are incorporated in the integrated steps (Table 1.1) and this integration is illustrated in Table 1.2.

Table 1.2 RQO steps as integrated in the Integrated Classification Steps

Integrated steps		RQO steps	Comment
1	*Delineate the units of analysis and Resource Units (RUs), and describe the status quo of the water resource(s) (completed).*	*1. Delineate IUAs and define RUs*	*RUs are defined at a broad level on a sub-quaternary basis.*
		3. Prioritise and select RUs for RQO determination	*Process to determine priority areas called hotspots defines the priority levels for RQO determination*
2	*Initiation of stakeholder process and catchment visioning (on-going).*	*2. Establish a vision for the catchment and key elements for the IUAs*	*Undertaken during Step 1 above.*
3	*Quantify the Ecological Water Requirements and changes in non-water quality ecosystem.*	*3. Prioritise and selected RUs for RQO determination*	*More detailed RUs defined for high priority rivers.*
		4Prioritise sub-components for RQO determination, select indicators for monitoring and propose direction of change	*Undertaken during Step 1 and 3 as part of the EcoClassification process.*
4	*Identification and evaluate scenarios within the Integrated Water Resource Management process.*		
5	*Evaluate the scenarios with stakeholders and determine Management Classes.*	*6. Agree RUs, RQOs and numerical limits with stakeholders*	*Is undertaken during all preceding stakeholder meetings. RQOs (hydrological) are agreed during the MC decision making as the*

Integrated steps		RQO steps	Comment
			hydrological RQOs are the flows associated with the MC
6	**Develop draft RQOs and numerical limits.**	*5. Develop draft RQOs and numerical limits*	*The focus in this step is on finalising the habitat, biota and water quality RQOs.*
7	*Gazette and implement the class configuration and RQOs.*	*7. Finalise and gazette RQOs*	

1.6 OPERATIONAL SCENARIOS, MANAGEMENT CLASS AND RQOs

Various scenarios were tested and the selected Management Class (MC) indicated for each scenario. The recommended scenario consisted of

- *Tzaneen Dam raising, Nwamitwa Dam construction, groundwater use within limits and a possible Crystalfontein Dam on the Klein Letaba River.*
- *Improved assurance of supply and additional water for domestic and urban use available.*
- *Maintenance of low flow EWR to maintain the Present Ecological State in the main stem.*
- *Release of some EWR floods during January, February, March.*

The recommended scenario (referred to as Scenario 11 (Sc 11) in this document and the draft Management Classes for each IUA are provided in Table 1.3 (DWA, Feb 2014). Each IUA has a catchment configuration consisting of various nodes (representing RUs), each with its distinct Ecological Category and other characteristics. For example, two IUAs which have both been awarded MC II will have different catchment configurations.

It must be noted that the recommended scenario does not impact on most of the tributaries.

RQOs are therefore determined for the hydrology and water quality and Ecological Categories associated with the MC.

Table 1.3 Target Ecological Categories and Management Classes for the Letaba River System

IUA	IUA Number	Class for IUA	Catchment Configuration	River Name	Target Ecological Category
Letaba Upstream of Tzaneen Dam	*1*	**II**	*B81A-00242*	*Broederstroom*	*C*
			B81A-00256	*Unnamed tributary*	*D*
			B81A-00263	*Unnamed tributary*	*D*
			B81A-00270	*Broederstroom*	*C*
			B81B-00233	*Mahitse*	*C*
			B81B-00234	*Mahitse*	*C*
			B81B-00246	*Politsi*	*C*
			B81B-00251	*Unnamed tributary*	*D*
			B81B-00269	*Morudi*	*B*
			B81B-00227	*Mahitse*	*D*
			B81B-00240	*Politsi*	*C*
			B81B-00247	*Great Letaba*	*C*
			EWR1	*Great Letaba*	*C*
Letsitele and Thabina	*2*	**III**	*B81D-00277*	*Thabina*	*D*
			B81D-00280	*Bobs*	*B*
			B81D-00296	*Mothlaka-Semeetse*	*B*

IUA	IUA Number	Class for IUA	Catchment Configuration	River Name	Target Ecological Category
			EWR2	Letsitele	D
			B81D-00272	Letsitele	C
Letaba Downstream of Tzaneen to Proposed Nwamitwa Dam	3	III	B81C-00245	Groot Letaba	C
			B81E-00213	Nwanedzi	D
			B81E-00244	Groot Letaba	D
Letaba from Proposed Nwamitwa Dam to Klein Letaba Confluence	4	II	EWR3	Groot Letaba	C
			B81F-00212	Groot Letaba	C
			B81F-00215	Groot Letaba	C
			B81F-00218	Groot Letaba	C
			B81F-00231	Groot Letaba	C
			B81J-00209	Groot Letaba	C
			EWR4	Groot Letaba	C
Southern Tributaries to Letaba in IUA 4	5	I	B81F-00228	Reshwele	B
			B81F-00232	Makwena	B
Northern Tributaries to Letaba in IUA 4	6	III	B81F-00189	Merekome	C
			B81F-00203	Lerwatlou	C
			B81G-00164	Molototsi	D
			B81H-00162	Metsemola	C
			B81H-00171	Molototsi	D
			B81J-00187	Mbhawula	C
Upper Middle Letaba and Tributaries Upstream of Middle Letaba Dam	7	III	B82A-00168	Middel Letaba	C
			B82B-00173	Koedoes	D
			B82C-00175	Brandboontjies	E
			B82D-00163	Lebjelebore	C
			B82D-00154	Middel Letaba	D
			B82D-00166	Mosukodutsi	D
			B82D-00146	Middel Letaba	E
Klein Letaba Upstream of Middle Letaba Dam	8	II	B82E-00149	Khwali	B
			B82E-00150	Klein Letaba	C
			B82F-00141	Soeketse	C
			B82F-00128	Klein Letaba	C
			B82F-00137	Klein Letaba	D
Klein Letaba Downstream of Middle Letaba Dam	9	III	EWR5	Klein Letaba	C/D
			B82J-00165	Klein Letaba	C/D
			B82J-00178	Klein Letaba	C/D
			B82J-00201	Klein Letaba	C/D
			B82J-00207	Klein Letaba	C/D
Lower Klein Letaba Tributaries	10	I	B82H-00127	Nsama	C
			B82H-00139	Magobe	B
			B82H-00157	Nsama	B
			B82J-00153	Nalatsi	A
			B82J-00159	Byashishi	A
			B82J-00197	Ka-Malilibone	B
Letaba River (main stem) in the Kruger National Park	11	II	B83A-00220	Letaba	B
			B83A-00230	Letaba	C
			EWR6	Letaba	C
			B83A-00252	Letaba	C
			B83D-00250	Letaba	C

IUA	IUA Number	Class for IUA	Catchment Configuration	River Name	Target Ecological Category
			EWR7	*Letaba*	*C*
			B83E-00265	*Letaba*	*C*
Letaba Tributaries in the Kruger National Park	*12*	**I**	*B83A-00193*	*Shipikani*	*A*
			B83A-00238	*Nharhweni*	*A*
			B83A-00254	*Ngwenyeni*	*A*
			B83B-00161	*Tsende*	*A*
			B83D-00204	*Manyeleti*	*A*
			B83D-00208	*Makhadzi*	*A*

1.7 PURPOSE AND OUTLINE OF THIS REPORT

The purpose of this document is to provide a summary of the narrative and numerical RQOs for the Letaba Catchment.

The report outline is as follows:

Chapter 1: Introduction
This Chapter provides general background to the project Task.

Chapter 2: Priority Resource Units
This Chapter provides an overview of the important Resource Units in the study area.

Chapter 3: Approach
Outlines the various multi-disciplinary methodologies adopted during this task.

Chapter 4 – 15: Resource Quality Objectives
These chapters outline the RQOs of the various components per Integrated Unit of Analysis.

Chapter 9: References

Chapter 10: Appendix A: Report Comments

2 PRIORITY RESOURCE UNITS

2.1 RIVER RESOURCE UNITS

Resource units (RUs) are delineated as follows:

- *Sub-quaternary (SQ) reaches have been identified (DWA 2013a) for the study area. These are surrogate for RUs in areas where further detailed RU determination will not be undertaken. These RUs are represented by desktop biophysical nodes (DWA 2013a)*
- *Management Resource Units (MRU) reaches have been identified (DWA 2006a) and modified during this study. The MRUs are represented by key biophysical nodes (DWA 2013a).*

Resource Unit (RU) priority is based on the outcome of the hotspot assessment (Step 1 of the integrated steps for the NWRC and RQO determination) as well as available information and confidence in the information. There are three priority levels (Table 2.1) each with the broad type and detail of RQOs indicated:

Table 2.1 RU priority level and associated RQO description

RU priority level	RU priority level	Associated RQO
Low (1)	*1a*	*Flow RQO. Habitat RQO in terms of Present Ecological State (PES) and Recommended Ecological Category (REC) (EcoStatus).*
	1b	*Habitat RQO in terms of PES and REC (EcoStatus) (total river length in usually in declared conservation areas.).*
Moderate (2)	*2*	*Flow RQO. Habitat and biota RQO (broad).*
High (3)	*3a*	*Forms part of RU represented by an Ecological Water Requirement (EWR) site.*
	3b	*EWR site. Flow RQO related to Scenario (Sc) 11. Detailed habitat and biota RQO (EcoSpecs).*

2.1.1 Priority of Resource Units

The allocated priority level to each Sub Quaternary (SQ) reach represented by a node name is provided in Table 2.2 and figure 2.1. The information is based on the results of the hotspot determination.

Table 2.2 Priority level for RQO RUs

Node name	River	RU Priority
IUA 1		
B81A-00242	*Broederstroom*	*2*
B81A-00256		*2*
B81A-00263		*2*
B81A-00270	*Broederstroom*	*2*
B81B-00233	*Mahitse*	*2*
B81B-00234	*Mahitse*	*1a*
B81B-00251		*1a*
B81B-00246	*Politsi*	*2*
B81B-00269	*Morudi*	*2*
B81B-00227	*Mahitse*	*2*
B81B-00240	*Politsi*	*2*
B81B-00247	*Great Letaba*	*3a*
EWR 1	*Great Letaba*	*3b*

Node name	River	RU Priority
IUA 7		
B82A-00168	*Middel Letaba*	*1a*
B82D-00163	*Lebjelebore*	*1a*
B82D-00154	*Middel Letaba*	*1a*
B82B-00173	*Koedoes*	*2*
B82D-00166	*Mosukodutsi*	*2*
B82C-00175	*Brandboontjies*	*3*
B82D-00146	*Middel Letaba*	*3*
IUA 8		
B82E-00149	*Khwali*	*1a*
B82E-00150	*Little Letaba*	*1a*
B82F-00141	*Soeketse*	*1a*
B82F-00128	*Little Letaba*	*2*
B82F-00137	*Little Letaba*	*2*

Node name	River	RU Priority
IUA 2		
B81D-00277	Thabina	2
B81D-00272	Letsitele	2
B81D-00280	Bobs	1a
B81D-00296	Mothlaka-Semeetse	1a
EWR 2	Letsitele	3b
IUA 3		
B81C-00245	Great Letaba	3a
B81E-00244	Great Letaba	3a
B81E-00213	Nwanedzi	2
IUA 4		
EWR 3	Great Letaba	3b
B81F-00212	Great Letaba	3a
B81F-00215	Great Letaba	3a
B81F-00218	Great Letaba	3a
B81F-00231	Great Letaba	3a
B81J-00209	Great Letaba	3a
EWR 4	Great Letaba	3b
IUA 5		
B81F-00228	Reshwele	1a
B81F-00232	Makwena	1a
IUA 6		
B81F-00189	Merekome	1a
B81F-00203	Lerwatlou	1a
B81G-00164	Molototsi	1a
B81H-00162	Metsemola	1a
B81J-00187	Mbhawula	1a
B81H-00171	Molototsi	2

Node name	River	RU Priority
IUA 9		
EWR 5	Little Letaba	3b
B82J-00165	Little Letaba	3a
B82J-00178	Little Letaba	3a
B82J-00201	Little Letaba	3a
B82J-00207	Little Letaba	3a
IUA 10		
B82H-00127	Nsama	2
B82H-00157	Nsama	
B82H-00139	Magobe	1a
B82J-00197	Ka-Malilibone	1a
B82J-00153	Nalatsi	1b
B82J-00159	Byashishi	1b
IUA 11		
B83A-00220	Letaba	3a
B83A-00230	Letaba	3a
EWR 6	Letaba	3a
B83A-00252	Letaba	3a
B83E-00265	Letaba	3a
B83D-00250	Letaba	3a
EWR 7	Letaba	3b
IUA 12		
B83A-00238	Nharhweni	1a
B83A-00193	Shipikani	1b
B83A-00254	Ngwenyeni	1b
B83B-00161	Tsende	1b
B83D-00204	Manyeleti	1b
B83D-00208	Makhadzi	1b
B83D-00261	Nwanedzi	1b
B83D-00236	Makhadzi	1b

2.1.2 Selection of RQO components indicators

RQO indicators are selected for RQO determination. Only relevant indicators (or high priority ones) are selected. The indicators can be for different components, subcomponents and specific species or taxa. For High Priority RUs, RQOs are provided in as much detail as available information allows for all components. These are in terms of habitat and biota EcoSpecs. For Moderate Priority RQOs the component indicators for which RQOs will be determined are identified based on the specific sources and causes that have caused changes in the state of the ecosystem. These are provided in Table 2.3. The Causes/sources comment column indications the highest levels of impacts and activities (in red). The next column provides an indication whether thekey impacts or activities are due to or caused by non-flow related impacts, flow related impacts or water quality impacts from source controls. From this information the indicator components for which RQOs must be determined can be derived and this is provided in the last column. A rating of most important (allocated 1) is also provided. The next most important will be allocated 2 and so forth.

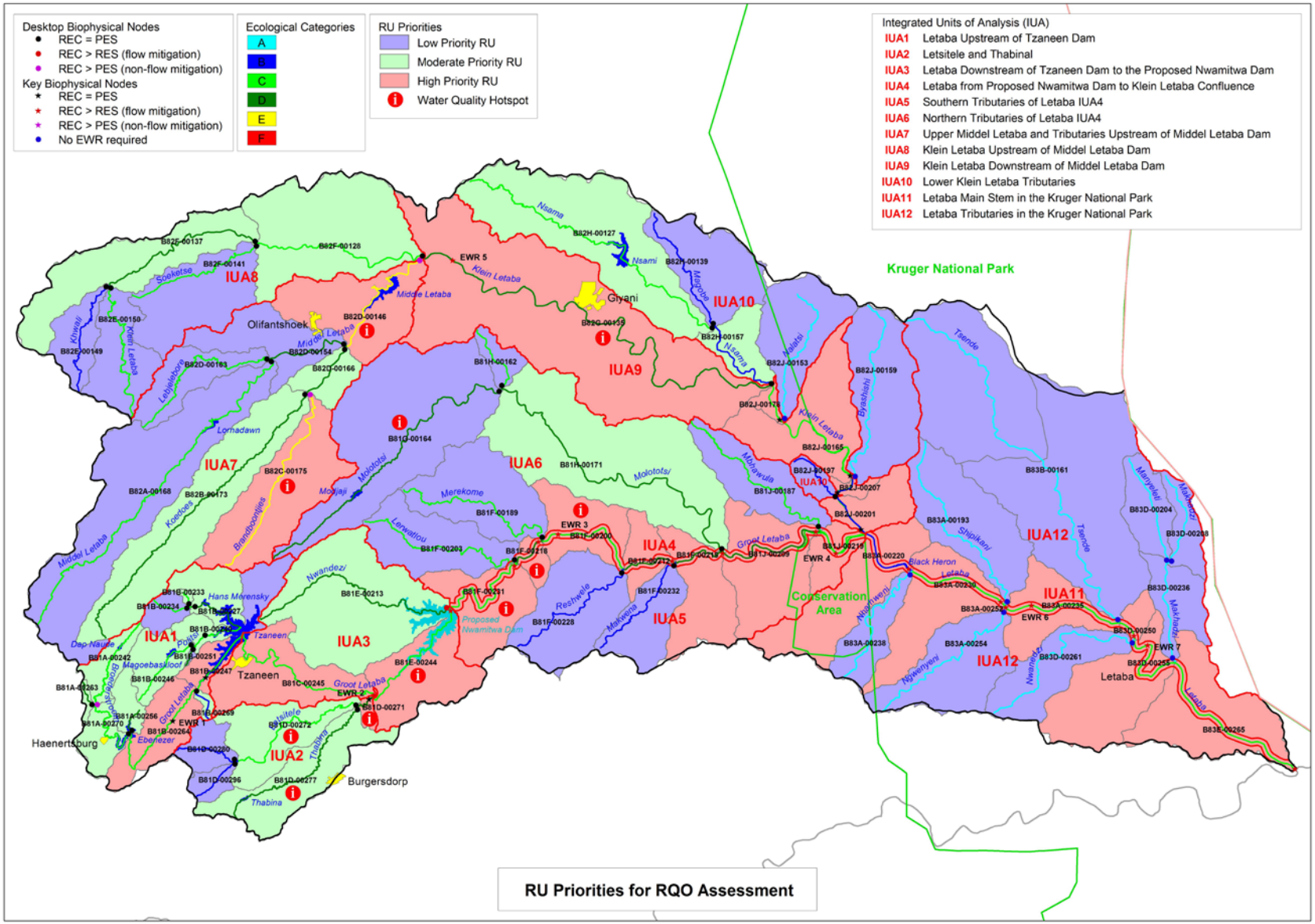


Figure 2.1 Low, Moderate and High RUs for RQO determination in the Letaba Catchment

Table 2.3 Component indicators selected for Moderate Priority RUs

RU	River	WQ hotspots	Causes/sources comment	PES	REC	RU RQO priority rating	Component indicator
IUA 1							
B81A-00242	Broederstroom		The following impacts/activities were identified: SMALL: Erosion, Inundation, Large dams, Natural areas/nature reserves, Small dams (farm), MODERATE:None, **LARGE: Crossings low water, Exotic vegetation, Roads, Vegetation removal, SERIOUS:None, CRITICAL: Forestry,**	C	B	2	1. Riparian vegetation 2. Instream biota
B81A-00256			The following impacts/activities were identified: SMALL: Abstraction (run-of river)/increased flows, Inundation, Small dams (farm), MODERATE: Crossings low water, Large dams, **LARGE: Exotic vegetation, Vegetation removal, SERIOUS:None, CRITICAL: Forestry,**	D	D	2	1. Riparian vegetation 2. Instream biota
B81A-00263			The following impacts/activities were identified: SMALL:None, MODERATE: Crossings low water, **LARGE: Abstraction (run-of river)/increased flows, Exotic vegetation, Forestry, Inundation, Vegetation removal, SERIOUS: Agricultural lands, Small dams (farm),** CRITICAL:None,	D	D	2	1. Riparian vegetation 1. Instream biota
B81A-00270	Broederstroom		The following impacts/activities were identified: SMALL: Agricultural lands, Erosion, MODERATE: Crossings low water, Fire, Inundation, Large dams, Small dams (farm), **LARGE: Exotic vegetation, Roads, Vegetation removal, SERIOUS: Forestry,** CRITICAL:None,	C	C	2	1. Riparian vegetation 2. Instream biota
B81B-00233	Mahitse		The following impacts/activities were identified: SMALL: Algal growth, MODERATE: Forestry, Natural areas/nature reserves, Small dams (farm), Vegetation removal, **LARGE: Agricultural lands, SERIOUS: Exotic vegetation,** CRITICAL:None,	C	C	2	1. Riparian vegetation 2. Instream biota
B81B-00246	Politsi		The following impacts/activities were identified: SMALL: Abstraction (run-of river)/increased flows, Agricultural lands, Crossings low water, MODERATE: Inundation, Large dams, Small dams (farm), Vegetation removal, **LARGE: Exotic vegetation, SERIOUS: Forestry,** CRITICAL:None,	C	C	2	1. Riparian vegetation 2. Instream biota
B81B-00269	Morudi		The following impacts/activities were identified: SMALL: Roads, Sedimentation, MODERATE: Crossings low water, Vegetation removal, **LARGE: Exotic vegetation,** SERIOUS:None, **CRITICAL: Forestry**,	B	B	2	1. Riparian vegetation 2. Instream biota
B81B-00227	Mahitse		The following impacts/activities were identified: SMALL: Small dams (farm), **MODERATE: Agricultural lands, Algal growth, Forestry, Inundation, Irrigation, Runoff/effluent: Irrigation, Vegetation removal, LARGE: Exotic vegetation, Large dams,** SERIOUS:None, CRITICAL:None,	D	D	2	1. Riparian vegetation 2. Instream biota

RU	River	WQ hotspots	Causes/sources comment	PES	REC	RU RQO priority rating	Component indicator
B81B-00240	Politsi		The following impacts/activities were identified: SMALL: Crossings low water, Roads, Sedimentation, Small dams (farm), **MODERATE: Inundation, Large dams, LARGE: Agricultural lands, Algal growth, Exotic vegetation, Forestry, Irrigation, Runoff/effluent: Irrigation, Vegetation removal,** SERIOUS:None, CRITICAL:None,	C	C	2	1. Riparian vegetation 2. Instream biota
IUA 2							
B81D-00277	Thabina	3	The following impacts/activities were identified: SMALL: Chicken farms, Inundation, Large dams, Natural areas/nature reserves, **MODERATE: Abstraction (run-of river)/increased flows, Bed stabilisation, Erosion, Sedimentation, Grazing / trampling, LARGE: Agricultural lands, Algal growth, Exotic vegetation, Runoff/effluent: Urban areas, Vegetation removal,** SERIOUS:None, CRITICAL:None,	D	D	2	1. Riparian vegetation 1. Instream biota 1. Water quality
B81D-00272	Letsitele	3	The following impacts/activities were identified: SMALL: Erosion, Roads, Runoff/effluent: Irrigation, MODERATE: Abstraction (run-of river)/increased flows, Inundation, Irrigation, Grazing / trampling, **LARGE: Agricultural lands, Algal growth, Exotic vegetation, Runoff/effluent: Urban areas, Urbanization, Vegetation removal, SERIOUS: Small dams (farm),** CRITICAL:None,	C	C	2	1. Riparian vegetation 1. Instream biota 1. Water quality
IUA 3							
B81E-00213	Nwanedzi	2	The following impacts/activities were identified: SMALL: Crossings low water, **MODERATE: Erosion, Inundation, Irrigation, Mining, Runoff/effluent: Irrigation, Runoff/effluent: Urban areas, Sedimentation, Grazing / trampling, LARGE: Abstraction (run-of river)/increased flows, Agricultural lands, Algal growth, Exotic vegetation, Small dams (farm), Urbanization, Vegetation removal,** SERIOUS:None, CRITICAL:None,	D	C	2	1. Instream biota 1. Water quality. 2. Riparian vegetation
IUA 6							
B81H-00171	Molototsi	1	The following impacts/activities were identified: SMALL: Runoff/effluent: Urban areas, Urbanization, MODERATE: Agricultural lands, Exotic vegetation, LARGE: Crossings low water, Erosion, Sedimentation, Vegetation removal, SERIOUS: Grazing / trampling, CRITICAL:None,	D	D	2	
IUA 7							
B82B-00173	Koedoes	2	The following impacts/activities were identified: SMALL: Canalization, MODERATE: Crossings low water, Exotic vegetation, Roads, **LARGE: Abstraction (run-of river)/increased flows, Erosion, Inundation, Irrigation, Runoff/effluent: Irrigation, Sedimentation, Grazing / trampling, Vegetation removal, SERIOUS: Agricultural lands, Small dams (farm),** CRITICAL:None,	D	D	2	1. Instream biota 1. Water quality 2. Riparian vegetation

RU	River	WQ hotspots	Causes/sources comment	PES	REC	RU RQO priority rating	Component indicator
B82D-00166	Mosukodutsi	1	The following impacts/activities were identified: SMALL:None, **MODERATE: Exotic vegetation, Sedimentation, Vegetation removal, LARGE: Agricultural lands, Crossings low water, Grazing / trampling,** SERIOUS:None, CRITICAL:None,	D	D	2	1. Instream biota 1. Water quality 2. Riparian vegetation
IUA 8							
B82F-00128	Little Letaba	2	The following impacts/activities were identified: SMALL: Abstraction (run-of river)/increased flows, Irrigation, Small dams (farm), MODERATE: Algal growth, Crossings low water, Exotic vegetation, Roads, Grazing / trampling, **LARGE: Erosion, Runoff/effluent: Urban areas, Sedimentation, Urbanization, Vegetation removal, SERIOUS: Agricultural lands,** CRITICAL:None,	C	C	2	1. Riparian vegetation 1. Water quality 2. Instream biota
B82F-00137	Little Letaba	2	The following impacts/activities were identified: SMALL: Abstraction (run-of river)/increased flows, Small dams (farm), **MODERATE: Crossings low water, Exotic vegetation, Natural areas/nature reserves, Roads, Sedimentation, LARGE: Agricultural lands, Algal growth, Erosion, Runoff/effluent: Urban areas, Grazing / trampling, Urbanization, Vegetation removal,** SERIOUS:None, CRITICAL:None,	D	D	2	1. Riparian vegetation 1. Water quality 2. Instream biota
IUA 10							
B82H-00127	Nsama	2	The following impacts/activities were identified: SMALL: Abstraction (run-of river)/increased flows, Algal growth, Fire, Inundation, Irrigation, Large dams, Runoff/effluent: Irrigation, Sedimentation, Small dams (farm), **MODERATE: Agricultural lands, Crossings low water, Exotic vegetation, Grazing / trampling, Vegetation removal, LARGE: Runoff/effluent: Urban areas, Urbanization,** SERIOUS:None, CRITICAL:None,	C	C	2	1. Riparian vegetation
B82H-00157	Nsama		The following impacts/activities were identified: SMALL: Crossings low water, Exotic vegetation, **MODERATE: Agricultural lands, Erosion, Natural areas/nature reserves, Sedimentation, Grazing / trampling, Vegetation removal,** LARGE:None, SERIOUS:None, CRITICAL:None,	B	B	2	1. Riparian vegetation

2.2 WETLANDS

During the Status quo assessment (DWA, 2013a) an assessment was made to identify quaternary and SQ catchments that are potentially important due to the presence, frequency, extent or condition of wetlands. These wetlands were then evaluated to determine the PES of each wetland. The assessment was conducted as a desktop exercise and made use of the Letaba Wetland Scoping report (DWAF 2006a), the National Freshwater Ecosystem Priority Areas (NFEPA) wetland classification and importance coverages, (Nel et al., 2011) and the Present Ecological State and Ecological Importance - Ecological Sensitivity (PESEIS) work that was done for the B8 secondary catchment (Kotze et al., 2012).

Important wetlands occurring in the Letaba catchment are listed in Table 2.4. The PES score represents an average score for wetlands associated with the SQ and is generally a C or D PES. Wetlands in the Tsende River (B83B-00161) have an A/B PES and are well conserved within the KNP. Many of these wetlands (predominantly channelled valley-bottom wetlands) are associated with tributaries in B83C. The most common problem that has caused the PES is vegetation removal.

Table 2.4 Important wetlands in the Letaba catchment and key drivers resulting in modification from natural

SQ code	River	Wetland FEPA	Impor-tance	Wetland PES			Key drivers causing PES
		Associated with riparian		IHI[1] score	%	EC[2]	
B81A-00270	Broederstroom		Moderate	1.64	67.2	C	Vegetation removal and to a lesser degree, flow impacts.
B81C-00245	Great Letaba	Y	High	2.19	56.1	D	Vegetation removal and agriculture.
B81D-00277	Thabina	Y	High	2.59	48.3	D	Vegetation removal.
B81D-00272	Letsitele	Y	Moderate	2.09	58.2	C/D	Flow changes and vegetation removal.
B81E-00213	Nwanedzi	Y	Moderate	2.43	51.3	D	Vegetation removal and to a lesser degree, flow impacts.
B81E-00244	Great Letaba	Y	Moderate	2.36	52.8	D	Vegetation removal, agriculture and inundation.
B81F-00200	Great Letaba		Moderate	1.64	67.2	C	Vegetation removal and agriculture.
B81F-00231	Great Letaba	Y	Moderate	2.05	59.0	C/D	Vegetation removal and some dams.
B82B-00173	Koedoes		Moderate	2.41	51.8	D	Vegetation removal, agriculture and overgrazing.
B82C-00175	Brandboontjies		Moderate	2.30	54.0	D	Vegetation removal, agriculture and overgrazing.
B82D-00146	Middel Letaba		Moderate	2.62	47.7	D	Flow.
B82F-00128	Little Letaba		Moderate	2.00	59.9	C/D	Vegetation removal.
B82G-00135	Little Letaba	Y	Moderate	2.02	59.6	C/D	Vegetation removal.
B82H-00127	Nsama		Moderate	1.60	73.5	C	Vegetation removal.
B83B-00161	Tsende	Y	Low	0.47	90.7	A/B	N/A

1 Integrated Habitat Integrity *2 Ecological Category*

2.3 GROUNDWATER RESOURCE UNITS

The catchment can be divided into several hydrogeological regions (GRUs) based on topopgraphy, surface groundwater interactions, and groundwater yield characteristics (Figure 2.2). These units are:

- *Drakensberg Escarpment*
- *Drakensberg Foothills and valleys*
- *Bandolierskop*
- *Giyani-Gravelotte greenstones*
- *Low veld plains*
- *Lebombo*
- *Alluvium*

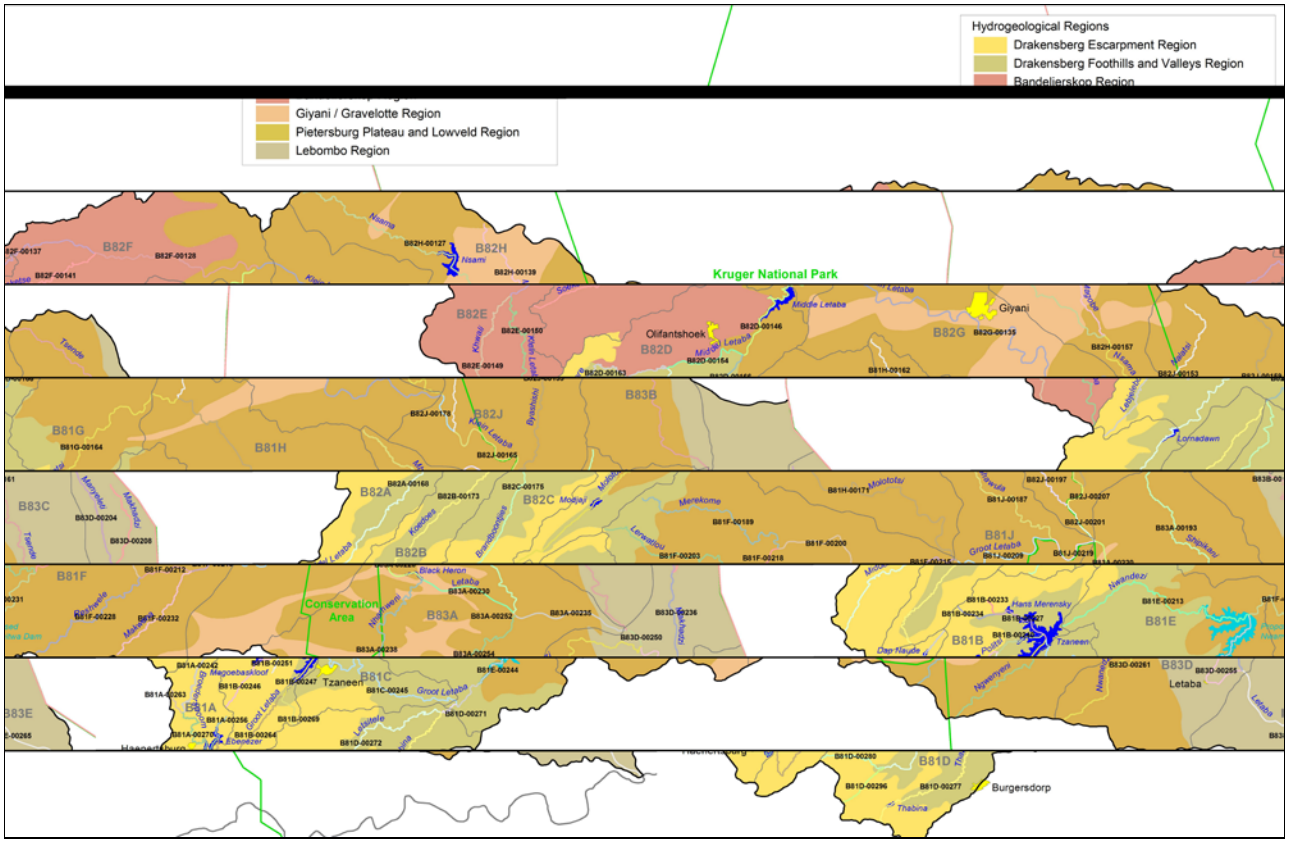


Figure 2.2 Distribution of hydrogeological regions in the Letaba

The distribution of GRUs per quaternary catchment is shown in Table 2.5.

Table 2.5 Distribution (%) of GRUs per quaternary catchment

Quat	GRU						
	Bandolierskop	Escarpment	Foothills and Valleys	Giyani Gravelotte	Lebombo	Lowveld Plains	Total
B81A	0%	100%	0%	0%	0%	0%	100%
B81B	0%	72%	28%	0%	0%	0%	100%
B81C	0%	25%	75%	0%	0%	0%	100%
B81D	0%	51%	49%	0%	0%	0%	100%
B81E	0%	6%	57%	0%	0%	37%	100%
B81F	0%	0%	8%	2%	0%	90%	100%
B81G	0%	11%	26%	0%	0%	63%	100%
B81H	0%	0%	0%	5%	0%	95%	100%
B81J	0%	0%	0%	17%	0%	83%	100%
B82A	0%	71%	29%	0%	0%	0%	100%
B82B	0%	26%	74%	0%	0%	0%	100%
B82C	0%	36%	64%	0%	0%	0%	100%
B82D	37%	14%	31%	0%	0%	18%	100%
B82E	100%	0%	0%	0%	0%	0%	100%

B82F	75%	0%	0%	0%	0%	24%	100%
B82G	0%	0%	0%	22%	0%	78%	100%
B82H	0%	0%	0%	27%	0%	73%	100%
B82J	0%	0%	0%	1%	0%	99%	100%
B83A	0%	0%	0%	12%	1%	87%	100%
B83B	0%	0%	0%	0%	18%	82%	100%
B83C	0%	0%	0%	0%	79%	21%	100%
B83D	0%	0%	0%	0%	63%	37%	100%
B83E	0%	0%	0%	0%	100%	0%	100%

2.3.1 Escarpment Zone

This zone forms is found in the south-western part of the catchment, where it constitutes the Transvaal Drakensberg mountain range. The Escarpment zone ranges from Wolkberg sedimentary rocks in the south, to primarily Vaalian age intrusive granites intruded into Goudplaats gness in the central zone, to Goudplaats gneiss in the northern region. Scattered xenoliths of ultramafic schists, amphibolite and magnetite quartzite of the Pietersburg Group exist throughout. Numerous north-east, south-west striking dykes have also intruded the area.

Rainfall exceeds 1000 mm/a, except in the upper Kudus and Middle Letaba valleys where rainfall is 600 mm/a due to the rain shadow effect of the Duiwelskloof mountains. The main aquifers are associated with fractured dyke contact zones and lithological contact zones (DWAF, 1990). Although they may be highly permeable, storage in these fractured aquifers is very limited, especially where a deep overlying weathered zone is absent. As a result they may provide high initial yields, which decline rapidly as the larger joints and fractures are dewatered.

On the steep slopes that generally exceed 15^{o}, recharge to these aquifers is rapidly discharged in the forms of springs, which provide baseflow to the rivers that may exceed 200 mm/a, however, these resources are not directly exploitable by the regional aquifers that occur in the valley bottoms. As a result, a large fraction of recharge generates interflow and cannot be directly exploited through boreholes. Interflow can be depleted by commercial afforestation and alien vegetation, or by transmission losses downstream where abstraction causes the water level to drop below the river, inducing losses from the river to the aquifer.

To a lesser extent, as a result of the steep topography, an intermittent weathered zone aquifer is found where deep weathering occurs. The steep topography generally inhibits deep weathered profiles, hence weathered zone aquifers are generally found only at the top of the escarpment where the Pietersburg plateau exists, or in valley bottoms. Where these weathered zones exist they provide storage of groundwater which feeds the underlying fractured aquifer when it is subjected to pumping.

Groundwater yields typically vary between 0.5 and 1.5 l/s and groundwater quality is expected to be good, with Total Dissolved Salts (TDS) being less than 500 mg/l. Groundwater generally occurs in fractures situated on average 10 m below the static water level.

Although recharge is high, up to 40% of boreholes are dry, indicating that the bulk of recharge does not enter the regional fractured aquifer, but is shed as interflow from shallow fractures above the regional water level. Furthermore, it should be noted that groundwater has a rapid turn-over time in the aquifers and is soon discharged in the form of springs, contributing significantly to stream flow. Spring yields vary between 1 and 3 l/s.

Forestry and natural forest occurs along the escarpment. The escarpment area is ecologically sensitive and represents an important groundwater recharge zone and interflow region where uncontrolled development will have adverse impacts on baseflow.

2.3.2 Drakensberg Foothills and Valleys

The Drakensberg foothills and valleys has a the geology is similar to the Escarpment zone, except that gabbroic and dioritic rocks of the Rooiwater Complex, and greenstones of the Gravelotte Group are intruded by the Vaalian age granitoid rocks in the extreme south. Rainfall is 500 - 1000 mm and slopes are generally flat to moderate, with slopes generally less than 15%.

The aquifers are of a composite type, consisting of fractured zone and overlying weathered zone aquifers (DWAF, 1990). Deep weathering occurs along rivers and streams and dyke contact zones are highly fractured. The Rooiwater aquifer is deeply weathered and is generally of the weathered type. This region differs from the Escarpment zone in that baseflow is generated from the regional aquifer as groundwater baseflow, and the flatter nature of the terrain allows for more extensive evapotranspiration from groundwater from shallow water table regions.

Scientifically sited boreholes yield more than 3 l/s and approximately 30% of all boreholes drilled are expected to be dry. Groundwater quality is good to fair and TDS of up to 1000 mg/l are expected. Borehole yields in the northern granite areas tend to be in the 2 – 5 l/s range with local areas of deep weathering and good structural development supporting yields >5 l/s.

The aquifers are extensively used by rural water supply boreholes. A fair proportion of these boreholes are situated in the granite aquifer. Boreholes had yields ranging between 0.5 to 3.0 l/s and less than 30% were dry.

As a result of the lack of sanitation facilities, elevated nitrate concentrations commonly occur in groundwater. The hardness of granites and consequent shallow depth of weathering aggravates the impact of contamination of granite aquifers in the absence of adequate sanitation systems and uncontrolled animal grazing, both of which are part of the rural population's lifestyle.

The Granite aquifers meet the domestic demand of the communities in the area around Tzaneen and Letsitele. Extensive sub-tropical agriculture is practised in the south of the Lowveld plain east of Tzaneen, especially along the Letaba River. Groundwater is reported to be used for supplementary irrigation along the Letaba River.

Groundwater development for irrigation purposes takes place on a large scale at Letsitele (1 to 2 million m^3/a), Mooketsi (2 to 5 million m^3/a). Very few intrusive hydrogeological investigations have been carried out to conceptualize and quantify groundwater flow, recharge and the water balance to enable long-term aquifer management.

Large-scale irrigation of permanent crops, i.e. citrus, mango, avocado, banana, litchi and macadamia nuts takes place at Letsitele and Mooketsi to the east and north of Tzaneen, conjunctively using surface and groundwater. The 1000 ha large tea plantations of SAPICO are situated on the plateau. The sole reliance of farmers on permanent crops makes agriculture, which is the most important economic activity in the greater Tzaneen area, very sensitive and highly dependent on the water supply conditions. In general, large-scale irrigation and agricultural activities reduce considerably towards the 'drier' east.

These aquifers are very vulnerable and sensitive to changes in rainfall patterns during droughts. During times of drought, boreholes dry out if not managed properly. Extensive forestry and agricultural activities in and around Tzaneen also impacts on the volumes and quality of groundwater flowing back to the Letaba River as baseflow.

2.3.3 Bandelierskop

This granitic area lies immediately south of the Soutspansberg Mountains. The western areas form the escarpment trending north from Tzaneen towards Thohoyandou. Below the escarpment, the Lowveld forms a gently rolling to flat landscape.

The Bandelierskop region consists of mafic volcanic and pelitic rocks infolded into basement gneisses, as well numerous NE trending diabase dykes and some xenoliths of the Pietersburg Group. Intrusions of Valian age granites, and granites and gabbros of the Schiel complex also occur.

Significant faulting is also evident. The regional MAP is 500 - 1000 mm. The region is hilly and has slopes of 5 - 15°.

Groundwater occurrence is controlled by the presence of weathering zones and structural features. Fractures and faults formed by the various deformational phases and dykes are thought to constitute the main aquifers as a result of deeper weathering. A considerable number of water supply boreholes were installed in this aquifer to meet the basic human need requirements of rural communities. Borehole yields are generally less than 1.5 l/s, however higher yields are associated with faults. Local areas of deep weathering and good structural development can result in yields >5 l/s, such as on well-developed regional structures and faults.

Boreholes are generally 70 – 100 m deep and water levels 15 – 40 m below surface depending upon the topography.

Groundwater quality is generally good (Class 1) to moderate (Class 2) with conductivities between 70 and 300 mS/m. Elevated NO_3 levels are reported in many of the settlements.

2.3.4 Giyani-Gravelotte

This greenstone belt region includes highly metamorphosed ultramafic to mafic schist, amphibolite, mafic meta-lava, quartzitic schist, quartzite and ironstone. Local fractured aquifers dominate this region as a result of the intense folding and associated fracturing. Rainfall varies from 500-600 mm/a and the topography is generally flat, except where steep ridges where quartzite and ironstone formations outcrop.

These lithologies form a SW – NE trending outcrop in the central part of the Letaba and Shingwidzi catchments between the Molototsi river in the south and Shingwidzi in the north, and a southern outcrop sub-paralleling the boundary with the Olifants catchment. These areas form a hilly landscape and are characterised by numerous gold, silver, copper, nickel and zinc deposits and small abandoned mines.

Much of the central area around Giyani and the area around Letsitele in the south comprise communal lands. These areas rely on groundwater for domestic supplies and stock watering. Large-scale groundwater abstraction used to take place at Giyani for domestic purposes. Localized low yielding boreholes are also in use by various rural communities to meet their basic human need requirements.

Groundwater occurrence is controlled by the presence of weathering zones and structural features and tends to be favourably developed especially within the mafic and ultramafic units.

Borehole yields in the central area average 2 – 5 l/s with local areas of deep weathering and good structural development supporting yields >5 l/s. The groundwater resources are less well developed in the southern areas and yields tend to be between 0.5 and 2 l/s. Boreholes are generally 70 – 100 m deep and water levels 15 – 30 m below surface depending upon the topography.

Groundwater quality is generally moderate to good with conductivities between 70 and 300 mS/m. Elevated NO_3 levels are reported in many of the settlements.

2.3.5 The Lowveld Plains

This region covers underlies the largest part of the plains of the central Letaba to approximately the Kruger Park eastern boundary.

These aquifers are composed largely of fractured Goudplaats gneiss, with xenoliths of undifferentiated metamorphic rocks and meta-arenaceous rocks (quartzite, gneiss and migmatite). In the east the Timbavati Gabbro and numerous diabase dykes are intrusive.

Rainfall varies from 500 - 600 mm/a. Groundwater occurrence is controlled by the presence of weathering zones and structural features. Yields are lower than in the footfills to the west, and tend to be between 0.5 and 2 l/s. Where local weathering is shallow and structural features limited, yields are <0.5 l/s. Boreholes are generally 70 – 100m deep and water levels 15 – 40 m below surface depending upon the topography.

Much of the Lowveld area comprises communal lands. There has been heavy dependence on groundwater in Giyani (B81H and J, B82F, G, H, and J), Sekgosese (B82D) Bolebedu (B81E, F and G), and NW of Phalaborwa (B81F and J), however, many of these have been converted to surface water schemes. Conjunctive use schemes supply many of the communities, particularly in the Giyani area.

In addition to the above, localized groundwater use for domestic and game watering purposes is widespread at the various game farms in the area from Phalaborwa to Hoedspruit and various rural water supply boreholes exist with yields ranging between 0.5 and 3.0 l/s.

Localized use of granite aquifers for domestic and game watering purposes in granite aquifers also takes place on private game farm property to the east. Several boreholes have been drilled in the Kruger Park and are utilized by private game reserves in the vicinity. Although the Park obtains most of its domestic supplies from surface water, there is a concern that private game reserves might overexploit groundwater resources to supplement game viewing water holes.

Groundwater quality is generally moderate to good with conductivities between 70 and 300mS/m, Class 1 or 2. Elevated NO_3 levels are reported in many of the settlements.

Groundwater levels are generally below stream level, hence baseflow is unlikely to be generated except in exceptionally wet periods. In general, all aspects surrounding the groundwater/surface water interaction need to be investigated further.

2.3.6 Lebombo

This region is situated in the east and underlies the Kruger Park. The geology consists of a thin basal sequence of Clarens Formation sandstone overlain by basalts and rhyolites at the eastern margin. Intrusions of granophyre also exist in the east. The Mean Annual Precipitation (MAP) is less than 500 mm. Borehole yields are generally less than 0.5 - 1.5 l/s and a large fraction are dry. Static water levels are between 15 and 30 metres below ground level (mbgl), and boreholes are generally 50 – 80 m deep. The groundwater resources of the fine grained rhynolite are marginal.

The basalt forms the wide north south trending central plains and gently rolling countryside of the northern part of the Kruger National Park from Pafuri in the north to Letaba in the south. Rhyolite forms the higher ground of the degraded Lebombo range along the Mozambique border in B83C, D and E.

2.3.7 Alluvium

Primary aquifers, consisting of saturated alluvium, are often present along major river drainage systems and are composed of unconsolidated clayey silts to coarse gravels and boulders. The highest yielding aquifer of this type is present in the south-eastern and eastern regions of the Letaba catchment, mostly in the Kruger Park. In the middle and upper reaches of the Klein Letaba and Molotsi rivers alluvial deposits of up to 150 m wide and 8 m thick are present.

These aquifers extending along the river course can be up to 500 m in width and up to 10 m thick. The average borehole yield of this aquifer is more than 5 l/s. During the rainy season, up to 20 l/s per borehole can be abstracted. However, the yield diminishes during the dry season if the volume of storage is limited or if there is no recharge from the host rock.

Groundwater quality in these aquifers is highly variable and a decrease in yield in the dry season is normally accompanied by an increase in salinity.

Alluvial aquifers form isolated local aquifers along major river courses and are recharged during periods of high streamflow and discharge once again to the river once stream stage drops. Since they are recharged by surface water rather than conventional direct groundwater recharge, their maintenance depends on ensuring periods of high flow to replenish bank storage, and their use result in significant flow depletion as transmission losses.

They exist in delicate equilibrium with surface water and ecosystems present along the river course. In terms of the future exploitation potential of these aquifers, the sensitivity of ecosystems along the Letaba River to a drop in water table resulting from a change in the flow regime need to be evaluated.

These sand deposits generally obtain water, either directly from the surface flow of the river, or from sand abstraction schemes constructed in the river bed sediments. Well points offer a means of abstracting water from rivers from the subsurface flow and storage within the sand aquifers after the visible flow has ceased. Usually these schemes operate until the subsurface flow has diminished and the water level has declined to such an extent that the volume of water delivered is no longer viable for the intended use.

3 APPROACH

3.1 RIVERS

3.1.1 Water quality

Four levels of RQOs were identified during the Letaba Classification study. Water quality RQOs were produced for:

- *Level 2 RQOs, but only when water quality was identified as a component of interest;*
- *Level 3 RQOs, which are high priority sites and may be EWR sites (Level 3b).*

The water quality component of developing Level 2 and 3 RQOs was undertaken as follows:

Level 2 RQOs: *No detailed water quality assessment was conducted. PESEIS data and literature sources (e.g. DWA, 2012b; 2013a,b) were used for the assessment.*

Level 3a RQOs: *Detailed RQOs were produced for water quality using any existing information as these are high priority water quality sites (e.g. the Brandboontjies).*

Level 3b RQOs: *Detailed water quality assessments had been conducted for the Reserve study using Tool for Ecological Aquatic Chemical Habitat Assessment (TEACHA) and Physico-chemical Driver Assessment Index (PAI models) (DWAF, 2008).*

Numerical and narrative RQOs were produced using all existing data sources, particularly the preliminary water quality objectives produced by DWA Water Quality Planning (DWA, 2010a). Objectives were produced for the Levuvhu, Shingwedzi, Letaba and Groot Letaba sub-catchments using data from identified monitoring points, and for the following users:

- *Ecological requirements.*
- *Domestic use; assumes primary treatment.*
- *Agriculture - Stock watering.*
- *Agriculture – Irrigation.*
- *Industrial - Category 3.*
- *Recreation - Intermediate contact.*

Note that although preliminary objectives were available for a number of sub-catchments, they were not available for tributaries. Objectives used to produce RQOs were therefore those for the Letaba and Groot Letaba only.

Preliminary objectives were expressed in terms of Ideal, Acceptable and Tolerable categories for a range of water quality variables. The most sensitive user was identified per variable and the preliminary objective set in terms of that user's requirements (DWA, 2010a). This approach was followed for setting water quality RQOs for identified reaches.

Completing water quality RQOs
Background information was provided under the following headings per relevant SQ. An example is provided below:

Source: *Water quality assessment was conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b).*
Model*: TEACHA and PAI models (DWAF, 2008)*
Users, with the most sensitive user(s) shown in bold: *Forestry and some* **irrigation***.*

Water quality issue: *The area is predominantly forested (Eucalyptus and Pinus species). Water is abstracted for irrigation (cultivated lands – bananas, mangos and tea plantations), with few rural/urban settlements present. Slight nutrient elevations are therefore the main water quality issue.*

Narrative and numerical RQOs were then produced following the assumptions shown below:

- *Microbial compliance targets for the Waste Water Treatment Works (WWTW) are not specified as numerical RQOs, as these would be specified in the water use license for the discharge.*
- *Run-of-river objectives (faecal coliforms and Escherichia coli) are focused on full contact recreational use, e.g. swimming and boating, and not water used for drinking. It is assumed that run-of-river water is not used for domestic use UNLESS primary treatment has been undertaken. Objectives for domestic use, such as drinking untreated water from the river, are therefore not covered in the water quality RQOs.*
- *Detailed EcoSpecs and TPCs are provided for the EWR sites, as available from the Reserve study of 2006 (DWAF, 2006c). Note the following conditions:*
    - *A distinction must be made between RQOs and the Reserve template for water quality, i.e. both that for the ecological component and that for basic human use; particularly for salts. Aggregated salts are provided as objectives for the ecology in the Ecological Reserve template (where available and generated from ions using TEACHA), while salts appear as ions for basic human use in the Basic Human Needs part of the Reserve template. These standards are enforced through the licensing process and are a measure for managing water quality state IN ADDITION to RQOs.*
    - *Issues related to the use of TEACHA, data storage, and the use of salts data (i.e. ions vs salts vs Electrical Conductivity), are issues related to Reserve methodology and not to the development of RQOs.*
    - *It is assumed that the person using TEACHA to produce aggregated salts will be a DWA water quality or Reserve practitioner that is conducting the water quality component of the Reserve monitoring. Reporting regarding EcoSpecs, TPCs and monitoring for the water quality part of the Ecological Reserve always specifies that someone trained in water quality will have to conduct this component.*

3.1.2 Fish

The available information, as provided in the PESEIS project (DWA, 2013b) was used as the primary fish information source for RUs with a level 2 priority rating. A version of the PESEIS Model that allows the determination of expected Frequency of Occurrence (FROC) of fish in a reach (Pers. Comm., Kleynhans, 2014) was used as a starting point to determine the expected (Reference) FROC. This was based on the length of relevant geozones within a reach where a specific species is expected to occur, in relation to the length of the entire reach. Aerial footage (Google earth) and all relevant available information were used to determine the expected present suitability of the reach for each species (indicated as percentage change from natural). This information (PESEIS Pers. Comm., Kleynhans, 2014) was then transferred to the Fish Response Assessment Index (FRAI) (Kleynhans, 2007) and refined using additional information and professional judgement.

The FRAI results were then used to identify sub-component indicators (such as PES, species richness, primary and secondary indicator species) and describe the narrative and numerical RQOs for each of this sub component indicators for the reach.

Monitoring

EWR sites*: Fish surveys should be done at representative sites within the EWR SQ reach. At least two different sites or various different sub-sites at the EWR site should be sampled. The minimum sampling effort per site should be electrofishing for a minimum period of 20 minutes. The preferred habitats of the primary indicator species (generally fast flowing habitats, fast-deep and fast-shallow/rapids/runs/riffles) should be targeted to determine the presence/absence of the species at the site. Other methods should also be applied where applicable, especially when targeting indicator species in specific habitat. This can include methods such as 10 sweeps with a 4m pole seine net in pools (slow-deep or slow-shallow), or electrofishing overhanging vegetation in shallow pools when searching for indicator species with a preference for these habitat features.*

The data gathered during these surveys should be used to run the FRAI and the results should then be used to determine whether any of the Thresholds of Potential Concern (TPCs) has been reached (preferably use the FRAI model populated as part of the reserve study as a starting point). The information used in the compilation of the initial FRAIs should be verified and refined as more information (actual fish data) becomes available. Should TPCs indicate possible deterioration or "red flags", reference should be made to other available information and more detailed or focussed fish surveys may be required.

Level 2 reaches: *It is unlikely that routine fish monitoring will be applied in these reaches. Fish surveys may however be initiated should developments or activities in the catchment significantly jeopardise the ecological status of the reach. These fish surveys should ideally follow the same approach as described for the EWR site reaches. Should this not be viable, electrofishing should at least be applied for a minimum of 20 minutes at a representative site (and preferably at various sub-sites at the representative site). The sampling should focus especially ion the preferred habitat of the indicator species identified for the reach. Fish results gathered as part of ad hoc studies (biomonitoring programmes, environmental impact assessment, water use licence monitoring) should also be stored in a central database and used to assess the ecological status, based on fish, for these reaches.*

The results gathered through any fish surveys in an SQ reach should be used to run the FRAI (preferably use the FRAI model populated as part of this study as a starting point). The information used in the compilation of the initial FRAIs should be verified and refined as more information (actual fish data) becomes available. The results should be used to verify whether the RQOs for the reach are met and to identify any potential deterioration.

3.1.3 Macro-invertebrates

In the approach to establish EcoSpecs for the Level 2 sites, the following steps were used:

- *The reach was examined by using Google Earth images of the node and the dominant habitat types were identified.*
- *Historical data or extrapolated data (obtained from the PESEIS files (DWA, 2013a)) was used to list the expected macro-invertebrate taxa.*
- *By linking the habitat information and the macro-invertebrate taxa expected, the key species per habitat (maximum 2 species) are written in as an EcoSpec for the most sensitive habitat as listed below:*
  - *Rapid velocities: >0.6 m/s in the stones-in-current (SIC) biotope*
  - *Moderate velocities: 0.3 - 0.6 m/s in the SIC biotope.*
  - *Marginal vegetation.*
  - *Acceptable water quality.*
  - *Remaining pools in the stream bed (seasonal).*

Monitoring

Monitoring should take place in winter (between July and August), using the South African Scoring System (SASS) method (Dickens and Graham, 2002).

Sampling should be undertaken separately in each of the following biotopes if they are present:

- *Riffle.*
- *Run (may differentiate shallow, slow trickle run from deep/fast run).*
- *Stones out of current (backwaters).*
- *Emergent vegetation in current.*
- *Submerged vegetation.*
- *Vegetation out of current (usually emergent).*
- *Sand/gravel.*

The Macro-invertebrate Response Assessment Index (MIRAI) (Thirion, 2007) should also be used to determine the Invertebrate EC. It is done by integrating the ecological requirements of the invertebrate taxa in a community or assemblage and their response to modified habitat conditions.

3.1.4 Riparian vegetation

The following vegetation components, when assessed together, satisfactorily describe the overall state of the riparian zone:

- *Invasion by perennial (and in some cases annual) alien species.*
- *Terrestrialisation (the disproportionate abundance of terrestrial species within the riparian zone).*
- *General vegetation structure and composition as shown by proportions of riparian woody species, reeds and non-woody species (grasses, sedges and dicotyledonous forbs).*

Please note the hypotheses that underpin the RQOs need to be refined by the Decision Support System (DSS) (ideally each hypothesis should be tested in a research environment).

Invasion of the riparian zone by alien species

The hypothesis relating aerial cover of alien species to the EC of the riparian zone is shown in Table 3.1. Data from the Crocodile and Sabie rivers were used to establish the hypothesis, which has been adjusted for use on the Letaba System (DWA, 2010b). The relation of the EC (as determined by an overall approach using the Vegetation Response Assessment Index (VEGRAI – Kleynhans, et al., 2007) of a site/reach to the permissible aerial cover of perennial alien species is a general rule of acceptance rather than a deterministic relationship, since the overall EC is a function of multiple deviations from the reference condition, and not merely the abundance of alien species.

Table 3.1 Hypothesis for the acceptance levels (% aerial cover) of perennial alien species within the riparian zone, given the overall EC of the zone

EC	% Cover (perennial aliens)
A	*0*
A/B	*<10*
B	*10 - 20*
B/C	
C	*20 - 30*
C/D	

D	30 - 50
D/E	
E	50 - 70
E/F	
F	>70

Terrestrialisation

Terrestrialisation is the disproportionate abundance, density or occurrence of terrestrial species within the riparian zone. Under reference conditions woody terrestrial species are not expected in the marginal zone, are expected to be transient (if any) in the lower zone due to frequent flooding disturbance, and are expected to occur in the upper zone in numbers concurrent with natural flooding frequency, magnitude and duration for the reach (i.e. hydrologically controlled abundance). In cases where RQOs were set for the riparian obligate/terrestrial species mix, it was always for the upper zone since this is the area where terrestrialization first manifests, and in all cases the previous EcoSpecs were used to define RQOs (DWA, 2006c).

Indigenous Riparian Woody Species Cover

The hypothesis of expected aerial cover of indigenous riparian woody vegetation is applicable to sites/reaches where the climax community of the macro-channel bank and alluvial bars is dominated by woody riparian obligates (Table 3.2). In the absence of unnatural disturbance the proportion (% cover) will tend to increase to values as high as 70 or 100% of suitable habitat.

This hypothesis is for Lowveld Bushveld rivers (generalised) and is based on a dynamic whereby riparian vegetation in the lower and upper zones will always tend towards increased woody cover with diminishing non-woody cover (including reeds), this being "reset" by large flood events. "Reset" here refers to the removal of woody plants by floods, the resulting open space being available for quick colonising non-woody species (including reeds). The hypothesis assumes that if woody cover increases beyond a given value and remains high, that the flooding regime has been changed so that large floods are smaller or less frequent or both.

Table 3.2 The hypothesis relating EC to expected aerial cover of indigenous riparian woody vegetation in different sub-zones of the riparian zone

EC	Marginal Zone	Lower Zone	Upper Zone
A	10 - 20	20 - 40	40 - 50
A/B	20 - 40		
B	40 - 60; 5 - 10	10 - 20; 40 - 60	30 - 40; 50 - 60
B/C	60 - 70		60 - 70
C	70 - 80; 1 - 5	5 - 10; 60 - 70	20 - 30; 70 - 80
C/D			80 - 90
D	>80; 0	<5; 70 - 80	10 - 20; >90
D/E			
E		>80	5 - 10
E/F			
F			<5

Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs)

The hypothesis of expected aerial cover of indigenous non-woody vegetation is shown in Table 3.3.

Table 3.3 Hypotheses for expected indigenous non-woody cover in relation to EC

EC	Non - woody indigenous cover (grasses, sedges and dicotyledonous forbs)
A	*70 - 80*
A/B	*60 - 70*
B	*50 - 60; 80 - 90*
B/C	*40 - 50*
C	*30 - 40; >90*
C/D	
D	*20 - 30*
D/E	
E	*10 - 20*
E/F	
F	*<10*

***Phragmites* (reeds) cover**

In both VEGRAI and Rapid Habitat Assessment Method (RHAM) (DWA, 2009), reeds are classified as non-woody, and although they are a grass, their importance in riparian structure and function warrants their separate assessment in terms of RQOs, EcoSpecs and TPCs. The expectations for aerial cover of reeds in relation to EC are shown in Table 3.4. This hypothesis for Lowveld Bushveld rivers (generalised) is a corollary to the riparian woody cover hypothesis i.e. it is based on a dynamic whereby riparian vegetation will always tend towards increased woody cover with diminishing reed cover, this being "reset" by large flood events. "Reset" here refers to the removal of woody plants by floods, the resulting open space being available for quick colonising reeds. The hypothesis assumes that reeds will colonise open alluvium (similar to the pioneer species concept) created by floods, and will increase in cover until slowly replaced by woody vegetation as shading occurs. A natural flow regime will create a patch mosaic of woody versus reeded areas, thus a mix is always expected (in the absence of very infrequent extreme events); an increase in reed cover beyond a specified value is seen to be a loss of riverine diversity and as such will begin to reduce the EC. Reeds would decrease with increasing proportions of bedrock, hence in bedrock anastomosing sites all values would have to be decreased before application.

Table 3.4 Hypotheses for expected *Phragmites* (reed) cover in relation to sub-zones within the riparian zone and EC

EC	Marginal Zone	Lower Zone	Upper Zone
A	*60 - 80*	*40 - 60*	*20 - 30*
A/B	*40 - 60*	*60 - 70*	
B	*(20) 30 - 40; >80*	*(20) 30 - 40; 70 - 80*	*<20; 30 - 40*
B/C			
C	*10 - 20*	*10 - 20; 80 - 90*	*40 - 50*
C/D			
D	*1 - 10*	*1 - 10; >90*	*50 - 60*
D/E	*0*	*0*	
E			*60 - 70*
E/F			
F			*>70*

Riparian zone integrity

Since riparian zone integrity was an integral factor in the PESEIS assessment (DWAF, 2013b) and since it is an important measure of riparian condition within a reach, it was used to define certain riparian RQOs for each reach. Added to this, it is a characteristic of the riparian zone which lends itself to assessment from satellite imagery and hence is easier and quicker to measure, while remaining meaningful.

Longitudinal riparian zone continuity

Similarly, since longitudinal riparian zone continuity was also an integral factor in the PESEIS assessment (DWAF, 2013b) and since it is another important measure of riparian condition within a reach, it was additionally used to define certain riparian RQOs for each reach. Riparian zone continuity is also a characteristic of the riparian zone which lends itself to assessment from satellite imagery and hence is easier and quicker to measure, while remaining meaningful.

3.2 WETLANDS

In the Letaba system distinction was made between Level 2 and Level 3 RQOs for wetlands and reliance was made on previous data and assessments such as the wetland scoping phase (DWAF, 2006A), wetland assessments during the Classification project (DWA, 2013a) and extensive data from the PESEIS project (DWA, 2013b). All wetlands that were MODERATE or HIGH in importance, or were specialised (e.g. thermal springs) were included for the development of Level 2 RQOs. Level 3 RQOs were only developed for high priority RUs where wetlands also occurred, or for specific SQs where wetland EI was HIGH.

Level 2 RQOs were based on the most current assessments of PES and Ecological Importance (EI) of wetlands as well as the IHI for wetlands. In each case the narrative RQO was to maintain the current (2013) EC (e.g. B/C) and EI (e.g. HIGH). Value scores for each of the EC, EI and IHI were used for numerical RQOs. An example of Level 2 RQOs for a thermal spring is shown in Table 3.5 below.

Table 3.5 Example of Level 2 RQOs (narrative and numerical) for a thermal spring on the Great Letaba

SQ	River	Subcomponent indicator	Narrative RQO	Numerical RQO
B81F-00200	Great Letaba	Wetland PES	Maintain EC of C.	Maintain wetland EC score above 67%.
		Integrated wetland importance and sensitivity and IHI	Maintain MODERATE EI	Maintain Median EI score equal to or above 2 and IHI score equal to or above 1.6.

Level 3 RQOs are mostly narrative only, and include a general RQO aimed mostly at the largest impact/s to wetland integrity and continuity, as well as RQOs for several wetland components including Hydrology, Geomorphology, Vegetation, Mammals, Birds, Amphibians, Reptiles and where applicable Fish. Data emanating from PESEIS project (DWA, 2013b) was used for these more detailed RQOs. An example of a general RQO for wetlands that are surrounded and encroached by forestry is "Wetland fragmentation shall not increase (from 2013 state). There shall be no expansion of forestry [or agricultural where applicable] activities into wetlands and existing forestry shall not expand or intensify towards wetlands".

3.3 GROUNDWATER

The approach to developing the RQOs is shown in Figure 3.1.

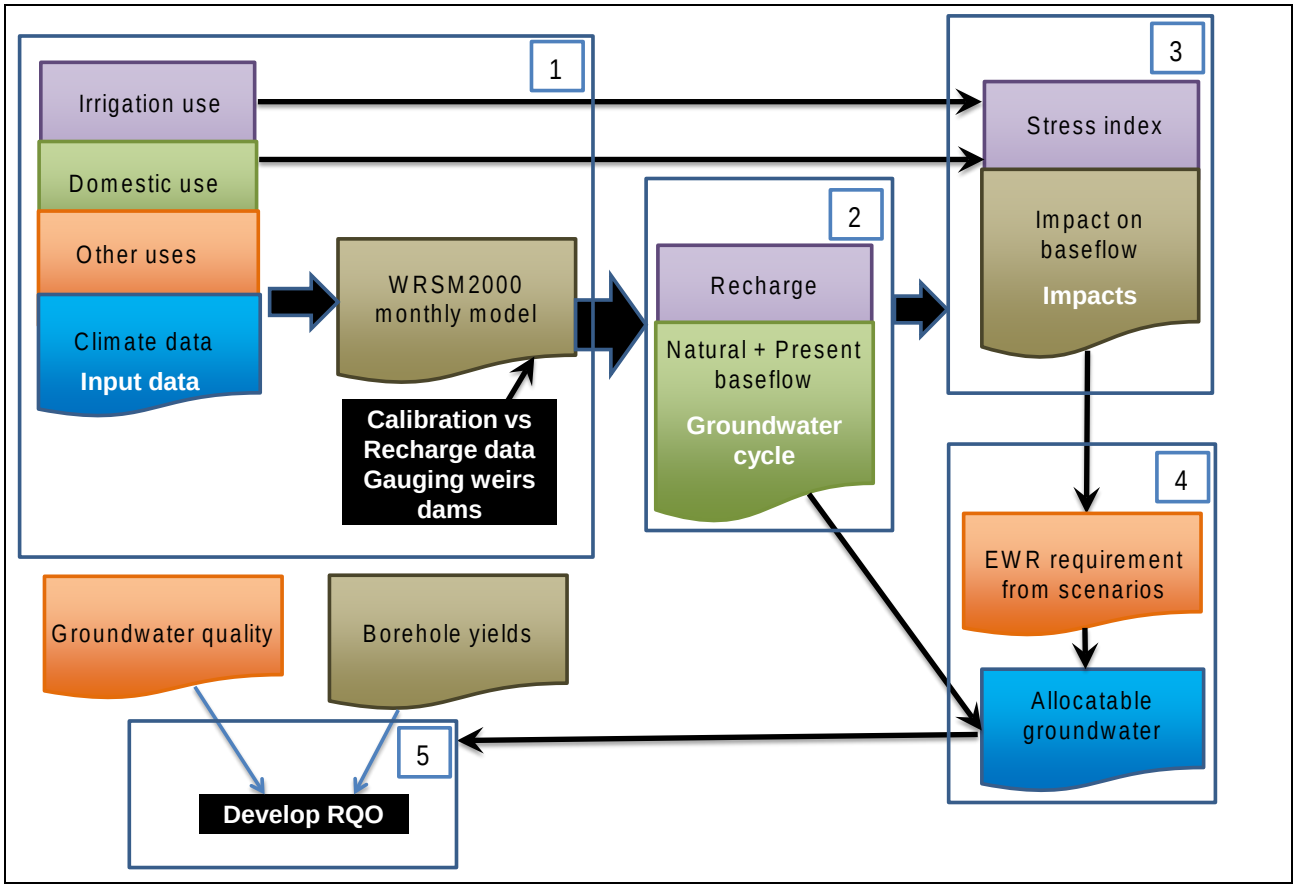


Figure 3.1 Approach to developing groundwater RQOs

The process followed to develop the RQOs was a 5 stage process:

1. *Data on surface and groundwater use and climatic data, together with hydrological parameters were entered into the WRSM2000 model to quantify surface and groundwater resources and interactions, such as recharge and baseflow and evapotranspiration from shallow groundwater. The model was run from 1920 - 2010 and calibrated against DWA flow gauging data, dam volumes, and recharge data such as in the Groundwater Resource Assessment Phase II (GRA2) (DWAF, 2006d). For groundwater, calibration included calibrating recharge, aquifer recharge and interflow to fit observed low flows, and flow depletion due to abstraction.*
2. *The abstraction and afforestation was removed and WRSM2000 was run under virgin conditions. Data was extracted from the model to determine the ground balance in terms of recharge, aquifer recharge, interflow, groundwater baseflow and evapotranspiration, both under virgin conditions and with groundwater abstraction at present day levels.*
3. *Present day ground water use was divided by aquifer recharge to determine the stress index of the units. Impacts on baseflow were determined from baseflow reduction under present day abstraction relative to virgin baseflow.*
4. *The allocatable groundwater was determined from the difference between present day abstraction and aquifer recharge.*
5. *Data from the above steps were utilised to develop qualitative and quantitative RQOs, and estimate reductions in baseflow from further groundwater abstraction.*

Groundwater data was synthesised for each quaternary catchment in each IUA in order to determine:

- *Borehole yields and groundwater quality as limiting factors for groundwater use.*
- *Existing groundwater use and stress index (total use/aquifer recharge).*
- *The Harvest and economic Exploitation Potentials.*
- *Recharge and aquifer recharge (which excludes the component of recharge lost as interflow and not available to groundwater users).*
- *Groundwater contribution to baseflow, interflow and total baseflow.*
- *The Natural Mean Annual Runoff (MAR), and the present MAR resulting only from present day groundwater abstraction.*
- *The reduced baseflow that would occur if groundwater abstraction would be increased to the harvest potential.*
- *Significance of baseflow to the catchment.*
- *Groundwater numerical RQO for the protection of baseflow.*

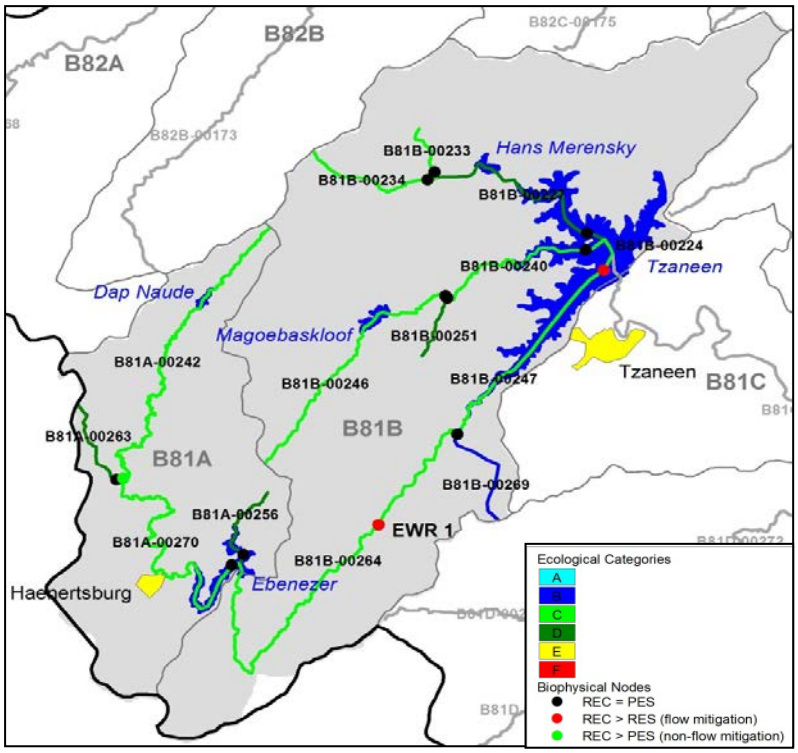
4 IUA 1: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The management of IUA 1 is related to the inter-basin transfers, forestry, run-of river and groundwater abstractions, and operation of various dams with limited operational capabilities. Impacts on the river ecology are mostly flow related, inundation, sedimentation and alien vegetation encroachment. Management options will be limited flow management and possible abstraction allocation reductions, and catchment management that include alien vegetation removal and establishment of a riparian buffer zone.

IUA 1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table. Shaded cells indicate SQs for which EWR data is applicable.

IUA 1 - LETABA UPSTREAM OF TZANEEN DAM



PRIORITY RATINGS

SQ	River	Priority rating
B81A-00242	*Broederstroom*	*2*
B81A-00256		*2*
B81A-00263		*2*
B81A-00270	*Broederstroom*	*2*
B81B-00233	*Mahitse*	*2*
B81B-00234	*Mahitse*	*1a*
B81B-00246	*Politsi*	*2*
B81B-00251		*1a*
B81B-00269	*Morudi*	*2*
B81B-00227	*Mahitse*	*2*
B81B-00240	*Politsi*	*2*
B81B-00247	*Great Letaba*	*3a*
B81B-00264 (EWR 1)	*Great Letaba*	*3b*

Water resource use

The IUA is highly regulated by four dams, namely Dap Naude, Ebenezer, Hans Merensky and Tzaneen Dams. Water is transferred out of the catchment from Dap Naude and Ebenezer dams to augment the water supply of Polokwane. There are a number of river abstractions mostly by the irrigation sector and significant volumes of groundwater are utilised by the irrigation sector, with most of the utilisable exploitation potential used in the IUA. Return flows generated from the irrigations sector enter the river systems which has a negative impact on the water quality. Abstractions from groundwater represent a high portion of the Utilisable Exploitation Potential (Potable) and will possibly cause reductions in base flow. The only future surface water resource development planned for the area is the raising of the Tzaneen Dam.

The groundwater response unit consists of largely Drakensberg Escarpment. The groundwater Use is less than 10% of the aquifer recharge is utilised

Water quality
Water quality state is Good, with few impacts other than forestry.

Economy
The main economic activities are the primary industries of sub-tropical fruits, commercial forestry, the secondary industry of tomato processing as well as the tertiary industry of eco-tourism.

EGSA
This area is dominated by commercial farming and forestry. The population densities, relative to the rest of the catchment are on the lower side. Overall the livelihood reliance on ecological goods and services is limited. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. There are significant dams in the area and as such the recreational aspects of the ecological goods and services attributes are significant in this regard.

River and wetland ecology
The PES of most rivers (Broederstroom, Great Letaba, Politsi and upper Mahitse) in this zone is predominantly a C PES with 57% of the SQ reaches in this zone falling in this Ecological Category. Thirty-six percent of the SQ reaches in this zone falls within a D PES (tributaries of the Broederstroom/Great Letaba, tributaries of the Politsi and the lower Mahitse), while only 1 SQ (7%) falls in a B PES (Morudi, a short tributary of the Great Letaba). The predominant land-use in this zone is forestry and agriculture, with the primary impacts being related to flow modification (damming and forestry), sedimentation, and alien vegetation encroachment.

This zone was highlighted as having potential wetlands (DWAF, 2006a), the bulk of which are seeps (particularly in B81A) and some channelled valley-bottom wetlands (mainly in B81B). The Broederstroom (B81A-00270) was noted in this study for wetland frequency, also mainly seeps and channelled valley-bottom wetland, with an overall wetland C PES.

4.1 RQOs FOR RU B81A-00242 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it has moderate ecological importance, low Socio-Cultural Importance (SCI) and high water resource use importance. The detail of available information also plays a role and there was no EWR site situated in the vicinity.

This RU is in a C PES for the EcoStatus and a B REC. The improvement that would be required is non-flow related (riparian zone) and the flow RQO is therefore set for a C. The recommended scenarios does not impact on this site, therefore the RQOs are set to maintain the REC of a B which is supported by a C EWR.

4.1.1 Flow RQOs

Source: *DWA (2013c).*
Model: *Revised Desktop Reserve Model (RDRM) (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR[1] (MCM)	pMAR[2] (MCM)	Low flows (MCM[3])	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Apr	
							90%	60%	90%	60%
B (C)	23.8	15.2	3.31	13.9	5.22	21.9	0.066	0.069	0.112	0.137

1 Natural Mean Annual Runoff *2 Present Day Mean Annual Runoff* *3 Million Cubic Metres*

4.1.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b; 2013a) were used.*
Model: *Not Applicable (N/A).*
Water quality issue: *Elevated nutrient levels in the reach are primarily due to Lenyenye WWTW not meeting discharge standards and being in a High risk rating. More efficient management of the WWTW will change the Risk rating from High to Medium or Low to meet the specified RQOs.*

Table 4.1 B81A-00242: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are Tolerable.	
Meet microbial compliance targets for the WWTW.	*As specified in the water use license for the discharge.*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

4.1.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Broederstroom	**LARGE:** *Crossings low water, exotic vegetation, roads, vegetation removal.* **CRITICAL:** *Forestry.*	C	B	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 4.2.

Table 4.2 Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*N/A.*
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the REC of a B.*	*Perennial alien plant species aerial cover should be less than 20% (requirement applicable to B Category).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 16.2%; F	*PES of fish is critically modified (possibly in a F Category) as a result of presence of predatory alien trout. Where applicable, alien species should be removed; not allowed to spread and indigenous fish should be reintroduced if possible.*	*Aim to achieve a PES of at least a Category D. Control and remove alien fish species where possible and prevent further introduction of alien species and construction of dams.*

FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
Species richness	*Aim to achieve an indigenous species richness of at least 3 species (reintroduction may be required).*	*Introduce at least the three expected indigenous species (AURA, BLIN, and BNEE) should alien fish be controlled, reduced or restricted.*
Primary indicator species: AURA	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA).*	*Ensure presence of AURA in reach and maintain a Frequency of Occurrence (FROC) at >5% of sites. To attain habitat conditions for AURA to fall in an EC of C, the following flows (maintenance (60%) and drought (90%) flow duration) and habitat suitability should at least be provided: Dry season maintenance flows: At least 0.69 m^3/s to ensure 9% moderate or better habitat suitability and at least 0.061 m^3/s during droughts to provide at least 7% moderate or better suitability. Wet season maintenance flows: 0.137 m^3/s to ensure at least 18% moderate or better suitability and 0.1119 m^3/s during droughts to provide >15% moderate or better suitability.*
Secondary indicator species: Flow: AURA Water quality: AURA Substrate: AURA/BLIN Vegetation: BNEE	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Elmidae	*To maintain suitable conditions for this flow dependent species (moderate velocity: 0.3 - 0.6 m/s) in the SIC biotope.*	
Coenagrionidae	*To maintain suitable conditions in the marginal vegetation for this key species.*	

4.1.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.3.

Table 4.3 Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*B8R006 (Spill - B8H053): Gauge downstream of dam wall measuring spills and releases. Only relevant for section downstream of dam wall.*
Water quality	*Meet biomonitoring requirements as specified in the water use license. This monitoring should be at the specified site or downstream of the Lenyenye WWTW and outside of the mixing zone.*
Habitat	*Rapid Habitat Assessment Method (RHAM) (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone.* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species and express as percentage of riparian zone area.*
Fish	*Fish Response Assessment Index (FRAI) (Kleynhans, 2007).*
Macro-invertebrates	*South African Scoring System version 5 (SASS 5) and Macro Invertebrate Response Assessment index (MIRAI) (Thirion, 2007).*

4.2 RQOs FOR RU B81A-00256 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has low ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there was no EWR site situated in the vicinity. Furthermore, this reach is short (2 km).

Considering the importance, and the fact that this SQ is only 2 km upstream from Ebenezer Dam with non-flow related impacts, the REC has been set to maintain the PES. The recommended scenarios do not impact on this site; therefore the RQOs are set to maintain the REC of a B which is supported by a C EWR.

4.2.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Apr	
							90%	60%	90%	60%
D	16.34	12.18	2.50	15.3	3.57	21.9	0.061	0.064	0.078	0.087

4.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
No name	**LARGE:** *Exotic vegetation, vegetation removal.* **CRITICAL:** *Forestry.*	D	D	*Riparian vegetation*

Habitat and biota RQOs are provided in Table 4.4.

Table 4.4 B81A-00256: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*N/A.*
Aerial cover of alien plant species	*Perennial alien plant species aerial cover within the riparian zone should conform to the REC of a D.*	*Perennial alien plant species aerial cover should be less than 50% (requirement applicable to D Category).*

4.2.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.5.

Table 4.5 B81A-00256: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No applicable gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone.*

	▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species and express as percentage of riparian zone area.*

4.3 RQOs FOR RU B81A-00263 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance, low SCI and high water resource use importance. The detail of available information also plays a role and there was no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

4.3.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2012).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Apr	
							90%	60%	90%	60%
D	5.75	4.00	0.87	15.1	1.26	21.9	0.012	0.021	0.030	0.032

4.3.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
No name	**LARGE:** *Abstraction (run-of river)/increased flows, exotic vegetation, forestry, inundation, vegetation removal.* **SERIOUS:** *Agricultural lands, small dams (farm).*	D	D	*Riparian vegetation* *Instream biota*

Habitat and biota RQOs are provided in Table 4.6.

Table 4.6 B81A-00263: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Longitudinal riparian zone continuity	*Longitudinal riparian zone fragmentation should not increase*	*Zero increase in riparian zone fragmentation (current % of longitudinal riparian zone axis that has woody cover should not decrease). Refer to González del Tánago and De Jalón. (2006) for an example of riparian zone fragmentation.*
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase in forestry within the riparian zone.*
Aerial cover of alien plant species	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 50% (requirement applicable to D Category). The relationship between % alien cover and EC is hypothesised and testable.*
FISH		

Indicators	Narrative RQO	Numerical RQO
PES Desktop FRAI: 35.6%; E	*PES of fish is seriously modified (possibly in an E EC) as a result of presence of predatory alien trout. Where applicable, alien species should be removed; not allowed to spread and indigenous fish should be reintroduced if possible.*	*Aim to achieve a PES of at least a Category D. Control and remove alien fish species where possible and prevent further introduction of alien species and construction of dams.*
Species richness	*Aim to achieve an indigenous species richness of at least 3 species (reintroduction may be required).*	*Introduce at least the three expected indigenous species (AURA, BLIN, and BNEE) should alien fish be controlled, reduced or restricted.*
Primary indicator species: AURA	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA).*	*Ensure presence of these species in reach and maintain a FROC at >5% of sites (in relevant geozones) for AURA.*
Secondary indicator species: Flow: AURA Water quality: AURA Substrate: AURA/BLIN Vegetation: BNEE.	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Simuliidae	*To maintain suitable conditions for this flow dependent species (rapid flows: > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae	*To maintain suitable conditions in the marginal vegetation for this key species.*	

4.3.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.7.

Table 4.7 B81A-00263: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No applicable gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary* ▪ *Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.4 RQOs FOR RU B81A-00270 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has moderate ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

4.4.1 Flow RQOs

Narrative:
Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Apr	
							90%	60%	90%	60%
C	44.47	30.0	8.447	19.0	12.043	27.1	0.112	0.159	0.213	0.25

4.4.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Broederstroom	**LARGE:** *Exotic vegetation, roads, vegetation removal.* **SERIOUS:** *Forestry.*	C	C	*Riparian vegetation* *Instream biota*

Habitat and biota RQOs are provided in Table 4.8.

Table 4.8 B81A-00270: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Natal ghost frog population	*Ghost frog population viability should be maintained.*	*Possibly need to express numerical RQO for Natal ghost frog as density of animals.*
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of forestry within the riparian zone.*
Aerial cover of alien plant species within the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category).* *Note: The relationship between % alien cover and EC is hypothesised and testable.*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES *Desktop FRAI: 41%; D/E*	*PES of fish is seriously modified (possibly in D/E) as a result of presence of predatory alien trout. Where applicable, alien species should be removed; not allowed to spread and indigenous fish should be reintroduced if possible.*	*Aim to achieve a PES of at least a Category D. Control and remove alien fish species where possible and prevent further introduction of alien species and construction of more instream dams.*
Species richness	*Aim to achieve an indigenous species richness of at least 3 species (reintroduction may be required).*	*Introduce at least the three expected indigenous species (AURA, BLIN, and BNEE) should alien fish be controlled, reduced or restricted.*
Primary indicator species: AURA	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA).*	*Ensure presence of these species in reach and maintain a FROC at >5% of sites (in relevant geozones) for AURA.*

FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
Secondary indicator species: Flow: AURA Water quality: AURA Substrate: AURA/BLIN Vegetation: BNEE.	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Trichorythidae	*To maintain suitable conditions for this flow dependent species (rapid flows: >0.6 m/s) in the SIC biotope.*	
Coenagrionidae	*To maintain suitable conditions in the marginal vegetation for this key species.*	

4.4.3 Wetland RQOs

Narrative:

Wetlands of moderate importance occur in quaternary catchment B81A and are mostly seeps associated with the escarpment. Maintaining the wetlands in their current condition is outlined below:

- *Maintain wetland EC score above 67%, and median EI score equal to or above 2 and IHI score equal to or above 1.5.*
- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013a). There should be no expansion of forestry activities into wetlands and existing forestry should not expand or intensify towards wetlands. Integrated wetland importance and sensitivity shall remain Moderate.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species (especially Pines and Bluegums) should not increase in cover or abundance within wetlands. The abundance of Gunnera perpensa (Declining) should not decline.*
- *Mammals: The abundance of dark-footed forest shrews, Angoni vlei rats, and vlei rats or water rats that utilise wetlands shall not decline (data - DWA, 2013b).*
- *Birds: The abundance of herons, ducks, moorhens, greenshank or sandpiper that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013b).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

4.4.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.9.

Table 4.9 B81A-00270: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No applicable gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Field based population assessments of Natal ghost frogs.* ▪ *Delineate and digitise riparian zone (most likely to be desktop based but include*

Component	Monitoring actions and tools
	more detail if available). ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*
Wetland	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery)*

4.5 RQOs FOR RU B81B-00233 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has moderate ecological importance, low SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

4.5.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	2.69	2.08	0.50	18.6	0.738	27.4	0.004	0.010	0.009	0.016

4.5.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Mahitse	**LARGE:** *Agricultural lands.* **SERIOUS:** *Exotic vegetation.*	C	C	*Riparian vegetation* *Instream biota*

Habitat and biota RQOs are provided in Table 4.10.

Table 4.10 B81B-00233: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Mountain wagtail population	*Mountain wagtail population viability should be maintained.*	*No decrease in mountain wagtail density.*
Aerial cover of alien plant species	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category).* *Note: The relationship between % alien cover and EC is hypothesised and testable.*
Longitudinal riparian zone continuity	*Longitudinal riparian zone fragmentation should not increase*	*Zero expansion of existing agriculture within the riparian zone.*
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of forestry within the riparian zone.*

FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 50.8%; D	*Maintain PES of at least D.*	*Maintain the Fish PES in at least a D EC (FRAI ≥ 50%).*
Species richness: BNEE, PPHI, TSPA	*Maintain current fish species richness.*	*Maintain current species diversity of at least 3 species (BNEE, PPHI and TSPA) (do not allow more than 10% deviation from species estimated for SQ reach).*
Primary indicator species: BNEE	*Flows should be adequate to ensure suitable habitats for BNEE.*	*Ensure presence of BNEE in reach and FROC should not decrease >10% from baseline value (to be established should monitoring be implemented).*
Secondary indicator species: Flow: BNEE Water quality: BNEE Substrate: BNEE Vegetation: PPHI/TSPA	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Belostomatidae and Nepidae	*To maintain suitable conditions in the marginal vegetation (wetland seeps) for these key species.*	

4.5.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.11.

Table 4.11 B81B-00233: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauges.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Make use of Southern African Bird Atlas data to assess mountain wagtail density changes.* ▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.* ▪ *Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.6 RQOs FOR RU B81B-00234 (LOW PRIORITY – 1A)

The RU is of low priority (Level 1) as it is in a C PES, has moderate ecological importance, low SCI and moderate water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

4.6.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	10.13	8.06	2.15	21.2	3.013	29.8	0.061	0.108	0.060	0.169

4.6.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Mahitse	**LARGE:** *Irrigation, vegetation removal.* **SERIOUS:** *Agricultural lands, exotic vegetation.*	C	C

4.7 RQOs FOR RU B81B-00246 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has moderate ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

4.7.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Mar	
							90%	60%	90%	60%
C	36.3	20.8	3.6	10	6.4	17.7	0.008	0.015	0.04	0.094

4.7.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Politsi	**LARGE:** *Exotic vegetation.* **SERIOUS:** *Forestry.*	C	C	*Riparian vegetation* *Instream biota*

Habitat and biota RQOs are provided in Table 4.12.

Table 4.12 B81B-00246: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Natal ghost frog, mountain wagtail and half collared kingfisher populations	*Mountain wagtail, Natal ghost frog and half collared kingfisher population(s) viability should be maintained.*	*No decrease in mountain wagtail or half collared kingfisher density. Possibly need to express numerical RQO for Natal ghost frog as density of animals.*

RIPARIAN VEGETATION

Indicators	Narrative RQO	Numerical RQO
Riparian zone boundary	*Forestry (areas formally planted with plantation species) and agriculture (orchard plantations) should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of forestry or agriculture within the riparian zone.*
Aerial cover of alien plant species	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category).*
Longitudinal riparian zone continuity	*Longitudinal riparian zone fragmentation should not increase.*	*Zero increase in riparian zone longitudinal fragmentation.*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 51.4%; D	*Maintain PES of at least D EC.*	*Maintain the Fish PES in at least a D EC (FRAI ≥51%).*
Species richness: (9 Species)	*Maintain current fish species richness.*	*Maintain current estimated fish species richness (do not allow more than 10% deviation from 9 species estimated for SQ reach).*
Primary indicator species: AURA	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA).*	*Ensure presence of this species in reach and maintain a FROC at >10% of sites (in relevant geozones).*
Secondary Indicator species: Flow: AURA Water quality: BEUT Substrate: AURA/BMAR Vegetation: PPHI/TSPA/BPAU.	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Perlidae and Hydropsychidae	*To maintain suitable conditions for this flow dependent species (rapid flows: >0.6 m/s) in the SIC biotope.*	
Atyidae	*To maintain suitable conditions in the marginal vegetation for this key species.*	

4.7.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.13.

Table 4.13 B81B-00246: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*B8R003: Gauge downstream of Magoebaskloof Dam wall measuring spills and releases. Only relevant for section downstream of dam wall.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Make use of Southern African Bird Atlas data to assess mountain wagtail and half collared kingfisher density changes.* ▪ *Field based population assessments of Natal ghost frogs.* ▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas and agriculture in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.*

	▪ *Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.8 RQOs FOR RU B81B-00251 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a D PES, has low ecological importance, moderate SCI and moderate water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

4.8.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
D	*1.34*	*0.98*	*0.094*	*7.0*	*0.206*	*15.4*	*0.00*	*0.00*	*0.001*	*0.006*

4.8.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
No name	**LARGE:** *Algal growth.* **SERIOUS:** *Exotic vegetation, irrigation, vegetation removal.* **CRITICAL:** *Agricultural lands.*	D	D

4.9 RQOs FOR RU B81B-00269 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a B PES, has moderate ecological importance, low SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a B PES for the EcoStatus and as the PES is already in a B, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

4.9.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
B	*1.95*	*1.95*	*0.47*	*23.9*	*0.68*	*34.6*	*0.002*	*0.005*	*0.005*	*0.014*

4.9.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Morudi	**LARGE:** *Exotic vegetation.* **CRITICAL:** *Forestry.*	**B**	**B**	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 4.14.

Table 4.14 B81B-00269: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*N/A.*
Aerial cover of alien plant species	*Perennial alien plant species aerial cover within the riparian zone should conform to a REC of a B.*	*Perennial alien plant species aerial cover should be less than 20% (requirement applicable to B Category).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 66.8%; C	*Maintain PES of at least C EC.*	*Maintain the Fish PES in at least a C/D EC (FRAI ≥ 66%).*
Species richness: 9 species	*Maintain relatively high fish species richness.*	*Maintain relative high fish species diversity (do not allow more than 10% deviation from six species estimated for SQ reach).*
Primary indicator species: AURA/CPRE	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA, CPRE).*	*Ensure presence of these species in reach and maintain a FROC at >10% of sites (in relevant geozones) for AURA and CPRE.*
Secondary Indicator species: Flow: AURA/CPRE Water quality: BEUT Substrate: AURA/CPRE Vegetation: PPHI/TSPA/BPAU	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Philopotamidae and Hydropsychidae	*To maintain suitable conditions for these flow dependent species (rapid velocities: > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae	*To maintain suitable conditions in the marginal vegetation for this key species.*	

4.9.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.15.

Table 4.15 B81B-00269: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauges.*
Habitat	*RHAM (visual) (DWA< 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available).* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species and express as percentage of riparian zone area.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.10 RQOs FOR RU B81B-00227 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate importance the REC is set to maintain the B PES. The recommended scenario does not influence this site.

4.10.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
D	*13.60*	*10.8*	*2.01*	*14.8*	*3.01*	*22.1*	*0.031*	*0.036*	*0.051*	*0.069*

4.10.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Mahitse	**LARGE:** *Exotic vegetation, Large dams.*	D	D	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 4.16.

Table 4.16 B81B-00227: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Mountain wagtail and half collared kingfisher populations	*Mountain wagtail and half collared kingfisher population(s) viability should be maintained.*	*No decrease in mountain wagtail or half collared kingfisher density.*
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*N/A.*
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to a REC of a B.*	*Perennial alien plant species aerial cover should be less than 20% (requirement applicable to B Category).*
FISH		

Indicators	Narrative RQO	Numerical RQO
PES Desktop FRAI: 50.2%; D	*Maintain PES of at least D.*	*Maintain the Fish PES in at least a D (FRAI ≥50%).*
Species richness: 16 species	*Maintain current fish species richness.*	*Maintain current species diversity of an estimated 16 species (do not allow more than 10% deviation from species estimated for SQ reach).*
Primary indicator species: LMOL/BMAR	*Flows should be adequate to ensure suitable habitats for LMOL/BMAR.*	*Ensure presence of LMOL/BMAR in reach and FROC should not decrease >10% from baseline value (to be established should monitoring be implemented).*
Secondary Indicator species: Flow: LMOL/BMAR Water quality: MMAC Substrate: LCYL Vegetation: BVIV/TREN	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Perlidae and Hydropsychidae	*To maintain suitable conditions for these flow dependent species (rapid velocities: > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae and Atyidae	*To maintain suitable conditions in the marginal vegetation for these key species.*	

4.10.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.17.

Table 4.17 B81B-00227: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*B8R002: Gauge downstream of Hans Merensky Dam wall measuring spills and releases. Only relevant for section downstream of dam wall.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Make use of Southern African Bird Atlas data to assess mountain wagtail and half collared kingfisher density changes.* ▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available).* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area. Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.11 RQOs FOR RU B81B-00240 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has moderate ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

4.11.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Mar	
							90%	60%	90%	60%
C	39	22.8	4.4	11.4	7.5	19.1	0.015	0.027	0.069	0.122

4.11.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Politsi	**MODERATE:** *Inundation, large dams.* **LARGE:** *Agricultural lands, algal growth, exotic vegetation, forestry, irrigation, runoff/effluent: irrigation, vegetation removal.*	C	C	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 4.18.

Table 4.18 B81B-00240: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Forestry (areas formally planted with plantation species) should not encroach into the riparian zone or cross the riparian zone boundary.*	*N/A.*
Longitudinal riparian zone continuity	*Longitudinal riparian zone fragmentation should not increase.*	*N/A.*
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to a REC of a B.*	*Perennial alien plant species aerial cover should be less than 30% (requirement applicable to C Category).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 49.5%; D	*Maintain PES of at least D EC.*	*Maintain the Fish PES in at least a D EC (FRAI ≥ 49%).*
Species richness: 18 species	*Maintain relatively high fish species richness.*	*Maintain relative high fish species richness. Do not allow more than 10% deviation from baseline (estimated at 18 species) estimated for SQ reach.*
Primary indicator species: AURA/CPRE	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA, CPRE).*	*Ensure presence of these species in reach and maintain a FROC at baseline levels (>10% desktop estimate) of sites for AURA and CPRE.*

FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
Secondary Indicator species: *Flow: AURA/CPRE* *Water quality: BEUT* *Substrate: AURA/CPRE* *Vegetation: BUNI/TREN*	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Perlidae and Hydropsychidae	*To maintain suitable conditions for these flow dependent species (rapid velocities: > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae and Atyidae	*To maintain suitable conditions in the marginal vegetation for these key species.*	

4.11.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 4.19.

Table 4.19 B81B-00240: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone.* ▪ *Use satellite imagery (such as Google Earth) to assess planted forestry areas in relation to riparian zone boundary.* ▪ *Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species and express as percentage of riparian zone area.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*

4.12 RQOs FOR RU EWR 1 (B81B-00264; B81B-00247) (HIGH PRIORITY - 3)

4.12.1 Flow RQOs

The EWR 1 is situated in B81B-00264. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. The flow RQO is provided below. Flow RQOs at other biophysical nodes in this RU are provided in Appendix A. It must be noted that these flows are a result of the recommended scenario's operating setup and if the operating rules change whilst still meeting the RQOs at EWR 1 these secondary flow RQOs will be different.

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*
Gauged at: *B8H014; weir used for calibration. Measures all releases from Ebenezer Dam and the incremental catchment and takes into account effects of two Irrigation canals.*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	99.84	52.66	11.82	11.8	21	21	0.125	0.198	0.172	0.343

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	No of events	Months	Daily average	Duration
CLASS I (1.2 - 2.5 m^3/s)	1	Mar	2	2
CLASS II (2 - 5 m^3/s)	3	Jan, Feb, Mar	3.5	3
CLASS IV (20 - 28 m^3/s)	1	Feb	20	6

4.12.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b).*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users (primary user is shown in bold text): *Forestry and some* **irrigation***.*
Water quality issue: *The area is predominantly forested (Eucalyptus and Pinus species). Water is abstracted for irrigation (cultivated lands – bananas, mangos and tea plantations), with few rural/urban settlements present. Slight nutrient elevations are therefore the main water quality issue.*
Narrative and Numerical: *Details provided in Table 4.20. Data used for water quality assessments should be collected from B8H014Q01. Analysis of data and possible monitoring action should be based on biotic cues. EcoSpecs and TPCs for a B Category are provided in Table 4.21.*

Table 4.20 B81B-00264: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than 0.015 mg/L PO_4-P (aquatic ecosystems: driver)
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements

Table 4.21 RU EWR 1: Water quality EcoSpecs and TPCs

River: Letaba	PES: B EC	
Monitoring site: B8H014Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95^{th} percentile of the data must be ≤ 16 mg/L.	The 95^{th} percentile of the data must be between 13 - 16 mg/L.
Na_2SO_4	The 95^{th} percentile of the data must be ≤ 20 mg/L.	The 95^{th} percentile of the data must be between 16 – 20 mg/L.
$MgCl_2$	The 95^{th} percentile of the data must be ≤ 15 mg/L.	The 95^{th} percentile of the data must be between 12 – 15 mg/L.
$CaCl_2$	The 95^{th} percentile of the data must be ≤ 21 mg/L.	The 95^{th} percentile of the data must be between 17 – 21 mg/L.
NaCl	The 95^{th} percentile of the data must be ≤ 45 mg/L.	The 95^{th} percentile of the data must be between 36 – 45 mg/L.
$CaSO_4$	The 95^{th} percentile of the data must be ≤ 351 mg/L.	The 95^{th} percentile of the data must be between 281 – 351 mg/L.

River: Letaba	PES: B EC	
Monitoring site: B8H014Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 30 mS/m.*	*The 95th percentile of the data must be between 24 – 30 mS/m.*
pH	*The 5th and 95th percentile of the data must be between 6.5 to 8.0.*	*5th percentile of the data must not be less than 6.7.* *95th percentile of the data must not be greater than 7.6.*
Temperature	*Small deviation from the natural temperature range.*	*Small deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 8 mg/L.*	*5th percentile of the data must be 6.4 – 8.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 0.25 mg/L.*	*The 50th percentile of the data must be between 0.2 –0.25 mg/L.*
PO_4-P	*The 50th percentile of the data must be ≤ 0.015 mg/L.*	*The 50th percentile of the data must be between 0.012 – 0.015 mg/L.*
Response variables		
Chl-a phytoplankton [(b)]	*The 50th percentile of the data must be ≤ 15 mg/m^2.*	*The 50th percentile of the data must be between 12 – 15 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 21 mg/m^2.*	*The 50th percentile of the data must be between 17 – 21 mg/m^2.*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the Target Water Quality Range (TWQR) as stated in DWAF (1996).*	*An impact is expected if the 95th percentile of the data exceeds the Chronic Effects Value (CEV) as stated in DWAF (1996a).*

(a) To be generated using Tool for TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

4.12.3 Habitat and biota RQOs (EcoSpecs)

4.12.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES of EWR 1, based on fish, is moderately modified, falling in a Category C and should be maintained in this ecological category in future. The current fish species richness of 20 indigenous fish species of an estimated 22 naturally occurring species should not be reduced. Various fish species intolerant to alteration or with a high preference for specific habitat features are present in this reach. These species provide valuable indicators of change that should be used to monitor potential change. The primary indicator fish species for this reach are the Stargazer (mountain catfish - AURA), being an indicator of flow modification (fast flowing habitats), rocky substrate condition and water quality. Other important indicators include the orangefin barb (BEUT - fast-flowing habitats, overhanging vegetation, undercut banks) and shortspine suckermouth (CPRE - similar than the Stargazer).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 4.22.*

Table 4.22 RU EWR 1: Fish EcoSpecs and TPCs

Indicator	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Metric: Ecological status			
PES	*PES status of fish is in a C (62.3%) (DWA, 2013b).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC of species.*
Metric: Species richness			
All indig. sp.	*20 of the expected 22 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*
Metric: Requirement for flowing water			
AURA CPRE	*AURA and CPRE have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*AURA and/or CPRE absent during any survey OR present at FROC[1] of < 3 for AURA and < 3 for CPRE. (DWAF, 2006c): A minimum of 5 AURA specimens should be sampled at 80% of sites during a survey of FS and FD, electrofishing for 20 minutes. A minimum of 20 CPRE specimens should be sampled at 100% of sites during a survey of Fast Shallow (FS) and FD, electrofishing for 20 minutes).*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*
Metric: Fast Deep (FD) habitats			
AURA BEUT	*AURA and BEUT have a high requirement for fast-deep habitats and are the most applicable indicator species for this velocity-depth category.*	*AURA and/or BEUT absent during any survey OR present at FROC of < 3 for AURA and < 3 for BEUT (DWAF, 2006c: AURA see "Requirement for flowing water", a minimum of 5 BEUT specimens should be sampled at 25% of sites during a survey of marginal vegetation (MV) and substrate, electrofishing for 20 minutes/10 sweeps with 4 m pole seine net.)*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).*
Metric: Fast Shallow (FS) habitats			
CPRE LCYL (DWAF, 2006c: AURA, CPRE)	*CPRE and LCYL have a high requirement for fast-deep habitats and are the most applicable indicator species for this velocity-depth category.*	*CPRE and/or LCYL absent during any survey OR present at FROC of < 3 for CPRE and < 3 for LCYL.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*
Metric: Substrate			
AURA CPRE (DWAF, 2006c: AURA, CPRE)	*CPRE and AURA have a high requirement for fast-deep habitats and are the most applicable indicator species for this habitat feature.*	*AMOS and/or AURA absent during any survey OR present at FROC of <3 for CPRE and <3 for AURA.*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates. Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.*
Metric: Water quality intolerance			
BEUT AURA	*BEUT and AURA have a high requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*BEUT and/or AURA absent during any survey OR present at FROC of < 3 for BEUT and <3 for AURA.*	*Decreased water quality (especially flow related water quality variables such as oxygen).*
Metric: Overhanging vegetation			
PPHI, BPAU (DWAF, 2006b: BEUT)	*PPHI and BPAU have a high requirement for overhanging vegetation and are the most applicable indicator species for this habitat feature.*	*PPHI and/or BPAU absent during any survey OR present at FROC of < 4.36 for PPHI and <3 for BPAU.*	*Significant change in overhanging vegetation habitats.*
Metric: Instream vegetation			

Indicator	EcoSpecs	TPC (Biotic)	TPC (Habitat)
TREN BPAU	*TREN and BPAU have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or BPAU absent during any survey OR present at FROC of < 3 for TREN and < 3 for BPAU.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)*
Metric: Undercut banks			
PCAT BEUT	*PCAT and BEUT have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*PCAT and/or BEUT absent during any survey OR present at FROC of < 0 for PCAT and < 3 for BEUT.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*
Metric: Water column			
MBRE BMAR	*MBRE and BMAR have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or BMAR absent during any survey OR present at FROC of < 3 for MBRE and < 3 for BMAR.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*
Metric: Slow Deep (SD) habitats			
BUNI TREN	*BUNI and TREN have a high requirement for slow-deep habitats and are the most applicable indicator species for this velocity depth category.*	*BUNI and/or TREN absent during any survey OR present at FROC of < 3 for BUNI and < 3 for TREN.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*
Metric: Slow Shallow (SS) habitats			
BVIV BUNI	*BVIV and BUNI have a high requirement for slow-shallow habitats and are the most applicable indicator species for this velocity depth category.*	*BVIV and/or BUNI absent during any survey OR present at FROC of < 3 for BVIV and < 3 for BUNI.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).*
Metric: Migratory success[2]			
AMOS BMAR	*It is estimated that the catadromous[1] AMOS may still be present, as well as various potamodromous[1] species (including BMAR).*	*Loss or decreased FROC[2] of catadromous (such as AMOS) or potamodromous species (such as BMAR).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*
Metric: Alien fish species			
Presence of any alien/ introd. spp.	*MSAL and OMYK known or expected to be present in the SQ reach.*	*Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.*	*N/A.*
Primary indicator species: AURA (CPRE and BEUT)			
	AURA estimated to be present at > 25% of sites in SQ reach (DWA, 2013b) (to be verified).	**See "requirement for flowing water" and "Fast Deep" above.**	**See "requirement for flowing water" and "Fast Deep" above.**

1 Migratory guilds:

Catadromous – *Fishes which spend most of their lives in freshwater and migrate to the sea (or saline reaches of estuaries) to breed as adults (e.g. eels) (Catchment scale migrations).*

Potamodromous: *Truly migratory species whose entire life cycle is completed within freshwater and that undertake migrations within freshwater zones (between SQ reaches) of rivers for a variety of reasons, such as for spawning, feeding, dispersion after spawning, colonisation after droughts, for over-wintering, etc.*

2 Frequency of Occurrence:

0 = Absent
1 = Present at very few sites (<10%)
2 = Present at few sites (>10 - 25%)
3 = Present at about >25 - 50 % of sites
4 = Present at most sites (>50 - 75%)
5 = Present at almost all sites (>75%)

4.12.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of a small foothill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks. Although upstream abstraction and water losses due to forestry leads to lower flows and associated poorer water quality parameters, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.*

Numerical: *Indicator taxa are provided in Table 4.23 and Table 4.24 provides EcoSpecs and TPCs for a C Category.*

Table 4.23 RU EWR 1: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*>0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 – 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 – 0.6*	*Cobbles*	*Moderate*
5	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 1 situated in B81B-00264, Letaba River is provided in Table 4.24. This RU consists of a relative small foothill stream with good SIC and marginal vegetation habitat.

Table 4.24 RU EWR 1: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs
To ensure that the SASS5 scores and Average Score Per Taxon (ASPT) values occur in the following range: SASS5 score: > 120; ASPT value: > 6.0.	*SASS5 scores less than 130 and an ASPT less than 6.0.*
To ensure that the MIRAI score remains within the range of a C Category (62% – 78%).	*A MIRAI score of 70% or less.*
To maintain suitable flow velocity (> 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance A).* ▪ *Trichorythidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Elmidae (Abundance A).* ▪ *Heptageniidae (Abundance B).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Coenagrionidae (Abundance A).* ▪ *Dytiscidae (Abundance 1-A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain suitable conditions for the following five key taxa: ▪ *Hydropsychidae* ▪ *Trichorythidae* ▪ *Heptageniidae* ▪ *Elmidae*	*Presence of less than four of the five key taxa listed in any survey.*

EcoSpecs	TPCs
▪ *Coenagrionidae*	
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae and Baetidae). To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.	*Any taxon occurring in an abundance of >1000 for two consecutive surveys.*

4.12.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative:

The overall PES (as at October 2013; DWA, 2013b) for riparian vegetation was a Category C, comprising the marginal zone in a Category B/C, the lower zone in Category C/D and the upper zone in a Category C. This is also the REC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and shall be maintained as viable populations: Breonadia salicina, Combretum imberbe and Philenoptera violacea. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2013. As such forestry and agricultural activities shall not encroach into the riparian zone or cross the riparian zone boundary.

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 4.25.*

Table 4.25 RU EWR 1: Riparian vegetation EcoSpecs and TPCs

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Vegetation Cover				
Marginal Zone	*Maintain marginal hydrophyte fringe along the active channel.*	*Maintain marginal hydrophyte fringe along the active channel.*	*Marginal fringe absent.*	*Adapted from DWAF (2006c), fringe cover (either reeds or woody overhang) is important habitat for instream and riparian fauna.*
Lower Zone	*Maintain B. salicina and Syzygium cordatum cover.*	*Maintain B. salicina and cover*	*Measurable decrease in either population of 50% or more.*	*Adapted from DWAF (2006c), active channel woody component is important habitat for instream and riparian fauna; B. salicina is protected species.*
Metric: Species composition				
Upper Zone	*Maintain riparian/terrestrial mix.*	*Maintain riparian/terrestrial mix.*	*When the proportion of terrestrial species reaches 50% of the total species count.*	*Adapted from DWAF (2006c), to prevent terrestrialisation of the upper zone.*
Upper Zone	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Visible decrease in B. salicina, C. imberbe or P. violacea cover/abundance*	*Data from DWA (2013b).*
Metric: Alien invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 30%.*	*Perennial alien plant species aerial cover less than 30%.*	*Increased alien perennial species cover above 30%.*	*See hypothesis for Lowveld rivers (alien invasion) (electronic information).*
Metric: Indigenous riparian woody cover				
Marginal Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not less than 5% and not more than 70%.*	*Increased riparian woody cover above 70% OR a decrease below 5%*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Lower Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not less than 5% and not more than 70%.*	*Increased riparian woody cover above 70% OR a decrease below 5%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 20% and not more than 80%.*	*Riparian woody species cover not less than 20% and not more than 80%.*	*Increased riparian woody cover above 80% OR a decrease below 20%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not less than 20%.*	*Reed cover not less than 20%.*	*Decreased reed cover below 20%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover between 10% and 90%.*	*Reed cover between 10% and 90%.*	*Decreased in reed cover below 10% OR and increase above 90%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover less than 50%.*	*Reeds cover less than 50%.*	*Increased reed cover above 50%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Metric: Riparian zone integrity				
Riparian zone	*Zero expansion of agriculture or forestry within the riparian zone.*	*Zero expansion of agriculture or forestry within the riparian zone.*	*Increased spatial extent of forestry or agriculture WITHIN the riparian zone.*	*Desktop assessment of area of interest; riparian delineation required; status quo should be calculated (% of riparian zone that is not forestry or agriculture) and used as base against which to assess change.*
Metric: Longitudinal riparian zone continuity				
Riparian zone	*Zero increase in riparian zone longitudinal fragmentation.*	*Zero increase in riparian zone longitudinal fragmentation.*	*Increased longitudinal fragmentation of the riparian zone.*	*Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover and use as base against which to assess change.*

4.13 GROUNDWATER RQOs

Groundwater RQOs cover IUA 1, Letaba upstream of Tzaneen Dam - 81A, B81B.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly for irrigation. The stress index (use/ aquifer recharge) is low and groundwater resources are under-utilised. Although recharge is high, the proportion reaching the regional aquifer is approximately 20%.*

	B81A	B81B	Total
Irrigation (Mm^3/a)	*0.15*	*2.64*	*2.79*
Water Supply (Mm^3/a)	*0*	*0*	*0*
Total use (Mm^3/a)	*0.15*	*2.64*	*2.79*
Stress index	*0.01*	*0.13*	
Harvest potential (Mm^3/a)	*2.72*	*7.72*	*10.44*
Exploitation potential (Mm^3/a)	*1.36*	*5.4*	*6.76*
Recharge (Mm^3/a)	*50.84*	*94.15*	*144.99*
Aquifer recharge (Mm^3/a)	*10.34*	*20.32*	*30.66*
Allocatable groundwater (Mm^3/a)	*10.19*	*17.68*	*27.87*
Status	*A - Unmodified*	*B - Largely Natural*	

Borehole yields: *Borehole yields in B81A are low, with yields being below 2 l/s and the median yield being 0.57 l/s. This limits groundwater development to small localised schemes.*

	B81A	B81B
N	4	4
Lower Quartile (l/s)	0.3	0.85
MEDIAN (l/s)	0.57	1.5
Upper Quartile (l/s)	1.07	2.16
Geometric Mean (l/s)	0.43	1.21
Yield >2 l/s (%)	0	25

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Groundwater is generally of DWA Class 0, or Ideal water quality. Some poor quality boreholes with elevated salinity and nitrates exist in B81B.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81A	1					1	100	1					1	100
B81B	4		1	2		7	71	5	1		1	1	8	75

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction and afforestation impacts significantly on baseflow in this IUA. This IUA provides nearly 45% of baseflow in the Letaba, hence is the most important source of baseflow to downstream users. Development in this region is therefore of concern. Only 7% of baseflow is from the regional aquifer, the remainder originating as interflow, consequently afforestation can have a greater impact than abstraction by diminishing interflow from high lying areas. Abstraction has reduced baseflow by 1%. Abstraction impacts significantly on groundwater baseflow, and groundwater baseflow reduction is 46% of abstraction.*

	B81A	B81B	Total
MAR (Mm^3/a)	75.71	134.26	209.97
Total Use (Mm^3/a)	0.15	2.64	2.79
Stress index	0.01	0.13	
Recharge (Mm^3/a)	50.84	94.15	144.99
Aquifer recharge (Mm^3/a)	10.34	20.32	30.66
Interflow (Mm^3/a)	40.5	73.83	114.33
Baseflow (Mm^3/a)	48.07	74.95	123.02
Groundwater water baseflow (Mm^3/a)	7.57	1.12	8.69
Present baseflow (Mm^3/a)	47.92	73.81	121.73
Present MAR reduction (Mm^3/a)	0.15	1.13	1.28
Increased abstraction (Mm^3/a)	2.57	5.08	7.65
Baseflow due to increased abstraction (Mm^3/a)	45.35	71.63	116.98
% contribution to total baseflow of the Letaba	44.95		

Numerical: *The Groundwater RQOs are provided in Table 4.26.*

Table 4.26 IUA 1: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater is underutilised. Abstraction impacts significantly on baseflow and this region is one of the most significant sources of baseflow in the Letaba system. Hence further investigations as to the impact of abstraction and streamflow reduction activities are required before any significant increase takes place.	*Groundwater abstraction can be increased from 2.79 Mm^3/a to 10.44 Mm^3/a, with a 4.76 Mm^3 reduction in baseflow.*

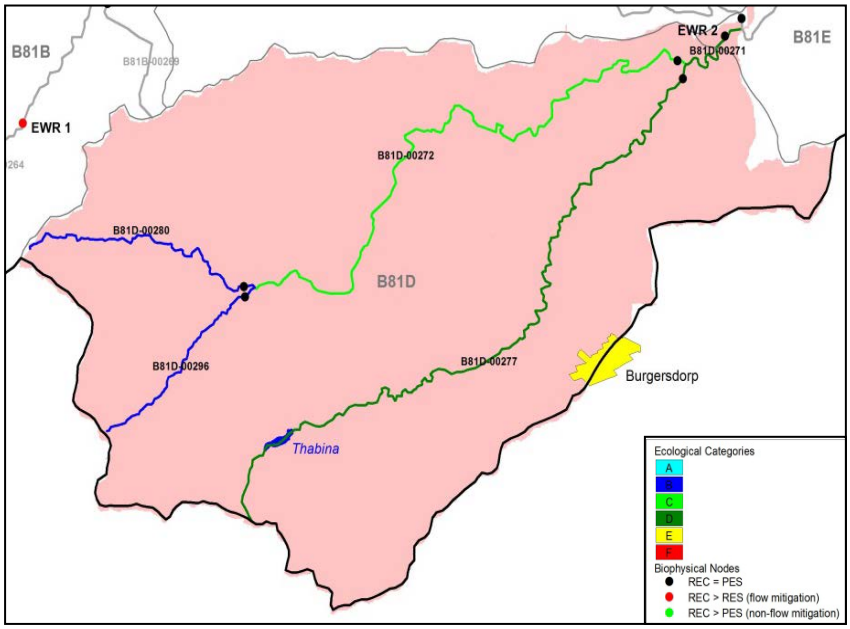
5 IUA 2: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Management of this IUA is related to agriculture (formal and informal) with run-of river and groundwater abstraction as well as sedimentation. Some flow modification due to small dams and forestry occur. The dense population density in the lower reaches result in high utilisation of the natural resources with overgrazing and resulting sedimentation prevalent. Management options to improve the IUA (if necessary) will largely be catchment management options and some flow abstraction allocation reduction. No future water resources infrastructure is being planned in this IUA.

IUA 2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table. Shaded cells indicate SQs for which EWR data is applicable.

IUA 2: LETSITELE AND THABINA



PRIORITY RATINGS

SQ	River	Priority rating
B81D-00277	*Thabina*	*2*
B81D-00280	*Bobs*	*1a*
B81D-00296	*Mothlaka-Semeetse*	*1a*
B81D-00271 (EWR 2)	*Letsitele*	*3b*
B81D-00272	*Letsitele*	*2*

Water resource use

This zone includes mostly the rivers (5 SQs) falling within quaternary catchment B81D. There is some storage regulation in the IUA by Thabina Dam. There are number of river abstractions mainly for the irrigation sector and a significant amount of groundwater is utilised by both the urban/domestic and irrigation sector with most of the utilisable exploitation potential used in the IUA. Return flows or effluent is mainly produced from the urban/domestic sector, with some return flows from the irrigation sector, which has reduced the water quality of the river systems below these areas. There is no surface water resource developments planned in the IUA.

The groundwater response unit consists of approximately 50% Drakensberg Escarpment zone and the rest are Drakensberg Foothills and Valleys. The groundwater use is approximately 60% of the aquifer recharge.

Water quality

Water quality state is dominated by elevated nutrients, salts and algal growth due to discharges from a WWTW in the Thabina, and extensive irrigation agriculture in the middle and lower Letsitele

River. Two water quality hotspots were identified in these reaches and the water quality state is generally Fair to Poor.

Economy

The main economic activities are the primary industries of citrus and sub-tropical fruit and the secondary industry that consist of fruit juice processing.

EGSA

The northern portion of the IUA consists of commercial forestry with the Agatha Forest Reserve a dominant feature. The recreational aspects associated with EGSA are of some importance here but overall utilisation is low. The southern portion is given over to very dense closer settlement that borders on formal urban development. Townships developed as satellites to Tzaneen are present. The utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high where utilisation does take place.

River and wetland ecology

The upper reaches of the Letsitele (Bobs and Mothlaka-Semeetse) falls in a B PES with the primary land use being forestry. The middle Letsitele River falls in a C PES, receiving the impacts related to forestry, agriculture, urban and rural settlements. The Thabina and lower Letsitele rivers are currently in a D PES, with the primary impacts being associated with extensive rural settlements (sedimentation, and agriculture) and some flow modification (dams, and forestry).

The quaternary (B81D) is noted for wetland frequency and diversity of types, and the Letsitele specifically (B81D-00272) for frequent channelled valley-bottom wetlands. An overall PES for these wetlands indicates fairly poor condition with an EC of a C/D.

5.1 RQOs FOR RU B81D-00277 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance, SCI and water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate importance the REC is set to maintain the D PES. The recommended scenario does not influence this site.

5.1.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Nov		Mar	
							90%	60%	90%	60%
D	25.28	18.90	1.053	8.4	4.640	18.4	0.00	0.015	0.013	0.043

5.1.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b; 2013b) were used.*
Model: *N/A.*
Users (primary users shown in bold): **Agriculture**, *urban use, rural settlements.*

Water quality issue: *Elevated nutrient levels in the reach are primarily due to Lenyenye WWTW not meeting discharge standards and being in a High risk rating. More efficient management of the WWTW will change the Risk rating from High to Medium or Low to maintain the specified RQOs.*

Table 5.1 B81D-00277: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (agriculture - irrigation: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

5.1.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Thabina	**MODERATE:** *Abstraction (run-of river)/increased flows, bed stabilisation, erosion, sedimentation, grazing/trampling.* **LARGE:** *Agricultural lands, algal growth, exotic vegetation, runoff/effluent: Urban areas, vegetation removal.*	**C**	**C**	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 5.2.

Table 5.2 B81D-00277: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 50% (requirement applicable to D EC). The relationship between % alien cover and EC is hypothesised and testable.*
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone. It is assumed that 80% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 80% (aerial cover).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 50.2%, D	*Maintain PES of at least D EC.*	*Maintain the Fish PES in at least a D EC (FRAI ≥ 50%).*
Species richness: 16 species	*Maintain current fish species richness.*	*Maintain current species diversity of an estimated 16 species (do not allow more than 10% deviation from species estimated for SQ reach).*
Primary indicator species: LMOL/BMAR	*Flows should be adequate to ensure suitable habitats for LMOL/BMAR.*	*Ensure presence of LMOL/BMAR in reach and FROC should not decrease >*

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
		10% from baseline value (to be established should monitoring be implemented).
Secondary Indicator species: *Flow: LMOL/BMAR* *Water quality: MMAC* *Substrate: LCYL* *Vegetation: BVIV/TREN*	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Hydropsychidae and Trichorythidae	*To maintain suitable conditions for these flow dependent species (rapid velocities: > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae and Belostomatidae	*To maintain suitable conditions in the marginal vegetation for these key species.*	

5.1.4 Wetland RQOs

Wetlands of high importance occur in quaternary catchment B81D and are mostly channelled valley bottom wetlands associated with B81D-00277 and tributaries. Maintaining the wetlands in their current condition is outlined below:

- *Maintain wetland EC score above 56%, and median EI score equal to or above 2.25 and IHI score equal to or above 2.5.*
- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013b). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain high.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands. The abundance of G. perpensa (Declining) should not decline.*
- *Birds: The abundance of herons, ducks or moorhens that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013b).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

5.1.5 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 5.3.

Table 5.3 B81D-00277: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*None.*
Water quality	*Meet biomonitoring requirements as specified in the water use license. This monitoring should be at the specified site or downstream of the Lenyenye WWTW and outside of the mixing zone.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available).* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).* ▪ *Use satellite imagery to assess vegetative cover (% of riparian zone banks).*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS5 and MIRAI (Thirion, 2007).*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

5.2 RQOs FOR RU B81D-00280 (LOW PRIORITY – 1A)

The RU is of low priority (Level 1) as it is in a B PES, has high ecological importance, low SCI and water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a B PES for the EcoStatus and as the PES is already in a B, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

5.2.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Mar	
							90%	60%	90%	60%
B	*18.50*	*13.95*	*3.647*	*19.7*	*5.417*	*29.3*	*0.027*	*0.041*	*0.081*	*0.095*

5.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Bobs	**MODERATE***: Agricultural lands, exotic vegetation, small dams (farm), vegetation removal.* **LARGE:** *Forestry.*	**B**	**B**

5.3 RQOs FOR B81D-00296 (LOW PRIORITY – 1A)

The RU is of low priority (Level 1) as it is in a B PES, has high ecological importance, low SCI and water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a B PES for the EcoStatus and as the PES is already in a B, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

5.3.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Mar	
							90%	60%	90%	60%
B	10.53	8.85	2.637	25.0	3.645	34.6	0.022	0.032	0.049	0.08

5.3.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Mothlaka-Semeetse	**SMALL:** *Crossings low water, natural areas/nature reserves, runoff/effluent: Irrigation, small dams (farm).* **MODERATE:** *Agricultural lands, algal growth, exotic vegetation, forestry, irrigation, vegetation removal.*	B	B

5.4 RQOs FOR RU EWR 2 (B81D-00271) (HIGH PRIORITY – 3)

5.4.1 Flow RQOs

EWR 2 is situated in B81D-00271. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. The flow RQO is provided below. Flow RQOs at other biophysical nodes in this RU are provided in Appendix A. It must be noted that these flows are a result of the recommended scenario's operating setup and if the operating rules change whilst still meeting the RQOs at EWR 1 these secondary flow RQOs will be different.

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*
Gauged at: *B8H010. Good gauge for the whole Letsitele River.*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
D	116.55	76.42	17.865	15.3	27.664	23.7	0.042	0.1	0.168	1.095

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	No of events	Months	Daily average	Duration
CLASS I (2.5 - 4 m^3/s)	6	2x[Jan – Mar]	3.5	2
CLASS III (15 m^3/s)	1	Feb	15	3

5.4.2 Water quality RQOs

Source: *Water quality assessment conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b).*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users (primary users shown in bold): **Citrus plantations and irrigation**, *urban and rural settlements, industry.*
Water quality issue: *Main land use is some irrigation agriculture, namely citrus plantations (mangos and bananas) and afforestation. Note that there are a number of WWTWs in this stretch, e.g. Nkowankowa WWTW. Manufacturing and processing industries are also located here. Main water quality issues are elevated nutrients, salts and potential toxics.*
Narrative and Numerical: *Details provided in Table 5.4. Data used for water quality assessments should be collected from B8H010Q01. Analysis of data and possible monitoring action should be*

based on biotic cues. Meet biomonitoring requirements as specified in the water use license for the WWTWs. This monitoring should be at the specified site or downstream of the WWTW and outside of the mixing zone. EcoSpecs and TPCs for a C Category are provided in Table 5.5.

Table 5.4 RU EWR 2: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (agriculture - irrigation: driver).*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 5.5 RU EWR 2: Water quality EcoSpecs and TPCs

River: Letsitele **Monitoring site: B8H010Q01**	**PES and recommended scenario: C EC**	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 16 mg/L.*	*The 95th percentile of the data must be between 13 - 16 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be between 16 – 20 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 15 mg/L.*	*The 95th percentile of the data must be between 12 – 15 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 21 mg/L.*	*The 95th percentile of the data must be between 17 – 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be between 36 – 45 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 30 mS/m.*	*The 95th percentile of the data must be between 24 – 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must be between 6.5 to 8.0.*	*5th percentile of the data must not be less than 6.7.* *95th percentile of the data must not be greater than 7.6.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by no more than 2°C.*	*Unnatural deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes with temporary high sediment loads and turbidity during runoff events.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
TIN	*The 50th percentile of the data must be ≤ 0.7 mg/L.*	*The 50th percentile of the data must be between 0.55 –0.7 mg/L.*

River: Letsitele Monitoring site: B8H010Q01		PES and recommended scenario: C EC
Water quality metrics	**EcoSpecs**	**TPC**
PO_4-P	*The 50th percentile of the data must be ≤ 0.025 mg/L.*	*The 50th percentile of the data must be between 0.02 – 0.025 mg/L.*
Response variables		
Chl-a phytoplankton (b)	*The 50th percentile of the data must be ≤ 20 mg/m^2.*	*The 50th percentile of the data must be between 16 – 20 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 21 mg/m^2.*	*The 50th percentile of the data must be between 17 – 21 mg/m^2.*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996a).*

(a) To be generated using TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

5.4.3 Habitat and biota RQOs (EcoSpecs)

5.4.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES of EWR 2, based on fish, is moderately to largely modified, falling in a Category C/D and should not be allowed to deteriorate further. The current fish species richness of 22 indigenous fish species of an estimated 24 naturally occurring species should not be allowed to decrease. Various fish species intolerant to alteration or with a high preference for specific habitat features provide valuable indicators of change that should be used to monitor potential change. The primary indicator fish species for this reach are the Stargazer (mountain catfish - AURA), being an indicator of flow modification (fast flowing habitats), rocky substrate condition and water quality. Other important indicators include the shortspine suckermouth (CPRE - similar to Stargazer), the orangefin barb (BEUT - fast-flowing habitats, overhanging vegetation, undercut banks) and the bowstripe barb (BVIV - slow habitats and marginal vegetation).*

Numerical: *EcoSpecs and TPCs for a C/D Category are provided in Table 5.6.*

Table 5.6 RU EWR 2: Fish EcoSpecs and TPCs

Indicator	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Metric: Ecological status			
All indigenous species.	*Present ecological status of fish is in a C/D (61.2%).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC[1] of species.*
Metric: Species richness			
CPRE AURA	*22 of the expected 24 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*
Metric: Requirement for flowing water			
AURA BEUT	*CPRE and AURA have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*CPRE and/or AURA absent during any survey OR present at FROC[1] of < 3 for CPRE and < 2 for AURA. (DWAF, 2006c: A minimum of 3 AURA specimens should be sampled at 20% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes. A minimum of 20 CPRE specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*
Metric: FD habitats			
CPRE LCYL	*AURA and BEUT have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*AURA and/or BEUT absent during any survey OR present at FROC of < 2 for AURA and < 2 for BEUT. (DWAF, 2006c: AURA see "Requirement for flowing water", a minimum of 5 BEUT specimens should be sampled at 35% of sites during a survey of MV and substrate, electrofishing for minimum 20 minutes/10 sweeps with 4 m pole seine net.)*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).*
Metric: FS habitats			
AURA CPRE	*CPRE and LCYL have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPRE and/or LCYL absent during any survey OR present at FROC of < 3 for CPRE and < 4 for LCYL. (DWAF, 2006c: CPRE see above).*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*
Metric: Substrate			
BEUT AURA	*AURA and CPRE have a high requirement for FD habitats and are the most applicable indicator species for this habitat feature.*	*AURA and/or CPRE absent during any survey OR present at FROC of < 2 for AURA and < 3 for CPRE. (DWAF, 2006c: CPRE and AURA see above).*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.*
Metric: Water quality intolerance			
PPHI BPAU	*BEUT and AURA have a high requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*BEUT and/or AURA absent during any survey OR present at FROC of < 2 for BEUT and < 2 for AURA. (DWAF, 2006c: BEUT and AURA see above)*	*Decreased water quality (especially flow related water quality variables such as oxygen).*
Metric: Overhanging vegetation			
TREN BPAU	*PPHI and BPAU have a high requirement for overhanging vegetation and are the most*	*PPHI and/or BPAU absent during any survey OR present at FROC of <5 for PPHI and <4 for BPAU.*	*Significant change in overhanging vegetation habitats.*

Indicator	EcoSpecs	TPC (Biotic)	TPC (Habitat)
	applicable indicator species for this habitat feature.		
Metric: Instream vegetation			
MMAC BEUT	*TREN and BPAU have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or BPAU absent during any survey OR present at FROC of < 5 for TREN and < 4 for BPAU.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).*
Metric: Undercut banks			
MBRE BMAR	*MMAC and BEUT have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*MMAC and/or BEUT absent during any survey OR present at FROC of < 2 for MMAC and < 2 for BEUT.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*
Metric: Water column			
BUNI TREN	*MBRE and BMAR have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or BMAR absent during any survey OR present at FROC of < 3 for MBRE and < 4 for BMAR.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*
Metric: SD habitats			
BVIV BLIN	*BUNI and TREN have a high requirement for SD habitats and are the most applicable indicator species for this velocity depth category.*	*BUNI and/or TREN absent during any survey OR present at FROC of < 5 for BUNI and < 5 for TREN.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*
Metric: SS habitats			
AMOS BMAR	*BVIV and BLIN have a high requirement for SS habitats and are the most applicable indicator species for this velocity depth category.*	*BVIV and/or BLIN absent during any survey OR present at FROC[1] of <4.5 for BVIV and <2 for BLIN. (DWAF, 2006c: A minimum of 20 BVIV specimens should be sampled at 50% of sites during a survey of MV and substrate, electrofishing for minimum 20 minutes/10 sweeps with 4m pole seine net).*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).*
Metric: Migratory success[2]			
Presence of any alien/ introduced spp.	*It is estimated that the catadromous AMOS may still be present, as well as various potamodromous species (including BMAR).*	*Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BMAR).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*
Metric: Alien fish species			
AURA (CPRE, BEUT, BVIV)	*No known or expected to be present in the SQ reach under PES.*	*Presence of any alien/introduced species.*	*N/A.*
Primary indicator species: All indigenous species			
	AURA estimated to be present at >25% of sites in SQ reach (DWA, 2013b) (to be verified).	**See relevant sections above for detail.**	**See relevant sections above for detail.**

1, 2: Refer to Table 4.21.

5.4.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of a small foothill stream assemblage with perennial flows. The habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks. Although upstream abstraction and*

water losses due to forestry leads to lower flows and associated poorer water quality parameters, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.

Numerical: *Indicator taxa are provided in Table 5.7 and Table 5.8 provides EcoSpecs and TPCs for a C Category.*

Table 5.7 RU EWR 2: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*>0.6*	*Cobbles*	*Moderate*
3	*Libellulidae*	*0.3 – 0.6*	*Cobbles*	*Low*
4	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*
5	*Gomphidae*	*0.3 – 0.6*	*Sand*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 2 is situated in B81D-00271, Letsitele River is provided in Table 5.8. This RU consists of a stream of moderate size and velocity with some bedrock but little SIC habitat and good marginal vegetation habitat.

Table 5.8 RU EWR 2: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs
To ensure that the SASS 5 scores and ASPT values occur in the following range: SASS5 score: >100; ASPT value: >5.0.	*SASS5 scores less than 110 and an ASPT less than 5.2.*
To ensure that the MIRAI score remains within the range of a C Category (62% – 78%).	*A MIRAI score of 62% or less.*
To maintain suitable flow velocity (>0.6m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance B).* ▪ *Trichorythidae (Abundance 1-A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Libellulidae (Abundance 1-A).*	*This taxa missing in two consecutive surveys.*
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Coenagrionidae (Abundance A).* ▪ *Dytiscidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain sufficient quantity and quality of clean course sediment to support the following bottom-dwelling taxa: ▪ *Gomphidae (Abundance A).*	*This taxa missing in two consecutive surveys or present as a single individual in two consecutive surveys.*
To maintain suitable conditions for the following five key taxa: ▪ *Hydropsychidae* ▪ *Trichorythidae* ▪ *Libellulidae* ▪ *Coenagrionidae* ▪ *Gomphidae*	*Presence of less than three of the five key taxa listed in any survey.*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae and	*Any taxon occurring in an abundance of >1000 for two consecutive surveys.*

EcoSpecs	TPCs
Baetidae). To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.	

5.4.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES (as at October 2013) for riparian vegetation was a Category D, comprising the marginal zone in a Category D, the lower zone in Category D and the upper zone in a Category D/E. This is also the REC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and shall be maintained as viable populations: B. salicina, C. imberbe and P. violacea. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2013. As such agricultural activities shall not encroach into the riparian zone or cross the riparian zone boundary.*

Numerical: *EcoSpecs and TPCs for a D Category are provided in Table 5.9.*

Table 5.9 RU EWR 2: Riparian vegetation EcoSpecs and TPCs

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Non-woody cover				
Riparian zone	*Non-woody cover (excluding reeds) should not be less than 20%.*	*Non-woody cover (excluding reeds) should not be less than 20%.*	*A decrease in non-woody vegetation cover (excluding reeds) below 20%.*	*See hypothesis for Lowveld rivers (non-woody cover) (electronic information).*
Metric: Species composition				
Upper Zone	*Maintain riparian/terrestrial mix.*	*Maintain riparian/terrestrial mix.*	*When the proportion of terrestrial species reaches 60% of the total species count.*	*Extrapolated from DWA (2006c) for EWR 1, to prevent terrestrialisation of the upper zone.*
Upper Zone	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Visible decrease in B. salicina, C. imberbe or P. violacea cover/abundance.*	*Data from DWA (2013b).*
Metric: Alien invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 50%.*	*Perennial alien plant species aerial cover less than 50%.*	*An increase in alien perennial species cover above 50%.*	*See hypothesis for Lowveld rivers (alien invasion) (electronic information).*
Metric: Indigenous riparian woody cover				
Lower Zone	*Riparian woody species cover not more than 80%.*	*Riparian woody species cover not more than 80%.*	*An increase in riparian woody cover above 80%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 10%.*	*Riparian woody species cover not less than 10%.*	*An decrease in riparian woody cover below 10%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not absent.*	*Reed cover not absent.*	*An absence of reed cover.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover not absent.*	*Reed cover not absent.*	*An absence of reed cover.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover more than 60%.*	*Reeds cover more than 60%.*	*An increase in reed cover above 60%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Metric: Riparian zone integrity				
Riparian	*Zero expansion of*	*Zero expansion of*	*An increase of the*	*Desktop assessment of area of*

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
zone	*agriculture activities within the riparian zone.*	*agriculture activities within the riparian zone.*	*spatial extent of forestry or agriculture WITHIN the riparian zone.*	*interest; riparian delineation required; status quo should be calculated (% of riparian zone that is not forestry or agriculture) and used as base against which to assess change.*
Metric: Longitudinal riparian zone continuity				
Riparian zone	*Zero increase in riparian zone longitudinal fragmentation.*	*Zero increase in riparian zone longitudinal fragmentation.*	*An increase in the longitudinal fragmentation of the riparian zone.*	*Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover and use as base against which to assess change.*

5.5 RQOs FOR RU B81D-00272 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has high ecological importance and water resource use importance, and the SCI is moderate. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate importance the REC is set to maintain the C PES. The recommended scenario does not influence this site.

5.5.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Mar	
							90%	60%	90%	60%
C	*91.27*	*57.51*	*13.288*	*14.6*	*20.084*	*22*	*0.066*	*0.1*	*0.243*	*0.377*

5.5.2 Water Quality RQOs

Source: *Water quality assessment conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b). The assessment conducted for EWR 2 (B81D-00271) was valid for the whole stretch of the Letsitele River.*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users (primary user shown in bold text): **Citrus plantations and irrigation***, urban and rural settlements, forestry.*
Water quality issue: *Main land use is some irrigation agriculture, namely citrus plantations (mangos and bananas) and afforestation. Main water quality issues are elevated nutrients, salts and potential toxics.*

Table 5.10 B81D-00272: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (agriculture - irrigation: driver).*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

5.5.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Letsitele	LARGE: Agricultural lands, algal growth, exotic vegetation, runoff/effluent: Urban areas, urbanization, vegetation removal. SERIOUS: Small dams (farm).	C	C	Riparian vegetation
				Instream biota

Habitat and biota RQOs are provided in Table 5.11.

Table 5.11 B81D-00272: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category.*
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone.*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 80% (aerial cover).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES *Desktop FRAI: 61.9%, C/D*	*Maintain PES of at least C/D EC.*	*Maintain the Fish PES in at least a C/D (FRAI ≥61%) EC.*
Species richness	*Maintain relatively high fish species richness.*	*Maintain relative high fish species diversity (do not allow more than 10% deviation from 25 species estimated for SQ reach).*
Primary indicator species: AURA/CPRE	*Flows should be adequate to ensure suitable habitats for flow dependant species (AURA, CPRE).*	*Ensure presence of these species in reach and maintain a FROC at >10% of sites (in relevant geozones) for AURA and CPRE.*
Secondary Indicator species: *Flow: AURA/CPRE* *Water quality: BEUT* *Substrate: AURA/LROS* *Vegetation: BVIV/TREN*	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Hydropsychidae and Psephenidae	*To maintain suitable conditions for these flow dependent species (Rapid velocities: >0.6 m/s) in the SIC biotope.*	
Hydropsychidae and Heptageniidae	*To maintain suitable conditions regarding the water quality for these key species.*	

5.5.4 Wetland RQOs

The quaternary (B81D) is noted for wetland frequency and diversity of types, and the Letsitele specifically (B81D-00272) for frequent channelled valley-bottom wetlands. An overall PES for these wetlands indicates fairly poor condition with an EC of a C/D. Wetland RQOs are provided in Table 5.12.

Table 5.12 B81D-00272: Narrative and numerical wetland RQOs

Indicators	Narrative RQO	Numerical RQO
Wetland PES	*Maintain wetland EC of C/D.*	*Maintain wetland EC score above 58%.*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 2 and IHI score equal to or above 2.*

5.5.5 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 5.13.

Table 5.13 B81D-00272: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauges.*
Water quality	*Data used for water quality assessments should be collected from B8H010Q01. Analysis of data and possible monitoring action should be based on biotic cues.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).* ▪ *Use satellite imagery to assess vegetative cover (% of riparian zone banks).*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

5.6 GROUNDWATER RQOs

Groundwater RQOs cover IUA 2, Letsitele and Thabina - B 81D.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly for water supply. The stress index (use/ aquifer recharge) suggests groundwater resources are moderately utilised. Only 15% of recharge reaches the regional aquifer and the bulk is lost as interflow or from afforestation water use in the high lying areas.*

	B81D
Irrigation (Mm^3/a)	*1.13*
Water Supply (Mm^3/a)	*3*
Total use (Mm^3/a)	*4.13*
Stress index	*0.32*
Harvest potential (Mm^3/a)	*7.77*
Exploitation potential (Mm^3/a)	*5.44*
Recharge (Mm^3/a)	*90.25*
Aquifer recharge (Mm^3/a)	*12.84*
Allocatable groundwater (Mm^3/a)	*8.71*
Status	*C-Moderately modified*

Borehole yields: *Borehole yields are high, with 52% of boreholes having yields above 2 l/s and the median yield is 2.2 l/s, hence groundwater development is feasible.*

	B81D
N	*112*
Lower Quartile (l/s)	*1*
MEDIAN (l/s)	*2.2*
Upper Quartile (l/s)	*4.55*
Geometric Mean (l/s)	*1.66*
Yield >2 l/s (%)	*51.79*

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: Ground water is generally of DWA Class 0, or Ideal water quality.

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81D	*98*	*32*	*1*			*131*	*100*	*137*	*20*	*16*		*1*	*174*	*99*

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction and afforestation impacts significantly on baseflow in this IUA. This IUA provides nearly 29% of baseflow in the Letaba, hence is an important source of water to downstream users. Only 2% of baseflow is from the regional aquifer, the remainder originating as interflow, consequently afforestation can have a greater impact than abstraction by diminishing interflow from high lying areas. Abstraction has reduced baseflow by 2.3%. Abstraction impacts significantly on groundwater baseflow, and groundwater baseflow reduction is 44% of abstraction.*

	B81D
MAR (Mm^3/a)	*107.85*
Total Use (Mm^3/a)	*4.13*
Stress index	*0.32*
Recharge (Mm^3/a)	*90.25*
Aquifer recharge (Mm^3/a)	*12.84*
Interflow (Mm^3/a)	*77.41*
Baseflow (Mm^3/a)	*79*
Groundwater water baseflow (Mm^3/a)	*1.59*
Present baseflow (Mm^3/a)	*77.18*
Present MAR reduction (Mm^3/a)	*1.83*
Increased abstraction (Mm^3/a)	*3.64*
Baseflow due to increased abstraction (Mm^3/a)	*75.58*
% contribution to total baseflow of the Letaba	*28.86*

Numerical: *The Groundwater RQOs are provided in Table 5.13.*

Table 5.14 IUA 2: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater is moderately utilised. Abstraction impacts significantly on baseflow and this region is a significant source of baseflow in the Letaba system. Further investigations as to the impact of abstraction and stream flow reduction activities are required before any additional abstraction takes place.	*Groundwater abstraction can be increased from 4.13 Mm^3/a to 7.77 Mm^3/a, with a 1.60 Mm^3 reduction in baseflow.*

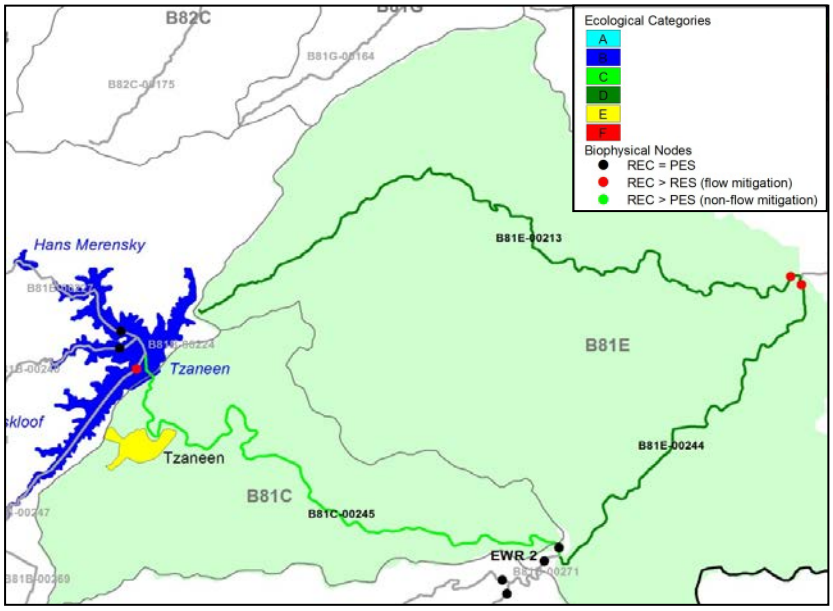
6 IUA 3: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Formal irrigation occurs next to the Letaba River and the irrigation water is released from Tzaneen Dam and also stored in various weirs. Flow-related modification are needed to achieve the REC and alternative scenarios of operation releases from Tzaneen Dam, also considering the planned dam raising, will have to be assessed. Within a system context it is likely that scenarios of flow releases downstream of the proposed Nwamitwa Dam need to be evaluated. Due to the two major dams at the upstream and downstream ends of the IUA it forms a logical management unit. The ecology in the Nwanedzi tributary is mainly influenced by non-flow related impacts related to agriculture and urbanization.

IUA 3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table. Shaded cells indicate SQs for which EWR data is applicable.

IUA 3: LETABA DOWNSTREAM OF TZANEEN TO PROPOSED NWAMITWA DAM



PRIORITY RATINGS

SQ	River	Priority rating
*B81C-00245**	*Great Letaba*	*3a*
B81E-00213	*Nwanedzi*	*2*
*B81E-00244**	*Great Letaba*	*3a*

** These SQs form part of RU EWR 3, which is situated largely in IUA 4. Please refer to Section 7.1.*

Water resource use

This zone includes mostly the rivers (3 SQ reaches) falling within quaternary catchments B81C and B81E. The flow in the Letaba River is regulated by releases from Tzaneen Dam located in IUA 1. There are a number of river abstractions mainly by the irrigation sector. Return flows generated from the irrigation sector enter the river systems which has a negative impact on the water quality. A future resource development planned at the outlet of the IUA is the development of the proposed Nwamitwa Dam at the confluence of the Nwanedzi, Letsitele and Groot Letaba Rivers. There is some potential for groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.
The groundwater response unit consists of approximately 50% Drakensberg Escarpment zone and the rest are Drakensberg Foothills and Valleys. The groundwater use is approximately 60% of the aquifer recharge.

The groundwater response unit falls largely within the Drakensberg Foothills and Valleys. The groundwater use is less than 10% of the aquifer recharge.

Water quality

Water quality state is dominated by elevated nutrients, salts and possible toxicants due to fertilizer /pesticide use associated with extensive (citrus) irrigation agriculture upstream of the proposed Nwamitwa Dam. Two water quality hotspots were identified in these reaches.

Economy

The main economic activities are the primary industries of citrus fruit and commercial forestry which is used in the secondary industries of saw milling and fruit juice processing.

EGSA

This IUA includes the formal town of Tzaneen in the western portion. The utilisation of EGSA tends to be low as the populations tend to be urbanised and alienated from direct use of the resources. The eastern part of the IUA is given over to commercial farming. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. The northern part is mixed land use with rural closer settlement dominating significant portions. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high

River and wetland ecology

The Great Letaba River, downstream of the Tzaneen Dam is currently in a C PES, being impacted by flow modification (Tzaneen Dam), agriculture and runoff associated with Tzaneen town and surrounds. The lower reach of the Great Letaba in this zone, after the confluence of the Letsitele, falls in a D PES, receiving the impacts related to forestry, flow modification and urban and rural settlements of the upper reaches. This reach is also locally highly impacted by agriculture and flow modification related to tributary dams. The Nwanedzi River also falls in a D PES, with primary land use and impacts being associated with urbanization and agriculture. This zone ends in the area earmarked for the construction of the Nwamitwa Dam.

This zone has a markedly high frequency and diversity of wetlands, particularly the Great Letaba and its unnamed tributaries in the B81E quaternary and the Nwanedzi River. Many however are associated with small impoundments and the general PES is a D.

6.1 RQOs FOR B81C-00245 (HIGH PRIORITY – 3A)

The RU is of high priority (Level 3) as the ecological importance and water resource use importance is high while the SCI is moderate. This SQ forms part of RU EWR 3, which is situated largely in IUA 4. Please refer to Section 7.1 for further detail on habitat and biotic RQOs.

6.1.1 Flow RQOs

Detailed data is provided under Section 7.1. However the following gauges that can be used for monitoring purposes are applicable for this SQ:

- *B8R005: At Tzaneen Dam which has a separate measurement of spills and releases.*
- *B8H009: Can* **only** *be used for verification of low flows. The gauge is inundated in periods of high flows due to being so close to the confluence with the Letsitele River.*

6.1.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2013b) were used.*

Model: *N/A.*

Users (primary user is shown in bold text): **Agriculture***, livestock, urban and rural settlements.*

Water quality issue: *Elevated nutrient levels in the reach are due to agricultural activities. More effective management should meet the specified RQOs.*

Narrative and Numerical: *Details provided in Table 6.1. Conduct biological monitoring at the lower end of the reach and institute water quality monitoring (physico-chemical variables and nutrients) if indicated by biotic state. EcoSpecs and TPCs for this reach are provided in Section 7.1.*

Table 6.1 B81C-00245: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (agriculture - irrigation: driver).*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

6.1.3 Wetland RQOs

Wetlands of high importance occur in B81C-00245. This SQ reach falls within RU EWR 3 and mostly channelled valley bottom wetlands associated with the SQ and tributaries occur in this reach. Maintaining the wetlands in their current condition is outlined below for all three SQs:

- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013b). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain high.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands. The abundance of G. perpensa (Declining) should not decline.*
- *Birds: The abundance of herons, ducks or moorhens that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013b).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

Numerical: *Wetland RQOs are provided in Table 6.2.*

Table 6.2 B81C-00245: Narrative and numerical wetland RQOs

Subcomponent indicator	Narrative RQO	Numerical RQO	Possible monitoring action and tools
Wetland PES	*Maintain wetland EC of D.*	*Maintain wetland EC score above 56%.*	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*
Integrated wetland importance and sensitivity and IHI	*Maintain High EI.*	*Maintain Median EI score equal to or above 2.25 and IHI score equal to or above 2.*	

6.2 RQOs FOR B81E-00213 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as the ecological importance and SCI is moderate and water resource use importance is high. The detail of available information also plays a role and there was no EWR site situated in the vicinity. This RU is in a D PES for the EcoStatus and a C REC. The improvement that would be required is related to catchment management and system operation as well as water quality and non-flow related aspects. The flow RQO is therefore set for a C. The recommended scenarios do not impact on the site, and therefore the RQOs are set to maintain the REC of a C.

6.2.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	*17.28*	*11.31*	*0.302*	*1.7*	*1.392*	*8.1*	*0*	*0*	*0*	*0*

6.2.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2013b) were used.*
Model: *N/A.*
Users (primary user shown in bold text): **Agriculture**, *livestock, urban and rural settlements*
Water quality issue: *Elevated nutrient levels in the reach are due to agricultural activities. More effective management should meet the specified RQOs.*

Table 6.3 B81E-00213: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (agriculture - irrigation: driver).*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95th percentile of the data must be less than or equal to 30 mS/m (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996b) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

6.2.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Nwanedzi	**MODERATE:** *Erosion, inundation, irrigation, mining, runoff/effluent - irrigation, runoff/effluent - urban areas, sedimentation, grazing/trampling.* **LARGE:** *Abstraction (run-of river)/increased flows, agricultural lands, algal growth, exotic vegetation, small dams (farm), urbanization, vegetation removal.*	D	C	*Riparian vegetation*
				Water quality

Habitat and biota RQOs are provided in Table 6.4.

Table 6.4 B81E-00213: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired (EC).*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C EC).*
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone.*

6.2.4 Wetland RQOs

This zone has a markedly high frequency and diversity of wetlands, particularly the Great Letaba and its unnamed tributaries in the B81E quaternary and the Nwanedzi River. Many however are associated with small impoundments and the general PES is a D. Wetland RQOs are provided in Table 6.4.

Table 6.5 B81E-00213: Narrative and numerical wetland RQOs

Indicators	Narrative RQO	Numerical RQO
Wetland PES	*Maintain wetland EC of D.*	*Maintain wetland EC score above 50%.*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 1.5 and IHI score equal to or above 2.4.*

6.2.5 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 6.4.

Table 6.6 B81E-00213: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauges.*
Water quality	*Conduct biological monitoring at the lower end of the reach and institute water quality monitoring (physico-chemical variables and nutrients) if indicated by biotic state.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).*

Component	Monitoring actions and tools
	▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

6.3 RQOs FOR RU B81E-00244 (HIGH PRIORITY – 3A)

The RU is of high priority (Level 3) as the ecological importance and water resource use importance is high while the SCI is moderate. This SQ forms part of RU EWR 3, which is situated largely in IUA 4. Please refer to Section 7.1 for further detail on RQOs.

6.3.1 Wetland RQOs

Moderately important wetlands occur in B81E-00244. This SQ falls within RU EWR 3 and channelled valley bottom wetlands associated with the SQs and their tributaries mostly occurs. Maintaining the wetlands in their current condition is outlined below for all three SQs:

- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013b). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain moderate.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands. The abundance of G. perpensa (Declining) should not decline.*
- *Birds: The abundance of herons, ducks or moorhens that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013b).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

Numerical: *Wetland RQOs are provided in Table 6.7.*

Table 6.7 B81E-00245: Narrative and numerical wetland RQOs

Subcomponent indicator	Narrative RQO	Numerical RQO	Possible monitoring action and tools
Wetland PES	*Maintain wetland EC of D.*	*Maintain wetland EC score above 52%.*	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*
Integrated wetland importance and sensitivity and IHI	*Maintain High EI.*	*Maintain Median EI score equal to or above 1.5 and IHI score equal to or above 2.3.*	

6.4 GROUNDWATER RQOs

Groundwater RQOs cover IUA 3, Letaba downstream of Tzaneen to proposed Nwamitwa Dam - B81C, B81E.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly and extensively used for irrigation. Groundwater use exceeds the Harvest Potential in both catchments and the stress index (use/ aquifer recharge) suggests groundwater resources are moderately to heavily utilised. Nearly 70% of recharge enters the regional aquifer and is available for abstraction.*

	B81C	B81E	Total
Irrigation (Mm^3/a)	5.47	15.16	20.63
Water Supply (Mm^3/a)	0	0.59	0.59
Total use (Mm^3/a)	5.47	15.75	21.22
Stress index	0.34	0.87	
Harvest potential (Mm^3/a)	3.33	8.95	12.28
Exploitation potential (Mm^3/a)	2	5.37	7.37
Recharge (Mm^3/a)	27.82	20.93	48.75
Aquifer recharge (Mm^3/a)	16.27	18.2	34.47
Allocatable groundwater (Mm^3/a)	10.8	2.45	13.25
Status	C – Moderately modified	E – Seriously modified	

Borehole yields: *Borehole yields are low, with only 9 - 15% of boreholes having yields above 2 l/s and the median yield is 0.65 - 0.75 l/s, hence groundwater development is feasible only with scientifically sited boreholes, or those tapping alluvial aquifers.*

	B81C	B81E
N	11	64
Lower Quartile (l/s)	0.34	0.1275
MEDIAN (l/s)	0.76	0.64
Upper Quartile (l/s)	1.68	1.5
Geometric Mean (l/s)	0.75	0.57
Yield >2 l/s (%)	9.09	15.63

Number of boreholes:

- >75%
- 50 - 75%
- 25 - 50%
- <25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 0, or Ideal water quality.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81C	15	7				22	100	53	5		1		59	98
B81E	74	37	5			116	100	124	8	11	2	1	146	98

- >80%
- 60 - 80%
- <60%,

Groundwater contribution to baseflow: *Groundwater abstraction impacts significantly on baseflow in this IUA. This IUA provides 9% of baseflow in the Letaba. Over 42% of baseflow is from the regional aquifer, the remainder originating as interflow; consequently a reduction in groundwater baseflow by abstraction can significantly impact on baseflow. Abstraction has reduced baseflow by 19%. Abstraction impacts significantly on groundwater baseflow, and groundwater baseflow reduction is 22% of abstraction.*

	B81C	B81E	Total
MAR (Mm^3/a)	*28.7*	*30.96*	*59.66*
Total Use (Mm^3/a)	*5.47*	*15.75*	*21.22*
Stress index	*0.34*	*0.87*	
Recharge (Mm^3/a)	*27.82*	*20.93*	*48.75*
Aquifer recharge (Mm^3/a)	*16.27*	*18.2*	*34.47*
Interflow (Mm^3/a)	*11.55*	*2.73*	*14.28*
Baseflow (Mm^3/a)	*22.09*	*2.77*	*24.86*
Groundwater water baseflow (Mm^3/a)	*10.54*	*0.04*	*10.58*
Present baseflow (Mm^3/a)	*18.21*	*1.98*	*20.19*
Present MAR reduction (Mm^3/a)	*3.86*	*0.77*	*4.63*
Increased abstraction (Mm^3/a)			
Baseflow due to increased abstraction (Mm^3/a)	*18.21*	*1.98*	*20.19*
% contribution to total baseflow of the Letaba		*9.08*	

Numerical: *The groundwater RQOs are provided in Table 6.8.*

Table 6.8 IUA 3: Groundwater RQOs

Quat	Groundwater narrative RQO	Groundwater numerical RQO
B81C	*Groundwater is heavily utilised. Abstraction impacts significantly on baseflow and this region is a significant source of baseflow in the Letaba system. Further investigations as to the impact of abstraction and stream flow reduction activities are required before any additional abstraction takes*	*Groundwater abstraction exceeds the Harvest Potential but not the simulated aquifer recharge. No further abstraction should take place without a review of the harvest potential.*
B81E	*Groundwater is over exploited and has resulted in significant baseflow depletion from the catchment. No further groundwater abstraction should be permitted.*	*Groundwater abstraction exceeds the Harvest Potential but not the simulated aquifer recharge. No further abstraction should take place without a review of the harvest potential.*

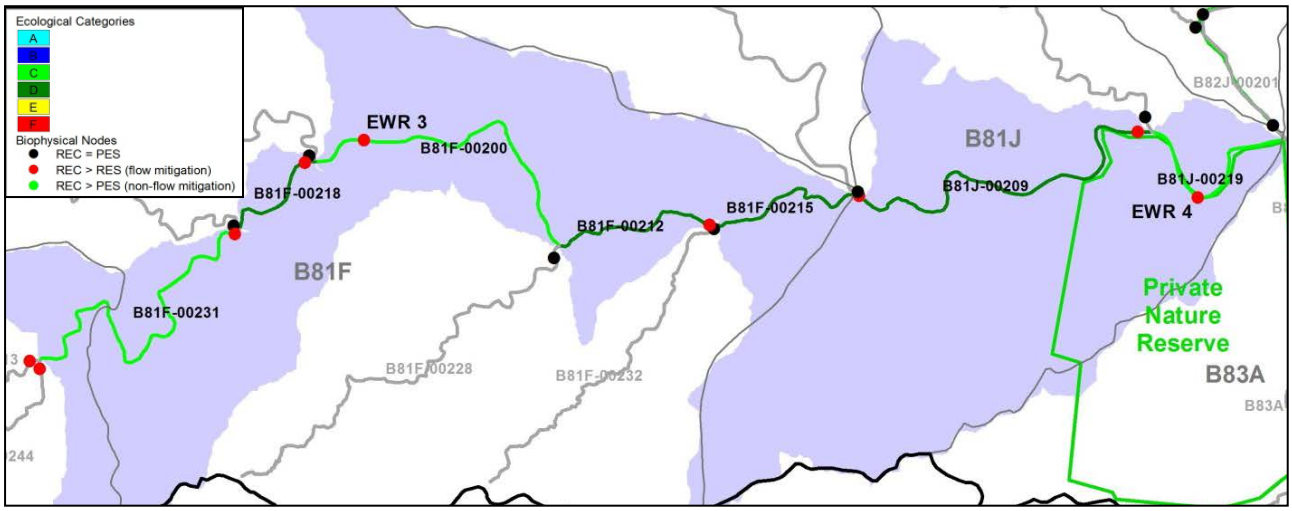
7 IUA 4: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The main Letaba River is the only source in this IUA which is operable and the potential for scenario development and different operating rules from the proposed Nwamitwa Dam makes this a logical unit. This is the major reason why in this case, a linear section of river has been selected as an IUA, rather than a catchment. The tributaries flowing into this IUA therefore form separate IUAs as operation and scenario options in those IUAs are very different to the Letaba River.

IUA 4 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table. Shaded cells indicate SQs for which EWR data is applicable.

IUA 4: LETABA FROM PROPOSED NWAMITWA DAM TO KLEIN LETABA CONFLUENCE



PRIORITY RATINGS

SQ	River	Priority rating
B81F-00200 (EWR 3)	*Great Letaba*	*3b*
*B81F-00212**	*Great Letaba*	*3a*
*B81F-00215**	*Great Letaba*	*3a*
*B81F-00218**	*Great Letaba*	*3a*
*B81F-00231**	*Great Letaba*	*3a*
B81J-00209#	*Great Letaba*	*3a*
B81J-00219 (EWR 4)	*Great Letaba*	*3b*

** These SQs form part of RU EWR 3. Please refer to Section 7.1.*

 # This SQ forms part of RU EWR4. Please refer to Section 7.2.

Water resource use

This IUA includes only the Letaba River downstream of the proposed Nwamitwa Dam site to the confluence with the Little Letaba. The IUA is currently regulated by Tzaneen Dam located in IUA 1 and water is mainly supplied to the irrigation sector. There is no surface water resource developments planned in the IUA. There is possibility for future groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

The groundwater response unit falls largely within the Lowveld Plains, but a section falls within Gravelotte-Giyani. The groundwater use is not confirmed but likely to be less than 20% of aquifer recharge.

Water quality

Water quality state is dominated by elevated nutrients, salts and possible toxicants due to fertilizer /pesticide use associated with extensive (citrus) irrigation agriculture. Two water quality hotspots were identified in these reaches.

Economy

The main primary economic activities are citrus and mangoes. The tertiary economic activity is eco-tourism.

EGSA

This IUA contains a portion of highly developed commercial farming where utilisation of ecological goods and services tends to be low. Some game farms are evident. Again ecological goods and services, bar those associated with the recreational and aesthetic aspects would be low. The northern portions are heavily dominated by the high density rural closer settlements characteristic of the former homeland areas. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology

It includes 7 SQs which currently are all influenced by the operational rules of Tzaneen Dam, many instream weirs, inundation, abstraction, irrigation, private Reserves and some rural settlements. The last SQ is within the Greater Kruger National Park (Letaba Ranch). Four of the seven SQs are in a D EC and three are in a C EC. This zone has no notable wetlands.

7.1 RQOs FOR RU EWR 3 (B81F-00200; B81C-00245; B81E-00244; B81F-00212; B81F-00215; B81F-00218; B81F-00231) (HIGH PRIORITY – 3)

7.1.1 Flow RQOs

The EWR 3 is situated in B81F-00200. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. This flow RQO is provided below. Flow RQOs at other biophysical nodes in this RU is provided in Appendix A. It must be noted that these flows are just a result of the recommended scenario's operating setup and if the operating rules change whilst still meeting the RQOs at EWR 3 these secondary flow RQOs will be different.

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*
Gauged at: *B8H017 should not be used to monitor flows. The canal outlet has been damaged and open since 1996. Recent flood partially closed the canal inlet and therefore there are losses.*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

nMAR (MCM)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
			90%	60%	90%	60%
394.91	173.42	43.9138	1.092	1.222	1.461	4.474

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	No of events	Months	Daily average	Duration
CLASS I (6 - 10 m^3/s)	*3*	*Jan, Feb, Mar*	*7*	*2*
CLASS II (12 - 18 m^3/s)	*2*	*Jan Mar*	*14*	*3*
CLASS III (50 - 90 m^3/s)	*1*	*Feb*	*70*	*4*
CLASS IV (150 - 220 m^3/s)	*1:2*	*Mar*	*160*	*6*

7.1.2 Water Quality RQOs

Source: *Water quality assessment conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b).*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users (primary user shown in bold text): **Irrigation agriculture***, particularly for citrus plantations (e.g. Nagude Farm Estate), settlements.*
Water quality issue: *Water quality issues therefore relate to the use of pesticides and herbicides, and expected elevated levels of chlorophyll-a, nitrogen and phosphates.*
Narrative and Numerical: *Details provided in Table 7.1. Data used for water quality assessments should be collected from B8H009Q01. Analysis of data and possible monitoring action should be based on biotic cues. EcoSpecs and TPCs for a B Category are provided in Table 7.2.*

Table 7.1 B81F-00200: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95th percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver).*
Ensure that pH stays within Ideal limits.	*5th and 95th percentiles of pH data must be between 6.5 and 8.0 (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 7.2 RU EWR 3: Water quality EcoSpecs and TPCs

River: Groot Letaba	**PES: B/C EC**	
Monitoring site: B8H009Q01	**Recommended scenario: B EC**	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 23 mg/L.*	*The 95th percentile of the data must be between 18 - 23 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be between 16 – 20 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 15 mg/L.*	*The 95th percentile of the data must be between 12 – 15 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 21 mg/L.*	*The 95th percentile of the data must be between 17 – 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 191 mg/L.*	*The 95th percentile of the data must be between 153 – 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*

Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be between 44 – 55 mS/m.*
pH	*The 5th and 95th percentiles of the data must be between 6.5 to 8.0.*	*5th percentile of the data must not be less than 6.7.* *95th percentile of the data must not be greater than 7.6.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by no more than 2°C.*	*Unnatural deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes with temporary high sediment loads and turbidity during runoff events.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
TIN	*The 50th percentile of the data must be ≤ 0.7 mg/L.*	*The 50th percentile of the data must be between 0.55 – 0.7 mg/L.*
PO_4-P	*The 50th percentile of the data must be ≤ 0.015 mg/L.*	*The 50th percentile of the data must be between 0.012 – 0.015 mg/L.*
Response variables		
Chl-a phytoplankton [(b)]	*The 50th percentile of the data must be ≤ 20 mg/m^2.*	*The 50th percentile of the data must be between 16 – 20 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 21 mg/m^2.*	*The 50th percentile of the data must be between 17 – 21 mg/m^2.*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996a).*

(a) To be generated using TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

7.1.3 Habitat and biota RQOs (EcoSpecs)

7.1.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES at EWR 3, based on fish, is moderately modified, falling in a Category C and should not be allowed to deteriorate any further. The recommended flow scenario for this reach is expected to result in a slight improvement in the PES but remaining within the same EC of a C. The current relatively high species richness of 30 indigenous fish species of an estimated 33 naturally occurring species should not be allowed to decrease. The recommended flow scenario is not expected to change the fish species richness of the reach but an improved FROC (distribution within a reach) is expected for species such as the orangefin barb (BEUT), Imberi (BIMB), shortspine suckermouth (CPRE) and lowveld suckermouth (CSWI). Various fish species intolerant to different stressors or with a high preference for specific habitat features provide valuable indicators of change that should be used to monitor potential change. The primary indicator fish species for this reach is the shortspine suckermouth, being an indicator of flow modification (fast flowing habitats), rocky substrate condition and water quality. Another important indicator for this reach with similar requirements, albeit slightly lower, is the sawfin suckermouth (CPAR).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 7.3.*

Table 7.3 RU EWR 3: Fish EcoSpecs and TPCs

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
Metric: Ecological status				
PES	*PES of fish is in a C (63.7%).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC[1] of species.*	*A slight improvement in the ecological conditions is expected but the fish will still remain in a C (67.6%). An improvement in the FROC of BEUT, BIMB, CPRE, and CSWI can be expected under this scenario.*
Metric: Species richness				
All indigenous species	*30 of the expected 33 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*	
Metric: Requirement for flowing water				
CPRE CSWI	*CPRE and CSWI have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*CPRE and/or CSWI absent during any survey OR present at FROC[1] of < 3 for CPRE and < 1.25 for CSWI. (DWAF, 2006c: A minimum of 20 CPRE specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*	*It is estimated that under the REC (Sc 11), improved condition may result in an increase in the FROC of CPRE (from 3 to 3.5) and CSWI (from 1.25 to 2). This species can therefore be expected to become slightly more widespread and abundant in the reach.*
Metric: FD habitats				
BEUT CPRE	*BEUT and CPRE have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*BEUT and/or CPRE absent during any survey OR present at FROC of < 2 for BEUT and < 3 for CPRE.*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).*	*It is estimated that under the REC (Sc 11), improved condition may result in an increase in the FROC of BEUT (from 2 to 3). This species can therefore be expected to become more widespread and abundant in the reach.*
Metric: FS habitats				
CPAR CPRE	*CPAR and CPRE have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or CPRE absent during any survey OR present at FROC of < 4 for CPAR and < 3 for CPRE. (DWAF, 2006c: A minimum of 20 CPRE and/or 10 CPAR specimens should be sampled at 100% of sites during a survey of FS and FD,*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*	*It is estimated that under the REC (Sc 11), improved condition may result in an increase in the FROC of CPRE (from 3 to 3.5). This species can therefore be expected to become slightly more widespread and*

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
		electrofishing for minimum 20 minutes)		*abundant in the reach.*
Metric: Substrate				
LROS CPAR	*LROS and CPAR have a high requirement for FD habitats and are the most applicable indicator species for this habitat feature.*	*LROS and/or CPAR absent during any survey OR present at FROC of < 4 for LROS and < 4 for CPAR.*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.*	
Metric: Water quality intolerance				
CPRE MMAC	*CPRE and MMAC have a high requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*CPRE and/or MMAC absent during any survey OR present at FROC of < 3 for CPRE and < 3 for MMAC.*	*Decreased water quality (especially flow related water quality variables such as oxygen).*	
Metric: Overhanging vegetation				
PPHI BPAU	*PPHI and BPAU have a high requirement for overhanging vegetation and are the most applicable indicator species for this habitat feature.*	*PPHI and/or BPAU absent during any survey OR present at FROC of < 5 for PPHI and < 4 for BPAU.*	*Significant change in overhanging vegetation habitats.*	
Metric: Instream vegetation				
TREN BVIV	*TREN and BVIV have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or BVIV absent during any survey OR present at FROC of < 5 for TREN and < 4 for BVIV.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)*	
Metric: Undercut banks				
MMAC BEUT	*MMAC and BEUT have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*MMAC and/or BEUT absent during any survey OR present at FROC of < 3 for MMAC and < 2 for BEUT.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*	
Metric: Water column				
MBRE SINT	*MBRE and SINT have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or HVIT absent during any survey OR present at FROC of < 4 for MBRE and < 5 for SINT.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*	

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
Metric: SD habitats				
BANN BUNI	*BANN and BUNI have a high requirement for SD habitats and are the most applicable indicator species for this velocity depth category.*	*BANN and/or BUNI absent during any survey OR present at FROC of <5 for BANN and <4 for BUNI.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: SS habitats				
BRAD BVIV	*BRAD and BVIV have a high requirement for SS habitats and are the most applicable indicator species for this velocity depth category.*	*BRAD and/or BVIV absent during any survey OR present at FROC of <4 for BRAD and <4 for BVIV.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: Migratory success[2]				
AMOS BMAR	*It is estimated that the catadromous AMOS may still be present, as well as various potamodromous species (including BMAR).*	*Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BMAR).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	
Metric: Alien fish species				
Presence of any alien/ Introd. spp.	*No alien/introduced species known or expected to be present in the SQ reach.*	*Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.*	*N/A.*	
Primary indicator species: CPRE (CPAR)				
	CPRE estimated to be present at >25% of sites in SQ reach (DWA, 2013b) (to be verified).	**See relevant sections above for detail.**	**See relevant sections above for detail.**	

1, 2: Refer to Table 4.21.

7.1.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of a Lowveld river in the middle reaches assemblage with seasonal traits. The habitats in the river are dominated by a wide channel with ample bedrock, SIC, and alluvial sediment habitats. Good marginal vegetation habitat is present on the river banks. Although upstream dams and abstraction leads to low flows and associated poorer water quality parameters (irrigation and rural settlements), the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will remain in a Category C, which is similar to the PES of the river and thus will not impact on the integrity of the river reach.*

Numerical: *Indicator taxa are provided in Table 7.4 and Table 7.5 provides EcoSpecs and TPCs for a C Category.*

Table 7.4 RU EWR 3: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*>0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 – 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 – 0.6*	*Cobbles*	*Moderate*
5	*Atyidae*	*N/A*	*Vegetation*	*Moderate*
6	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 3 is situated in B81F-00200, Letaba River is provided in Table 7.5. This RU consists of a larger stream with moderate velocities; ample SIC and good marginal vegetation habitat.

Table 7.5 RU EWR 3: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs
To ensure that the SASS 5 scores and ASPT values occur in the following range: SASS 5 score: > 120; ASPT value: > 5.5.	*SASS5 scores less than 130 and an ASPT less than 5.5.*
To ensure that the MIRAI score remains within the range of a C Category (62% – 78%).	*A MIRAI score of 62% or less.*
To maintain suitable flow velocity (>0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance B).* ▪ *Trichorythidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Heptageniidae (Abundance A).* ▪ *Elmidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Atyidae (Abundance A).* ▪ *Coenagrionidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*
To maintain suitable conditions for the following six key taxa: ▪ *Hydropsychidae*	*Presence of less than four of the six key taxa listed in any survey.*

EcoSpecs	TPCs
▪ *Trichorythidae* ▪ *Heptageniidae* ▪ *Elmidae* ▪ *Atyidae* ▪ *Coenagrionidae*	
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae and Baetidae). To ensure that no group consistently dominates the fauna, defined as D abundance (> 1000) over more than two consecutive surveys.	*Any taxon occurring in an abundance of >1000 for two consecutive surveys.*

7.1.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES (as at October 2013) for riparian vegetation was a Category C/D, comprising the marginal zone in a Category C/D, the lower zone in Category D and the upper zone in a Category C. The recommended scenario will however result in a Category C. Under this scenario vegetation cover (woody and non-woody) will be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species will be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone will reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and will be maintained as viable populations: B. salicina, C. imberbe and P. violacea. Both riparian zone integrity and longitudinal continuity will not deteriorate from its state in 2013. As such agricultural activities will not encroach into the riparian zone or cross the riparian zone boundary. Agricultural lands currently within the riparian zone will not expand or intensify.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 7.6.*

Table 7.6 RU EWR 3: Riparian vegetation EcoSpecs and TPCs

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Vegetation cover				
Marginal Zone	*Maintain marginal hydrophyte fringe and Phragmites along the active channel*	*Maintain marginal hydrophyte fringe and Phragmites along the active channel.*	*Marginal fringe absent; Phragmites fringe visibly (fixed photo) increasing in abundance/cover.*	*Adapted from DWAF (2006c), fringe cover (either reeds or woody overhang) is important habitat for instream and riparian fauna.*
Lower Zone	*Maintain Ficus sycomorus and Cyperus patches cover.*	*Maintain F. sycomorus and Cyperus patches cover.*	*Measurable decrease in either population.*	*Adapted from DWAF (2006c), active channel woody component is important habitat for instream and riparian fauna; two different types of important lower zone habitat.*
Metric: Species composition				
Upper Zone	*Maintain riparian/terrestrial mix.*	*Maintain riparian/terrestrial mix.*	*When the proportion of terrestrial species reaches 50% of the total species count.*	*Adapted from DWAF (2006c), to prevent terrestrialisation of the upper zone.*
Upper Zone	*Maintain Diospyros mespiliformis population.*	*Maintain D. mespiliformis population.*	*Visible decrease in D. mespiliformis cover/abundance.*	*Adapted from DWAF (2006c), typical upper zone species relying on bank storage, its demise a possible indication of reduced bank storage.*
Upper Zone	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Maintain B. salicina, C. imberbe and P. violacea populations.*	*Visible decrease in B. salicina, C. imberbe or P. violacea cover/abundance.*	*Data from DWA (2013b).*

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Alien invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 30%.*	*Perennial alien plant species aerial cover less than 30%.*	*Increases in alien perennial species cover above 30%.*	*See hypothesis for Lowveld rivers (alien invasion) (electronic information).*
Metric: Indigenous riparian woody cover				
Marginal Zone	*Riparian woody species cover not absent and not more than 80%.*	*Riparian woody species cover not absent and not more than 80%.*	*An increase in riparian woody cover above 80% OR an absence of woody riparian species.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Lower Zone	*Riparian woody species cover not more than 80%.*	*Riparian woody species cover not less than 5% and not more than 70%.*	*An increase in riparian woody cover above 80%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 20% and not more than 80%.*	*Riparian woody species cover not less than 20% and not more than 80%.*	*An increase in riparian woody cover above 80% OR a decrease below 20%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not less than 10%.*	*Reed cover not less than 10%.*	*A decrease in reed cover below 10%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover not absent.*	*Reed cover between 10% and 90%.*	*An absence of reed cover.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover less than 50%.*	*Reeds cover less than 50%.*	*An increase in reed cover above 50%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Metric: Riparian zone integrity				
Riparian zone	*Zero expansion of agriculture within the riparian zone.*	*Zero expansion of agriculture within the riparian zone.*	*An increase of the spatial extent of agriculture WITHIN the riparian zone.*	*Desktop assessment of area of interest; riparian delineation required; status quo should be calculated (% of riparian zone that is not forestry or agriculture) and used as base against which to assess change.*
Metric: Longitudinal riparian zone continuity				
Riparian zone	*Zero increase in riparian zone longitudinal fragmentation.*	*Zero increase in riparian zone longitudinal fragmentation.*	*An increase in the longitudinal fragmentation of the riparian zone.*	*Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover and use as base against which to assess change.*

7.1.4 Wetland RQOs

Moderately important wetlands occur in B81F-00231 and B81F-00200 which fall within RU EWR 3 and are mostly channelled valley bottom wetlands associated with the respective SQs and their tributaries. Maintaining the wetlands in their current condition is outlined below for both SQs:

- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013b). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain high.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands.*
- *Mammals: The abundance of Angoni vlei rats or vlei rats that utilise wetlands shall not decline (data - DWA, 2013b).*

- *Birds: The abundance of herons, ducks, moorhens, greenshank or sandpiper that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013a).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

Numerical: *Wetland RQOs are provided in Table 7.7 for B81F-00231 and B81F-00200.*

Table 7.7 Wetlands in SQ B81F-00231 and B81F-00200: Narrative and numerical RQOs

Subcomponent indicator	Narrative RQO	Numerical RQO	Possible monitoring action and tools
B81F-00231			
Wetland PES	*Maintain wetland EC of C/D.*	*Maintain wetland EC score above 59%.*	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 2 and IHI score equal to or above 2.*	
B81F-00200			
Wetland PES	*Maintain wetland EC of C.*	*Maintain wetland EC score above 67%.*	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 2 and IHI score equal to or above 1.6.*	

7.2 RQOs FOR RU EWR 4 (B81J-00219; B81J-00209) (HIGH PRIORITY – 3)

7.2.1 Flow RQOs

The EWR 4 is situated in B81J-00219. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. This flow RQO is provided below. Flow RQOs at other biophysical nodes in this RU is provided in Appendix A. It must be noted that these flows are just a result of the recommended scenario's operating setup and if the operating rules change whilst still meeting the RQOs at EWR 4 these secondary flow RQOs will be different.

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*
Guaged at: *B8H008 situated in B81J-00209 cannot be used for calibration as the station is unstable and there is flanking of station during high flows. Efforts are however being made to improve the station and it should only be used for low flow monitoring.*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

nMAR (MCM)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
			90%	60%	90%	60%
441.39	*187.73*	*42.53155*	*0.523*	*0.554*	*0.788*	*3.781*

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	NO OF EVENTS	Months	Daily average	Duration
CLASS I (4 - 8 m^3/s)	2	Jan, Mar	6	3
CLASS II (10 - 22 m^3/s)	1	Jan	15	4
CLASS III (60 - 180 m^3/s)	1	Mar	60	6
CLASS IV (250 - 420 m^3/s)	2	Feb, Mar	150	6

7.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b).*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users: *Limited cultivated lands, subsistence agriculture, livestock, and rural settlements.*
Water quality issue: *Land-use is primarily rural and domestic water use, i.e. limited cultivated lands and subsistence agriculture and livestock, before entering Letaba Ranch Nature Reserve. Issues are linked primarily to nutrient elevations and increased turbidity related to subsistence land use and settlements in the area.*
Narrative and Numerical: *Details provided in Table 7.8. Data used for water quality assessments should be collected from B8H008Q01. Analysis of data and possible monitoring action should be based on biotic cues. EcoSpecs and TPCs for a B/C Category are provided in Table 7.9.*

Table 7.8 B81J-00219: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	50^{th} percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (aquatic ecosystems: driver).
Ensure that electrical conductivity (salt) levels are within Ideal limits.	95^{th} percentile of the data must be less than or equal to 30 mS/m (Industry Cat 3: driver).
Ensure that pH stays within Acceptable limits.	5^{th} and 95^{th} percentiles of pH data must be between 6.5 and 8.4 (Industry Cat 3: driver).
Ensure that turbidity or clarity levels stay within Acceptable limits.	A moderate change from present with temporary high sediment loads and turbidity during runoff events (aquatic ecosystems: driver).
Ensure that toxics are within Ideal limits or A categories.	95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 7.9 RU EWR 4: Water quality EcoSpecs and TPCs

River: Groot Letaba		REC: B EC
Monitoring site: B8H008Q01		Recommended scenario: B/C
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	The 95^{th} percentile of the data must be ≤ 16 mg/L.	The 95^{th} percentile of the data must be between 13 - 16 mg/L.
Na_2SO_4	The 95^{th} percentile of the data must be ≤ 20 mg/L.	The 95^{th} percentile of the data must be between 16 – 20 mg/L.
$MgCl_2$	The 95^{th} percentile of the data must be ≤ 15 mg/L.	The 95^{th} percentile of the data must be between 12 – 15 mg/L.
$CaCl_2$	The 95^{th} percentile of the data must be ≤ 21 mg/L.	The 95^{th} percentile of the data must be between 17 – 21 mg/L.
NaCl	The 95^{th} percentile of the data must be ≤	The 95^{th} percentile of the data must be

River: Groot Letaba		REC: B EC
Monitoring site: B8H008Q01		Recommended scenario: B/C
Water quality metrics	**EcoSpecs**	**TPC**
	191 mg/L.	*between 153 – 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be between 44 – 55 mS/m.*
pH	*The 5th percentile of the data must be between 6.5 to 8.0, and the 95th percentile between 8.0 to 8.8.*	*5th percentile of the data must not be less than 6.7. 95th percentile of the data must not be greater than 8.6.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by no more than 2°C.*	*Unnatural deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen(b)	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity(b)	*Moderate changes with temporary high sediment loads and turbidity during runoff events.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 0.25 mg/L.*	*The 50th percentile of the data must be between 0.2 – 0.25 mg/L.*
PO_4-P	*The 50th percentile of the data must be ≤ 0.025 mg/L.*	*The 50th percentile of the data must be between 0.02 – 0.025 mg/L.*
Response variables		
Chl-a phytoplankton (b)	*The 50th percentile of the data must be ≤ 15 mg/m^2.*	*The 50th percentile of the data must be between 12 – 15 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 12 mg/m^2.*	*The 50th percentile of the data must be between 10 – 12 mg/m^2.*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996a).*

(a) To be generated TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

7.2.3 Habitat and biota RQOs (EcoSpecs)

7.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES of EWR 4, based on fish, is moderately modified, falling in a Category C and should not be allowed to deteriorate any further. The recommended flow scenario for this reach is expected to result in a slight deterioration in the PES but it should still remain within the same Ecological Category C. The current relatively high species richness of 26 indigenous fish species of an estimated 34 naturally occurring species should not be allowed to decrease. The recommended flow scenario is not expected to change the fish species richness of the reach but a slightly reduced frequency of occurrence (distribution within a reach) is expected for various species. Various fish species intolerant to different stressors or with a high preference for specific habitat features provide valuable indicators of change that should be used to monitor potential*

change. The primary indicator fish species for this reach is the shortspine suckermouth (CPRE), being an indicator of flow modification (fast flowing habitats), rocky substrate condition and water quality. Another important indicator for this reach with similar requirements, albeit slightly lower, is the sawfin suckermouth (CPAR).

***Numerical:** EcoSpecs and TPCs for a C Category are provided in Table 7.10.*

Table 7.10 RU EWR 4: Fish EcoSpecs and TPCs

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
Metric: Ecological status				
PES	*Present ecological status of fish is in a C (64.7%).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC[1] of species.*	*A very slight deterioration in the ecological conditions is expected but the fish will still remain in a C (63.4%). A slight decrease is expected in the FROC of BANN, BEUT, BMAR, BPAU, BRAD, BTOP, BTRI, BUNI, BVIV, CGAR, CPRE, CPAR, LCYL, LMOL, MBRE, MMAC, PCAT and PPHI, while LROS and LRUD may increase slightly.*
Metric: Species richness				
All indigenous species	*26 of the expected 34 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*	
Metric: Requirement for flowing water				
CPRE BEUT	*CPRE and BEUT have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*CPRE and/or BEUT absent during any survey OR present at FROC of <0.94 for CPRE and <0.5 for BEUT. (DWAF, 2006c: A minimum of 20 CPRE specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*	
Metric: FD habitats				
CPAR BMAR	*CPAR and BMAR have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or BMAR absent during any survey OR present at FROC of < 4.5 for CPAR and < 4 for BMAR. (DWAF, 2006c: A minimum of 20 CPAR specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).*	
Metric: FS habitats				
CPAR LCYL	*CPAR and LCYL have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or LCYL absent during any survey OR present at FROC of < 4.5 for CPAR and < 4 for LCYL. (DWAF, 2006c: A minimum of 20 CPAR specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*	
Metric: Substrate				
LROS CPAR	*LROS and CPAR have a high requirement for FD habitats and are the most applicable indicator species for this habitat feature.*	*LROS and/or CPAR absent during any survey OR present at FROC of < 4 for LROS and <4.5 for CPAR. (DWAF, 2006c: A minimum of 20 CPAR specimens should be sampled at 100% of sites during a survey of FS and FD, electrofishing*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive*	

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
		for minimum 20 minutes)	*algal growth on substrates.*	
Metric: Water quality intolerance				
BEUT *MMAC*	*BEUT and MMAC have a high requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*BEUT and/or MMAC absent during any survey OR present at FROC of < 0.5 for BEUT and < 5 for MMAC.*	*Decreased water quality (especially flow related water quality variables such as oxygen).*	
Metric: Overhanging vegetation				
PPHI *BPAU*	*PPHI and BPAU have a high requirement for overhanging vegetation and are the most applicable indicator species for this habitat feature.*	*PPHI and/or BPAU absent during any survey OR present at FROC of < 5 for PPHI and < 5 for BPAU.*	*Significant change in overhanging vegetation habitats.*	
Metric: Instream vegetation				
TREN *BPAU*	*TREN and BPAU have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or BPAU absent during any survey OR present at FROC of < 5 for TREN and < 5 for BPAU.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture)*	
Metric: Undercut banks				
MMAC *BEUT*	*MMAC and BEUT have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*MMAC and/or BEUT absent during any survey OR present at FROC of < 5 for MMAC and < 0.5 for BEUT.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*	
Metric: Water column				
MBRE *BANN*	*MBRE and BANN have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or BANN absent during any survey OR present at FROC of < 5 for MBRE and < 5 for BANN.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*	
Metric: SD habitats				
BANN *BUNI*	*BANN and BUNI have a high requirement for SD habitats and are the most applicable indicator species for this velocity depth category.*	*BANN and/or BUNI absent during any survey OR present at FROC of < 5 for BANN and < 5 for BUNI.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: SS habitats				

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
BRAD *BVIV*	*BRAD and BVIV have a high requirement for SS habitats and are the most applicable indicator species for this velocity depth category.*	*BRAD and/or BVIV absent during any survey OR present at FROC of < 5 for BRAD and < 5 for BVIV.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: Migratory success[2]				
BMAR *LCYL, etc.*	*It is estimated that the catadromous eels have been lost from this reach but various potamodromous species (including BMAR) is still present.*	*Loss or decreased FROC[1] of catadromous (such as AMOS) or potamodromous species (such as BMAR).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	
Metric: Alien fish species				
Presence of any alien/ introduced spp.	*No alien/introduced species known or expected to be present in the SQ reach.*	*Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.*	*N/A.*	
Primary indicator species: CPRE (CPAR)				
	CPRE estimated to be present at >25% of sites in SQ reach (DWA, 2013b) (to be verified).	**See relevant sections above for detail.**	**See relevant sections above for detail.**	

1, 2: Refer to Table 4.21.

7.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of an alluvial Lowveld river assemblage. The habitats in the river are dominated by alluvial sediments and have marked seasonal differences in flows. The ample alluvial sediment is dominating the habitats in this reach with marginal vegetation establishing on the river edges. SIC habitats in this reach are very limited. Although upstream abstraction leads to very low flows and associated poorer water quality parameters, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will reduce the PES of a Category C to a C/D, which will definitely impact adversely on the integrity of the river reach.*

Numerical: *Indicator taxa are provided in Table 7.11 and Table 7.12 provides EcoSpecs and TPCs for a C/D Category.*

Table 7.11 RU EWR 4: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*>0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 – 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 – 0.6*	*Cobbles*	*Moderate*
5	*Atyidae*	*N/A*	*Vegetation*	*Moderate*
6	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 4 is situated in B81J-00209, Letaba River is provided in Table 7.12. This RU consists of a shallow Lowveld river with lower velocities; SIC habitat at controls spread through the reach with alluvial substrate and limited marginal vegetation habitat.

Table 7.12 RU EWR 4: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs	Recommended scenario: C/D EC
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 120; ASPT value: > 5.0.	*SASS5 scores less than 120 and an ASPT less than 5.2.*	*The lower flows during winter will have an impact on the macro-invertebrate habitat and water quality. This will impact on the species preferring flow velocity (>0.6 m/s) and species requiring high water quality parameters.*
To ensure that the MIRAI score remains within the range of a C Category (62% – 78%).	*A MIRAI score of 62% or less.*	*The EcoSpecs will be downgraded to accommodate the lower MIRAI score of 57 - 62% (C/D).*
To maintain suitable flow velocity (>0.6m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance B).* ▪ *Trichorythidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*	*Since SIC habitat is restricted in the reach, Hydropsychidae and Trichorythidae might disappear from the system and the EcoSpec for the 0.3 – 0.6 m/s flow velocity will take its place.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single*	*Although these taxa will be stressed even more, it is not expected that they will disappear and this EcoSpec can still be*

EcoSpecs	TPCs	Recommended scenario: C/D EC
flow-dependent taxa: ▪ *Heptageniidae (Abundance A).* ▪ *Elmidae (Abundance A).*	*individual in two consecutive surveys.*	*used.*
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Atyidae (Abundance A).* ▪ *Coenagrionidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*	*Although this habitat will be stressed even more, it is not expected that the indicator species will disappear and this EcoSpec can still be used.*
To maintain suitable conditions for the following six key taxa: ▪ *Hydropsychidae* ▪ *Trichorythidae* ▪ *Heptageniidae* ▪ *Elmidae* ▪ *Atyidae* ▪ *Coenagrionidae*	*Presence of less than four of the six key taxa listed in any survey.*	*Since Hydropsychidae and Trichorythidae might disappear during this scenario, the EcoSpecs might change as follows:* *To maintain suitable conditions for the following four key taxa:* ▪ *Heptageniidae* ▪ *Elmidae* ▪ *Atyidae* ▪ *Coenagrionidae*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Gomphidae, Corixidae and Baetidae). To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.	*Any taxon occurring in an abundance of >1000 for two consecutive surveys.*	*The EcoSpecs should not change:* *Any taxon occurring in an abundance of >1000 for two consecutive surveys.*

7.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES (as at October 2013) for riparian vegetation was a Category C, comprising the marginal zone in a Category B/C, the lower zone in Category C and the upper zone in a Category A/B. The recommended scenario also results in a C EC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and shall be maintained as viable populations: B. salicina, C. imberbe and P. violacea. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2013.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 7.13.*

Table 7.13 RU EWR 4: Riparian vegetation EcoSpecs and TPCs

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Vegetation cover				
Marginal Zone	*Maintain marginal hydrophyte fringe and Phragmites along the active channel.*	*Maintain marginal hydrophyte fringe and Phragmites along the active channel.*	*Marginal fringe absent; Phragmites fringe visibly (fixed photo) increasing in abundance/cover.*	*Adapted from DWAF (2006c), fringe cover (either reeds or woody overhang) is important habitat for instream and riparian fauna.*
Lower Zone	*Maintain Nuxia floribunda and Combretum*	*Maintain N. floribunda and C. erythrophyllum cover.*	*Measurable decrease in either population; failure to recover*	*Adapted from DWAF (2006c), active channel woody component is important habitat*

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
	erythrophyllum cover.		*following large floods.*	*for instream and riparian fauna.*
Metric: Species composition				
Lower Zone	*Maintain at least 10 indigenous riparian tree species.*	*Maintain at least 10 indigenous riparian tree species.*	*Absence of any of the following: N. floribunda, C. erythrophyllum, Phoenix reclinata, P. violacea or B. salicina.*	*Adapted from DWAF (2006c).*
Metric: Alien invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 30%.*	*Perennial alien plant species aerial cover less than 30%.*	*Increases in alien perennial species cover above 30%.*	*See hypothesis for Lowveld rivers (alien invasion) (electronic information).*
Metric: Indigenous riparian woody cover				
Marginal Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not absent or not more than 80%.*	*An increase in riparian woody cover above 70% OR a decrease below 5%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Lower Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not less than 5% and not more than 70%.*	*An increase in riparian woody cover above 70% OR a decrease below 5%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 30% and not more than 60%.*	*Riparian woody species cover not less than 30% and not more than 70%.*	*An increase in riparian woody cover above 60% OR a decrease below 30%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not less than 20%.*	*Reed cover not less than 10%.*	*A decrease in reed cover below 20%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover between 10% and 90%.*	*Reed cover between 10% and 90%.*	*A decrease in reed cover below 10% OR and increase above 90%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover less than 40%.*	*Reeds cover less than 40%.*	*An increase in reed cover above 40%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*

7.3 GROUNDWATER RQOs

Groundwater RQOs cover IUA 4 and 5 and part of 6: Letaba from proposed Nwamitwa Dam to Klein Letaba confluence - B81F, B81J.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly for irrigation agriculture, particularly for citrus plantations (e.g. Nagude Farm Estate). Groundwater is significantly utilised in B81F and under-utilised in B81J.*

	B81F	B81J	Total
Irrigation (Mm^3/a)	*7.94*	*0*	*7.94*
Water Supply (Mm^3/a)	*0*	*0*	*0*
Total use (Mm^3/a)	*7.94*	*0*	*7.94*
Stress index	*0.43*	*0*	
Harvest potential (Mm^3/a)	*14.4*	*6.46*	*20.86*
Exploitation potential (Mm^3/a)	*10.08*	*4.52*	*14.6*
Recharge (Mm^3/a)	*18.47*	*6.4*	*24.87*
Aquifer recharge (Mm^3/a)	*18.47*	*6.34*	*24.81*
Allocatable groundwater (Mm^3/a)	*10.53*	*6.34*	*16.87*

	B81F	B81J	Total
Status	D - Largely modified	A - Unmodified	

Borehole yields: *Borehole yields are moderate, with 35 - 45% of boreholes having yields above 2 l/s and the median yield is 1.25 - 1.7 l/s, hence groundwater development is feasible.*

	B81F	B81J
N	146	25
Lower Quartile (l/s)	0.5	1
MEDIAN (l/s)	1.25	1.7
Upper Quartile (l/s)	2.68	3.8
Geometric Mean (l/s)	1.11	1.65
Yield >2 l/s (%)	34.93	44

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 2, or Marginal water quality due to elevated salinity. Significant nitrate concentrations also exist.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81F	19	79	82	8	2	190	95	103	22	57	54	28	264	69
B81J	2	10	43	2	2	59	93	42	13	20	5	5	85	88

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has little impact on baseflow in this IUA. This IUA provides minimal baseflow in the Letaba*

	B81F	B81J	Total
MAR (Mm^3/a)	23.67	9.06	32.73
Total Use (Mm^3/a)	7.94	0	7.94
Stress index	0.43	0	
Recharge (Mm^3/a)	18.47	6.4	24.87
Aquifer recharge (Mm^3/a)	18.47	6.34	24.81
Interflow (Mm^3/a)	0	0.06	0.06
Baseflow (Mm^3/a)	0.06	0.06	0.12
Groundwater water baseflow (Mm^3/a)	0.06	0	0.06
Present baseflow (Mm^3/a)	0	0.06	0.06
Present MAR reduction (Mm^3/a)	0.19	0	0.19
Increased abstraction (Mm^3/a)	6.46	6.46	12.92
Baseflow due to increased abstraction (Mm^3/a)	0	0	0
% contribution to total baseflow of the Letaba	0.04		

Numerical: *The Groundwater RQOs are provided in Table 7.14.*

Table 7.14 IUA 4, 5 and part of 6: Groundwater RQOs

Quat	Groundwater narrative RQO	Groundwater numerical RQO
B81F	*Groundwater is significantly utilised. Abstraction can be marginally increased up to the Harvest Potential with little to no impact on baseflow.*	*Groundwater abstraction can be increased from 7.94 Mm^3/a to 14.40 Mm^3/a, with no further reduction in baseflow.*
B81J	*Groundwater is underutilised and can be utilised up to the Harvest Potential with little to no impact on baseflow.*	*Groundwater abstraction can be increased to 6.46 Mm^3/a, with a 0.06 Mm^3 reduction in baseflow.*

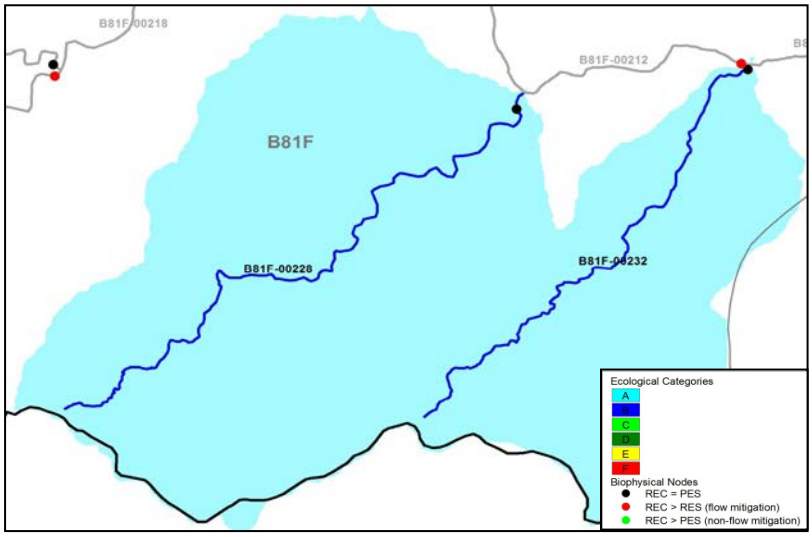
8 IUA 5: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Due to the very different hydrological characteristics, operation and land use from the Letaba River, these two SQs were placed in one IUA. No scenario development will be required.

IUA 5 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 5: SOUTHERN TRIBUTARIES TO LETABA



PRIORITY RATINGS

SQ	River	Priority rating
B81F-00228	*Reshwele*	*1a*
B81F-00232	*Makwena*	*1a*

Water resource use

Only two tributaries and SQs are situated in this zone, B81F-00228 (Reshwele River) and B81F-00232 (Makewena). The storage regulation is low in the IUA and there is no future resource developments planned in the IUA.

The groundwater response unit falls within the Lowveld Plains. The groundwater use is not confirmed but likely to be less than 20% of the aquifer recharge.

Water quality

The water quality state is Fair to Good, with some impacts due to agricultural activities. No water quality hotspots were identified.

Economy

The main primary economic activities are citrus and mangoes. The tertiary economic activity is eco-tourism.

EGSA

This IUA is largely dominated by game farms and nature reserves, particularly the Ndzalema Reserve. Again EGSA, bar those associated with the recreational and aesthetic aspects would be low.

River and wetland ecology

The source and most of the rivers flows through the Ndzalema Wildlife Reserve and other private Reserves. Downstream sections have some small dams, and fields. The rivers are seasonal, with

very little direct uses and due to the large sections flowing through a Reserve, relatively protected resulting in a B PES.

8.1 RQOs FOR B81F-00228 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

8.1.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B	3.53	2.87	0.03	0.8	0.322	9.1	Ephemeral - mostly floods.			

8.1.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Reshwele	**MODERATE:** *Small dams (farm).* **LARGE:** *Natural areas/nature reserves, Recreation.*	B	B

8.2 RQOs FOR B81F-00232 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

8.2.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B	2.75	2.54	0.094	3.4	0.346	12.6	Ephemeral - mostly floods.			

8.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Makwena	**MODERATE:** *Agricultural lands, Crossings low water, Grazing/trampling.* **LARGE:** *Natural areas/nature reserves.*	B	B

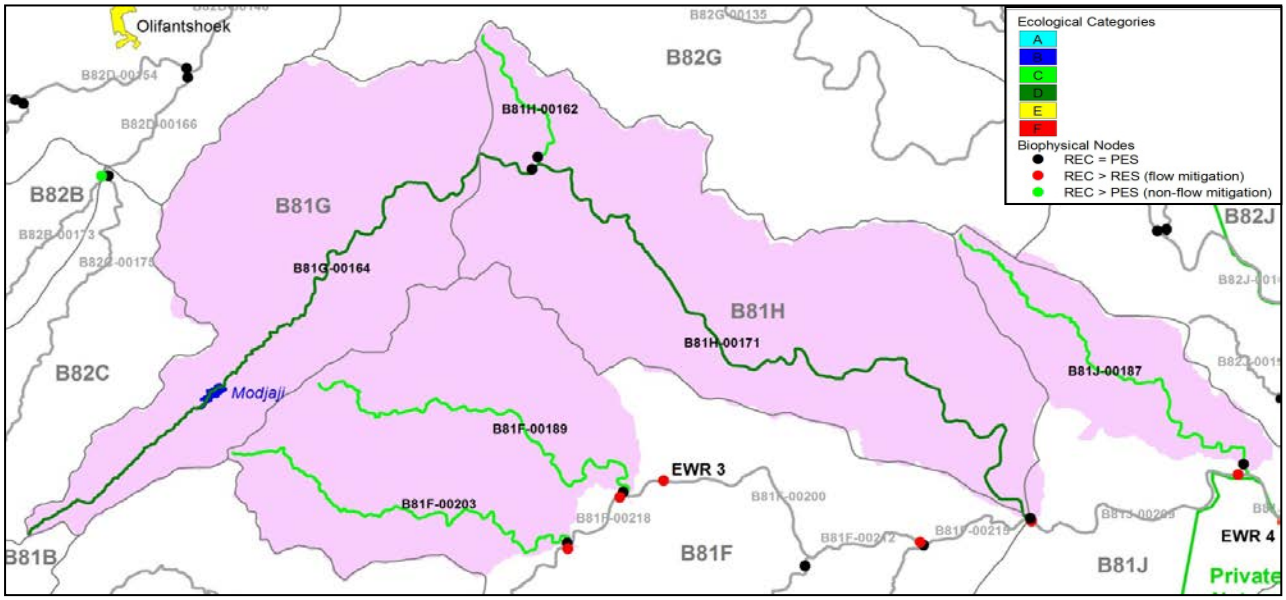
9 IUA 6: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

Due to the very different hydrological characteristics, operation and land use from the Letaba River, these three tributaries were placed in one IUA. These tributaries were also separated from the southern tributaries (IUA 5) due to the different ecological state and land use. Any scenario development will be limited to non-flow related issues associated with subsistence agriculture.

IUA 6 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 6: NORTHERN TRIBUTARIES TO LETABA



PRIORITY RATINGS

SQ	River	Priority rating
B81F-00189	*Merekome*	*1a*
B81F-00203	*Lerwatlou*	*1a*
B81G-00164	*Molototsi*	*1a*
B81H-00162	*Metsemola*	*1a*
B81H-00171	*Molototsi*	*2*
B81J-00187	*Mbhawula*	*1a*

Water resource use

This zone includes 3 short ephemeral rivers (3 SQs) and the seasonal Molototsi River has 3 SQs. The IUA is only regulated by the Modjadji Dam located in the upper reaches of the Molototsi River. Water is supplied from the dam to the urban/domestic sector. Return flows generated from the irrigations sector enter the river systems which has a negative impact on the water quality. Groundwater is currently utilised by domestic users and there is some potential for additional groundwater development in the area, depending on the locality of the groundwater resources relative to the users and the viability for development thus needs to be confirmed. A possible future development requiring further investigation is the artificial recharge of groundwater at Mulele on Molototsi River.

The groundwater response unit falls largely within the Lowveld Plains but sections fall within the Foothills, and Gravelotte-Giyani response unit. The groundwater use is approximately 40 - 50% of the aquifer recharge.

Water quality

The water quality state is dominated by elevated nutrients, salts and algal growth due to discharges from a WWTW in the Molototsi River, settlements and agricultural activities leading to increased instream turbidity levels.

Economy

The main economic activities are citrus, mangoes and tomatoes that form part of the primary sector while tomato processing is identified as a secondary sector and the eco-tourism is part of the tertiary sector.

EGSA

This area almost exclusively consists of the former homeland areas. As such the land use is rural closer settlement with clusters of dense village developments associated with the main road network and extensive subsistence farming. The utilisation of EGSA is likely to be relatively constrained – albeit not as high as in other parts of the catchment, and given the profile of the population in the IUA, the importance is likely to be high.

River and wetland ecology

The Molototsi River is in a D PES and all the other tributaries are in a C PES. It must be noted that during the middle 1990's, a rare population of Acacia erubuscens was found in the flood plain of the Molototsi and a tributary. This zone is characterised by being much drier in nature then the Letaba River and largely dominated by rural settlements and subsistence agriculture. Due to the very different hydrological nature, operation and land use from the Letaba River, these tributaries were placed in one zone.

9.1 RQOs FOR B81F-00189 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

9.1.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	*4.74*	*4.08*	*0.062*	*1.3*	*0.337*	*7.1*	*Ephemeral - mostly floods.*			

9.1.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Merekome	**MODERATE:** *Crossings low water, exotic vegetation, grazing/trampling, vegetation removal.* **LARGE:** *Agricultural lands, erosion, sedimentation.*	C	C

9.2 RQOs FOR B81F-00203 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

9.2.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	3.74	3.08	0.071	1.9	0.328	8.8	Ephemeral - mostly floods.			

9.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Lerwatlou	**MODERATE:** *Abstraction (run-of river)/increased flows, exotic vegetation, irrigation, runoff/effluent: Irrigation, small dams (farm), grazing/trampling, vegetation removal.* **LARGE:** *Agricultural lands, Runoff/effluent: Urban areas.*	C	C

9.3 RQOs FOR B81G-00164 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a D PES, has moderate ecological importance and SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

9.3.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
D	16.72	14.30	0.072	0.4	1.11	6.6	Ephemeral - mostly floods.			

9.3.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b; 2013a,b) were used.*
Model: *N/A.*
Users: *Settlements.*
Water quality issue: *Elevated nutrient levels in the reach are primarily due to Ga-Kgapene WWTW not meeting discharge standards and being in a High risk rating. More efficient management of the WWTW will change the Risk rating from High to Medium or Low to maintain the specified RQOs.*
Monitoring actions and tools: *Meet biomonitoring requirements as specified in the water use license for the WWTW. This monitoring should be at the specified site or downstream of the Ga-Kgapene WWTW and outside of the mixing zone. Baseline monitoring must be conducted for physico-chemical variables and nutrients to ensure that Tolerable levels are maintained for nutrients.*

Table 9.1 B81G-00164: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (aquatic ecosystem: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

9.3.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Molototsi	**LARGE:** *Agricultural lands, erosion, runoff/effluent: Urban areas, sedimentation, grazing/trampling, vegetation removal.* **SERIOUS:** *Urbanization.*	D	D

9.4 RQOs FOR B81H-00162 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

9.4.1 Flow RQOs

Gauged at: *B8R011. Downstream of Modjadji Dam and could be used for spills and releases.*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	*0.64*	*0.59*	*0.012*	*1.8*	*0.063*	*9.8*	*Ephemeral - mostly floods.*			

9.4.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Metsemola	**LARGE:** *Agricultural lands, vegetation removal.* **SERIOUS:** *Crossings low water.* **CRITICAL:** *Grazing/trampling.*	C	C

9.5 RQOs FOR B81H-00171 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance and SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

9.5.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
D	*25.84*	*22.6*	*0.254*	*1.0*	*1.671*	*6.5*	*Ephemeral - mostly floods.*			

9.5.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Molototsi	**LARGE:** *Crossings low water, erosion, sedimentation, vegetation removal.* **SERIOUS:** *Grazing/trampling.*	D	C	*Riparian vegetation*
				Instream biota

Habitat and biota RQOs are provided in Table 9.2.

Table 9.2 B81H-00171: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover).*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Hydropsychidae and Heptageniidae	*To maintain suitable conditions for these flow dependent species (moderate to rapid velocities: 0.3 - >0.6 m/s) in the SIC biotope.*	

9.5.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 9.3.

Table 9.3 B81H-00171: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Habitat	*RHAM (visual).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess vegetative cover (% aerial) along riparian zone banks.*
Macro-invertebrates	*SASS 5 and MIRAI.*

9.6 RQOs FOR B81J-00187 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

9.6.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
							90%	60%	90%	60%
C	2.53	2.53	0.014	0.5	0.247	9.8	0	0	0	0

9.6.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Mbhawula	**MODERATE:** *Crossings low water, erosion, natural areas/nature reserves, sedimentation, urbanization, vegetation removal.* **LARGE:** *Agricultural lands, grazing/trampling.*	C	B

9.7 GROUNDWATER RQOs

Groundwater RQOs cover IUA 6: Northern tributaries to Letaba - B81G, B81H parts of B81F and J.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly for irrigation. Groundwater use is between 30 - 40% of the aquifer recharge and is within the Harvest Potential in both catchments.*

	B81G	B81H	Total
Irrigation (Mm^3/a)	5.06	2.62	7.68
Water Supply (Mm^3/a)	0	0	0
Total use (Mm^3/a)	5.06	2.62	7.68
Stress index	0.4	0.3	
Harvest potential (Mm^3/a)	6.78	7.97	14.75
Exploitation potential (Mm^3/a)	4.75	5.58	10.33
Recharge (Mm^3/a)	18.32	8.8	27.12
Aquifer recharge (Mm^3/a)	12.58	8.8	21.38
Allocatable groundwater (Mm^3/a)	7.52	6.18	13.7
Status	D – Largely modified	C – Moderately modified	

Borehole yields: *Borehole yields are moderate to high, with 35 - 56% of boreholes having yields above 2 l/s and the median yield is 1.38 - 2.5 l/s, hence groundwater development is feasible.*

	B81G	B81H
N	208	89
Lower Quartile (l/s)	0.5775	0.8
MEDIAN (l/s)	1.38	2.5
Upper Quartile (l/s)	3.4	6.6
Geometric Mean (l/s)	1.37	2.07
Yield >2 l/s (%)	34.13	56.18

Number of boreholes:

- *>75%*
- *50 - 75%*
- *25 - 50%*
- *<25%, geometric mean less than 1 l/s*

Groundwater quality: *Ground water is generally of DWA Class 1 - 2, or Good to Marginal water quality. A significant occurrence of high nitrate levels occurs in B81H.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81G	78	100	57	2	3	240	98	189	43	31	44	19	326	81
B81H	2	26	88	3	3	122	95	64	17	31	41	17	170	66

>80%
60 - 80%
<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has little impact on baseflow in this IUA. This IUA provides 2.15% of baseflow in the Letaba. The bulk of baseflow is generated as interflow in the upper Molototsi, and aquifer recharge is lost predominantly by evapotranspiration. Consequently groundwater abstraction has little impact on baseflow. Abstraction has reduced baseflow by 3.5%. Abstraction has a minor impact on groundwater baseflow, with a groundwater baseflow reduction of only 2.7% of abstraction.*

	B81G	B81H	Total
MAR (Mm^3/a)	25.49	9.69	35.18
Total Use (Mm^3/a)	5.06	2.62	7.68
Stress index	0.4	0.3	
Recharge (Mm^3/a)	18.32	8.8	27.12
Aquifer recharge (Mm^3/a)	12.58	8.8	21.38
Interflow (Mm^3/a)	5.74	0	5.74
Baseflow (Mm^3/a)	5.87	0.01	5.88
Groundwater water baseflow (Mm^3/a)	0.13	0.01	0.14
Present baseflow (Mm^3/a)	5.72	0	5.72
Present MAR reduction (Mm^3/a)	0.16	0.05	0.21
Increased abstraction (Mm^3/a)	1.72	5.35	7.07
Baseflow due to increased abstraction (Mm^3/a)	5.67	0	5.67
% contribution to total baseflow of the Letaba	2.15		

Numerical: *The Groundwater RQOs are provided in Table 9.4.*

Table 9.4 IUA 6 – B81G, B81H: Groundwater RQOs

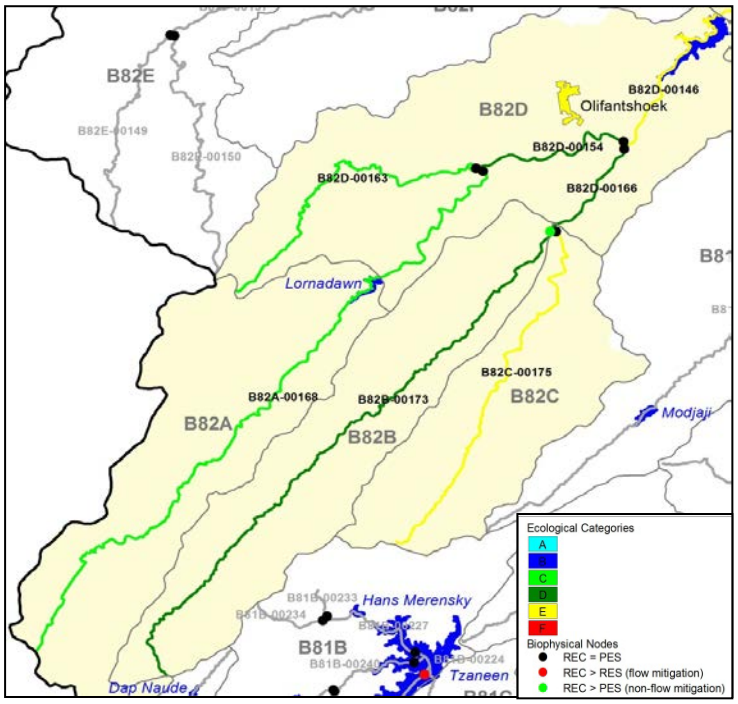
Quat	Groundwater narrative RQO	Groundwater numerical RQO
B81G	Groundwater is moderately utilised. Abstraction can be increased up to the Harvest Potential with little or no impact on baseflow.	Groundwater abstraction can be increased from 5.06 Mm^3/a to 6.78 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.
B81H	Groundwater use is low and can be utilised up to the Harvest Potential with little to no impact on baseflow.	Groundwater abstraction can be increased from 2.62 Mm^3/a to 7.97 Mm^3/a, with no reduction in baseflow.

10 IUA 7: RESOURCE QUALITY OBJECTIVES

This area has extensive formal agriculture with water use from many farm dams in the rivers and tributaries. This area upstream of Middel Letaba Dam can mostly be managed through possible abstraction allocation reductions as well as better agricultural practices to address water quality. This therefore forms a logical unit up to the Middel Letaba Dam as downstream of the dam scenarios would be linked to the operation of the dam. It is however doubtful that the section of river in an E Ecological Category (SQ B82C-00175) can be improved as this will require the removal of farm dams.

IUA 7 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 7: UPPER MIDDLE LETABA AND TRIBUTARIES US OF MIDDLE LETABA DAM



PRIORITY RATINGS

SQ	River	Priority rating
B82A-00168	*Middel Letaba*	*1a*
B82B-00173	*Koedoes*	*2*
B82C-00175	*Brandboontjies*	*3*
B82D-00163	*Lebjelebore*	*1a*
B82D-00154	*Middel Letaba*	*1a*
B82D-00166	*Mosukodutsi*	*2*
B82D-00146	*Middel Letaba*	*3a*

Water resource use

This zone includes all the SQs within the B82A, B82B, B82C and B82D quaternary catchments. It includes the Middle Letaba, Koedoes, Brandboontjies, Lebjelebore and Mosukodutsi rivers. The IUA is regulated by the Lornadawn Dam (Middel Letaba River) and the Middel Letaba Dam at the bottom of the IUA. Water is mainly supplied to the urban and irrigation sectors, with the urban domestic supply increasing constantly resulting in a reduction in irrigation supply. Significant volumes of groundwater are also utilised in the IUA with over 50% of the Utilisable Exploitation Potential (Potable) used by the irrigation sector in B82A and the domestic sector in B82E. The viability for additional groundwater development needs to be confirmed. Return flows from both these sectors enter the river systems. There is no surface water resource developments planned in the IUA.

The groundwater response unit falls largely within the Drakensberg Escarpment and Foothills and Valleys. The groundwater use is less than 10% in the upper reaches but 50% of aquifer recharge in B82D.

Water quality

The water quality state of the upper section of the Middel Letaba River is dominated by elevated nutrients, salts and possible toxicants due to fertilizer / pesticide use associated with extensive crop irrigation e.g. tomato crops. There are also elevated nutrients due to a WWTW on the Brandboontjies River. Two water quality hotspots were therefore identified in these reaches.

Economy

The main economic activities evolve from the tomato production as part of the primary sector. The secondary economic activity of tomato processing is also part of IUA 7.

EGSA

The southern portion of the IUA is dominated by commercial farming and forestry. The population densities, relative to the rest of the catchment are on the lower side. Overall the livelihood reliance on EGSA is limited. There is some utilisation by farm or plantation workers but this is not likely to be significant with regard to numbers and would be relatively ad hoc. The northern portion of the IUA is heavily dominated by the high density rural closer settlements characteristic of the former homeland areas, including Olifantshoek. Again the utilisation of ecological goods and services is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology

Three of the seven SQs have a D PES and the upper Middle Letaba and Lebjelebore have a C PES. Impacts are flow related, inundation, quality issues and other related to extensive agriculture. The Brandboontjies and Middel Letaba are in an E PES largely due to water quality and inundation issues. B82B and B82C have a high density and frequency of channelled valley bottom wetlands, with notable wetlands associated with B82B-00173 (Koedoes), B82C-00175 (Brandboontjies) and B82D-00146 (Middel Letaba). The wetlands are mostly in a D PES.

10.1 RQOs FOR B82A-00168 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a C PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

10.1.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	31.12	25.07	4.339	13.9	7.564	24.3	0.007	0.068	0.028	0.066

10.1.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2013a,b) were used.*
Model: *N/A.*
Users: *Agricultural activities, including commercial tomato producers ZZ2 at Mooketsi.*
Water quality issue: *Elevated nutrient levels and potential toxics from fertilizer use.*

Monitoring actions and tools: *Conduct biological monitoring at the lower end of the reach and institute water quality monitoring (physico-chemical variables and nutrients) if indicated by biotic state.*

Table 10.1 B81A-00168: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (aquatic ecosystems/agriculture - irrigation: drivers).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

10.1.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Middel Letaba	**MODERATE:** *Agricultural lands, algal growth, exotic vegetation, runoff/effluent: Urban areas, small dams (farm).* **LARGE:** *Crossings low water, erosion, sedimentation, grazing/trampling, urbanization, vegetation removal.*	C	C

10.2 RQOs FOR B82B-00173 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance, low SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

10.2.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
D	*23.13*	*15.76*	*1.377*	*6.0*	*2.848*	*12.3*	*0.007*	*0.012*	*0.013*	*0.038*

10.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Koedoes	**LARGE:** *Abstraction (run-of river)/increased flows, erosion, inundation, irrigation, runoff/effluent: Irrigation, sedimentation, grazing/trampling, vegetation removal.* **SERIOUS:** *Agricultural lands, small dams (farm).*	D	D	*Riparian vegetation*
				Instream biota
				Water quality

Habitat and biota RQOs are provided in Table 10.2.

Table 10.2 B82B-00173: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary and integrity	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary. Riparian zone fragmentation should not increase.*	*Zero increase of agricultural activities within the riparian zone.*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES Desktop FRAI: 52.4%, D	*Maintain PES of at least D.*	*Maintain the Fish PES in at least a D (FRAI ≥ 52%).*
Species richness: 7 Species	*Maintain fish species richness.*	*Maintain fish species richness. Do not allow more than 10% deviation from baseline (estimated at 7 species) for SQ reach.*
Primary indicator species: BVIV/BTOP	*Flows should be adequate to ensure suitable habitats for BVIV/BTOP.*	*Ensure presence of BVIV and BTOP in reach and FROC should not decrease >10% from baseline value (to be established should monitoring be implemented).*
Secondary indicator species: Water quality: BTOP/BVIV Vegetation: BVIV/TREN	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Hydropsychidae and Elmidae	*To maintain suitable conditions for these flow dependent species (Moderate to rapid velocities: 0.3 - > 0.6 m/s) in the SIC biotope.*	

10.2.3 Wetland RQOs

Wetlands of moderate importance occur in quaternary catchment B82B and are mostly channelled valley bottom wetlands associated with B81B-00173 and tributaries. Many are artificial since they are associated with dams in the backup zone. Maintaining the wetlands in their current condition is outlined below:

- *Maintain wetland EC score above 50%, and median EI score equal to or above 2 and IHI score equal to or above 2.4.*
- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013a). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain moderate.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands. The abundance of G. perpensa (Declining) should not decline.*

- *Birds: The abundance of herons, ducks moorhens, greenshank or sandpiper that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013a).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013a).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013a).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

10.2.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 10.3.

Table 10.3 B82B-00173: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

10.3 RQOs FOR B82C-00175 (HIGH PRIORITY – 3)

The RU is of high priority (Level 3) mainly due to water quality related problems with in the SQ. The PES is an E, with moderate ecological importance and SCI and high water resource use importance. Although the priority level is high, non-flow related impacts (water quality) dominate this reach and the REC was set to improve the PES as current conditions are unsustainable. The recommended scenario does not influence this site.

10.3.1 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Brandboontjies	**LARGE:** *Algal growth, canalization, runoff/effluent: Irrigation.* **SERIOUS:** *Abstraction (run-of river)/increased flows, agricultural lands, inundation, irrigation.* **CRITICAL:** *Small dams (farm).*	**E**	**D**	*Water quality*

10.3.2 Water Quality RQOs

Source: *Priority rating 3 but not an EWR site so no detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2012b; 2013a, b) were used.*
Model: *N/A.*
Users (primary user shown in bold text): **Agricultural activities***, urban and rural settlements.*
Water quality issue: *The PES is currently in an E Category due to poor water quality. Elevated nutrient levels in the reach are primarily due to the Modjadjiskoof-Duiwelskloof WWTW not meeting discharge standards and being in a Critical risk rating. More efficient management of the WWTW and the institution of monitoring should change the Risk rating and meet the specified RQOs.*

Table 10.4 B81C-00175: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than or equal to 0.125 mg/L PO_4-P (aquatic ecosystems/agriculture - irrigation: drivers).* *50th percentile of the data must be less than or equal to 1.0 mg/L TIN-N (aquatic ecosystems: driver).*
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	*95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure that toxics are within Ideal limits or A categories.	
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

10.3.3 Wetland RQOs

Wetlands of moderate importance occur in quaternary catchment B82C and are mostly channelled valley bottom wetlands associated with B81C-00175 and tributaries. Many are artificial since they are associated with dams in the backup zone. Maintaining the wetlands in their current condition is outlined below:

- *Maintain wetland EC score above 50%, and median EI score equal to or above 2 and IHI score equal to or above 2.3.*
- *General: Wetland fragmentation should not increase (from 2013 state; DWA, 2013b). There should be no expansion of agricultural activities into wetlands and existing agricultural lands within wetlands should not expand or intensify. Integrated wetland importance and sensitivity should remain moderate.*
- *Hydrology: Periodic flooding of wetlands should be allowed to occur in such a manner so as to maintain the current wetland EC.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands. The abundance of G. perpensa (Declining) should not decline.*
- *Birds: The abundance of herons, ducks moorhens, greenshank or sandpiper that utilise wetlands (especially during flooding) should not decline (data - DWA, 2013b).*
- *Amphibians: The Natal sand frog should continue to occur (data - DWA, 2013b).*
- *Reptiles: Green and brown water snakes should continue to occur (data - DWA, 2013b).*
- *Fish: Periodic flooding of wetlands should support fish breeding/productivity.*

10.3.4 Monitoring actions and tools

This RU is in an E PES for the EcoStatus and a D REC. The improvement that would be required is related to water quality aspects. Monitoring is essential to ensure sustainability of the reach and broad guidelines for monitoring actions and tools that could be used are provided in Table 10.5.

Table 10.5 B82C-00175: Possible monitoring actions and tools

Component	Monitoring actions and tools
Water quality	*Meet biomonitoring requirements as specified in the water use license for the WWTW. This monitoring should be at the specified site or downstream of the Modjadjiskoof-Duiwelskloof WWTW and outside of the mixing zone. Baseline*

Component	Monitoring actions and tools
	monitoring must be conducted for physico-chemical variables and nutrients to ensure that tolerable levels are met for nutrients.
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

10.4 RQOs FOR B82D-00163 (LOW PRIORITY – 1A)

The RU is of low priority (Level 1) as it is in a C PES, has moderate ecological importance, SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

10.4.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Nov		Feb	
							90%	60%	90%	60%
C	4.9	4.29	0.818	16.7	1.261	25.8	0.004	0.012	0.008	0.02

10.4.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Lebjelebore	**MODERATE:** *Crossings low water, exotic vegetation, natural areas/nature reserves, roads, sedimentation, grazing/trampling.* **LARGE:** *Agricultural lands, algal growth, erosion, runoff/effluent: Urban areas, urbanization, vegetation removal.*	C	C

10.5 RQOs FOR B82D-00154 (LOW PRIORITY – 1A)

The RU is of low priority (Level 1) as it is in a D PES, has moderate ecological importance, SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

10.5.1 Flow RQOs

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
D	40.53	32.96	3.527	8.7	7.025	17.3	0.015	0.071	0.019	0.058

10.5.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Middel Letaba	**MODERATE:** *Algal growth, exotic vegetation, runoff/effluent: Urban areas.* *LARGE: Erosion, sedimentation, grazing/trampling, vegetation removal.* **SERIOUS:** *Agricultural lands.*	D	D

10.6 RQOs FOR B82D-00166 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance and SCI and high water resource use importance. The detail of available information also plays a

role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

10.6.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Nov		Feb	
							90%	60%	90%	60%
D	42.25	27.77	1.776	4.2	4.296	10.2	0	0.004	0	0.031

10.6.2 Water Quality RQOs

Source: *No detailed water quality assessment conducted. PESEIS data and literature sources (e.g. DWA, 2013a,b) were used.*
Model: *N/A.*
Users: *Agricultural activities.*
Water quality issue: *Elevated nutrient levels.*

Table 10.6 B81D-00166: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (aquatic ecosystems/agriculture - Irrigation: drivers).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

10.6.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Mosukodutsi	**MODERATE:** *Exotic vegetation, sedimentation, vegetation removal.* **LARGE:** *Agricultural lands, crossings low water, grazing/trampling.*	D	D	*Riparian vegetation*
				Instream biota
				Water quality

Habitat and biota RQOs are provided in Table 10.7.

Table 10.7 B82D-00166: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary and integrity	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary. Riparian zone fragmentation should not increase.*	*Zero increase of agricultural activities within the riparian zone. RQOs only applicable to riparian zone not associated with dam or backup areas related to dam.*

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover). It is assumed that 60% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES *Desktop FRAI: 44.7%, D*	*Maintain PES of at least D.*	*Maintain the Fish PES in at least a D (FRAI ≥ 44%).*
Species richness: *7 Species*	*Maintain fish species richness.*	*Maintain fish species richness. Do not allow more than 10% deviation from baseline (estimated at 7 species) for SQ reach.*
Primary indicator species: BVIV/BTOP	*Flows should be adequate to ensure suitable habitats for BVIV/BTOP.*	*Ensure presence of BVIV and BTOP in reach and FROC should not decrease >10% from baseline value (to be established should monitoring be implemented).*
Secondary Indicator species: *Water quality: TOP/BVIV* *Vegetation: BVIV/TREN*	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*

10.6.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 10.8.

Table 10.8 B82D-00166: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Water quality	*Conduct biological monitoring at the lower end of the reach and institute water quality monitoring (physico-chemical variables and nutrients) if indicated by biotic state.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone) 3) and vegetative cover (% aerial) along banks.*
Fish	*FRAI (Kleynhans, 2007).*

10.7 RQOs FOR B82D-00146 (HIGH PRIORITY – 3)

The RU is of high priority (Level 3) mainly due to water quality related problems with in the SQ. The PES is an E, with moderate ecological importance and SCI and high water resource use importance. Although the priority level is high, non-flow related impacts (water quality) dominate this reach and the REC was set to improve the PES as current conditions are unsustainable. The recommended scenario does not influence this site.

10.7.1 Water Quality RQOs

Source: *No detailed water quality assessments conducted. PESEIS data and literature sources (e.g. DWA, 2013a,b) were used.*
Model: *N/A.*
Users: *Agricultural activities.*
Water quality issue: *Elevated nutrient levels due to agricultural activities.*

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (aquatic ecosystems/agriculture - irrigation: drivers).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

10.7.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicators
Middel Letaba	**LARGE:** *Inundation, large dams, grazing/trampling, vegetation removal.* **SERIOUS:** *Agricultural lands.*	**E**	**D**	*Water quality*

10.7.3 Wetland RQOs

There are notable wetlands associated with B82D-00146 (Middel Letaba). The wetlands are mostly in a D PES. Wetland RQOs are provided in Table 10.9.

Table 10.9 B82D-00146: Narrative and numerical wetland RQOs

Indicators	Narrative RQO	Numerical RQO
Wetland PES	*Maintain wetland EC of D.*	*Maintain wetland EC score above 47%.*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 2 and IHI score equal to or above 2.6.*

10.7.4 Monitoring actions and tools

This RU is in an E PES for the EcoStatus and a D REC. The improvement that would be required is related to water quality aspects. Monitoring is essential to ensure sustainability of the reach and broad guidelines for monitoring actions and tools that could be used are provided in Table 10.10.

Table 10.10 B82D-00146: Possible monitoring actions and tools

Component	Monitoring actions and tools
Water quality	*Conduct biological monitoring at the lower end of the reach and institute water quality monitoring (physico-chemical variables and nutrients) if indicated by biotic state.*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

10.8 GROUNDWATER RQOs

Groundwater RQOs cover IUA 7: Upper middle Letaba and tributaries upstream of middle Letaba Dam - B82A, B82B, B82C, B82D.

Narrative:

Groundwater use and resources: *Groundwater use is predominantly for irrigation and is over utilised in the Koedoes and Brandbootjies. The stress index (use/ aquifer recharge) is high and groundwater is over exploited. In the Middle Letaba (B82A and D), groundwater is utilised for both irrigation and water supply and is moderately exploited.*

	B82A	B82D	B82B	B82C	Total
Irrigation (Mm^3/a)	*1.48*	*0.52*	*14.5*	*13*	*29.5*
Water Supply (Mm^3/a)	*1.45*	*4*	*0*	*0*	*5.45*
Total use (Mm^3/a)	*2.93*	*4.52*	*14.5*	*13*	*34.95*
Stress index	*0.26*	*0.44*	*1.53*	*1.82*	
Harvest potential (Mm^3/a)	*7.37*	*10.11*	*6.5*	*4.76*	*28.73*
Exploitation potential (Mm^3/a)	*4.42*	*7.08*	*3.9*	*3.33*	*18.72*
Recharge (Mm^3/a)	*17.48*	*13.46*	*14.71*	*11.41*	*57.06*
Aquifer recharge (Mm^3/a)	*11.36*	*10.35*	*9.5*	*7.14*	*38.35*
Allocatable groundwater (Mm^3/a)	*8.43*	*0*	*0*	*5.83*	*14.26*
Status	*C – Moderately modified*	*D - Largely modified*	*F -Critically modified*	*F - Critically modified*	

Borehole yields: *Borehole yields are based on limited data in B82B and C. In B82A yields are low with only 13% of boreholes having yields above 2l/s. In B82D, 44% of boreholes have yields greater than 2 l/s and the median yield is nearly 1.5 l/s.*

	B82A	B82D	B82B	B82C
N	*46*	*3*	*14*	*144*
Lower Quartile (l/s)	*0.4*	*0.68*	*1.05*	*0.63*
MEDIAN (l/s)	*0.8*	*0.7*	*1.73*	*1.46*
Upper Quartile (l/s)	*1.42*	*0.95*	*3.17*	*4.83*
Geometric Mean (l/s)	*0.83*	*0.82*	*1.56*	*1.53*
Yield >2 l/s (%)	*13.04*	*0*	*42.86*	*44.44*

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 0 - 1, or Ideal to Good water quality. Some poor quality boreholes with elevated nitrates exist in B82D due to the reliance of alluvial boreholes.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B81A	*28*	*17*	*1*	*1*		*47*	*98*	*36*	*5*	*6*	*2*	*1*	*50*	*94*
B82D	*1*	*1*				*2*	*100*	*2*	*2*	*1*			*5*	*100*
B82B	*30*	*1*				*31*	*100*	*23*	*6*	*2*	*1*		*32*	*97*
B82C	*42*	*128*	*32*			*202*	*100*	*104*	*23*	*50*	*56*	*21*	*254*	*70*

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction impacts significantly on baseflow in this IUA. The bulk of recharge reaches the regional groundwater. This IUA provides 14% of baseflow in the Letaba, of which 52% is from the regional aquifer, the remainder originating as interflow. Consequently abstraction has had a great impact on baseflow. Abstraction has reduced baseflow by 53%, with groundwater baseflow reduction being 59% of abstraction.*

	B82A	B82D	B82B	B82C	Total
MAR (Mm^3/a)	*28.2*	*20.85*	*23.13*	*17.23*	*89.41*
Total Use (Mm^3/a)	*2.93*	*4.52*	*14.5*	*13*	*34.95*
Stress index	*0.26*	*0.44*	*1.53*	*1.82*	
Recharge (Mm^3/a)	*17.48*	*13.46*	*14.71*	*11.41*	*57.06*
Aquifer recharge (Mm^3/a)	*11.36*	*10.35*	*9.5*	*7.14*	*38.35*
Interflow (Mm^3/a)	*6.12*	*3.11*	*5.21*	*4.27*	*18.71*
Baseflow (Mm^3/a)	*12.57*	*7.87*	*10.68*	*7.54*	*38.66*
Groundwater water baseflow (Mm^3/a)	*6.45*	*4.76*	*5.47*	*3.27*	*19.95*
Present baseflow (Mm^3/a)	*11.05*	*5.47*	*1.55*	*0.26*	*18.33*
Present MAR reduction (Mm^3/a)	*1.53*	*2.39*	*9.18*	*7.34*	*20.44*
Increased abstraction (Mm^3/a)	*4.44*	*5.59*	*0*	*0*	*10.03*
Baseflow due to increased abstraction (Mm^3/a)	*8.74*	*2.51*	*1.55*	*0.26*	*13.06*
% contribution to total baseflow of the Letaba	*14.13*				

Numerical: *The Groundwater RQOs are provided in Table 10.11.*

Table 10.11 IUA 7 – B82A, B82B, B82C, B82D: Groundwater RQOs

Quat	Groundwater narrative RQO	Groundwater numerical RQO
B82A B82D	*Groundwater is moderately utilised. Abstraction impacts significantly on baseflow locally and on inflows into the middle Letaba Dam. Increases in abstraction should consider the impacts on the yield of the middle Letaba Dam.*	*Groundwater abstraction can be increased from 7.45 Mm^3/a to 17.47 Mm^3/a, with a 5.27 Mm^3/a reduction in baseflow. An investigation of the baseflow reduction on the yield of the middle Letaba Dam is required.*
B82B B82C	*Groundwater is over exploited and has resulted in significant reduction in inflows into the Middle Letaba Dam. No further groundwater abstraction should be permitted.*	*Groundwater abstraction exceeds the Harvest Potential and the simulated aquifer recharge. No further abstraction should take place.*

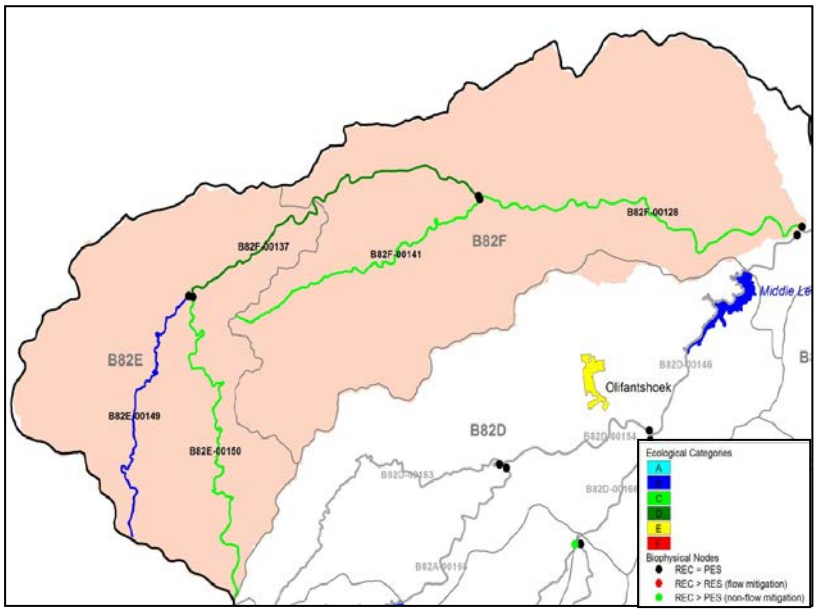
11 IUA 8: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

This area is a mixture of commercial farming and rural areas. As impacts are mostly non-flow related, and there is limited water resources infrastructure, scenarios will be limited to restrictions and catchment management options. Again this forms a logical IUA as downstream of the confluence with the Middel Letaba Dam, the operational options relates to possible flow regulation from Middel Letaba Dam.

IUA 8 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 8: KLEIN LETABA US FROM THE MIDDLE LETABA DAM



PRIORITY RATINGS

SQ	River	Priority rating
B82E-00149	*Khwali*	*1a*
B82E-00150	*Little Letaba*	*1a*
B82F-00141	*Soeketse*	*1a*
B82F-00128	*Little Letaba*	*2*
B82F-00137	*Little Letaba*	*2*

Water resource use

IUA 8 includes B82E and almost all the SQs within the B82F quaternary catchment, and excludes only the Middle Letaba (B82D-00146), i.e. the zone ends where the Middle Letaba joins the Little Letaba. Other rivers included in this zone are the Khwali and Soeketse Rivers. The storage regulation is low in the IUA with no major dams present in the area. Water supply is predominantly to the urban sector which also generates some return flows that enter the river system. Significant volumes of groundwater are utilised in the IUA especially in B82E where over 70% of the Utilisable Exploitation Potential (Potable) is used by the urban sector. The viability for additional groundwater development needs to be confirmed. A possible future surface water resource development is the construction of a new dam at two possible sites that have been identified, namely the Majosi or Crystalfontein Dam sites.

The groundwater response unit falls largely within Bandelierskop. The groundwater use is approximately 10 - 40% of the aquifer recharge.

Water quality

No water quality hotspots were found in this area with water quality state generally being Good.

Economy

The main economic activities is classified as part of the primary sector is identified as sub-tropical fruits and commercial forestry, while tomato processing as a secondary and eco-tourism as a tertiary sector is part of IUA 8.

EGSA

The upper portion of the IUA has relatively low population densities with pockets of commercial farming interspersed with subsistence farming. The areas associated with subsistence farming and lower population densities are likely to have high EGSA dependence. However the lower (Eastern) potions of the IUA become very highly populated and dense closer settlement associated with the former Gazankulu homeland dominate. Again the utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high.

River and wetland ecology

The PES ranges from a B (B82E-00149) to D (B82F-00137), but is predominantly a C PES. Impacts are non-flow related such as vegetation removal, trampling and water quality. B82E has a fairly high density of seep wetlands, none of which have been highlighted as important, while B82F-00128 (Little Letaba) has been noted for channelled valley bottom wetlands.

11.1 RQOs FOR RU B82E-00149 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a B PES, has high ecological importance, moderate SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the low ecological importance, the REC is set to maintain the B PES. The recommended scenario does not influence this site.

11.1.1 Flow RQOs

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
B	4.51	4.02	0.126	2.8	0.624	13.9	0	0	0	0.005

11.1.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Khwali	**MODERATE:** *Exotic vegetation, Roads.* **LARGE:** *Grazing/trampling.* **SERIOUS:** *Natural areas/nature reserves.*	B	B

11.2 RQOs FOR RU B82E-00150 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a C PES, has moderate ecological importance and SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the low ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

11.2.1 Flow RQOs

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Sep		Feb	
							90%	60%	90%	60%
C	3.48	3.08	0.037	1.1	0.558	16	0	0	0	0

11.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Little Letaba	**MODERATE:** *Abstraction (run-of river)/increased flows, agricultural lands, crossings low water, exotic vegetation, roads, small dams (farm), grazing/trampling, vegetation removal.*	C	C

11.3 RQOs FOR B82F-00141 (LOW PRIORITY – 1A)

The RU is of moderate priority (Level 1) as it is in a C PES, has moderate ecological importance and SCI as well as water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the low ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

11.3.1 Flow RQOs

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	*7.32*	*7.19*	*0.115*	*1.6*	*0.935*	*12.8*	*0*	*0*	*0.002*	*0.011*

11.3.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Soeketse	**MODERATE:** *Algal growth, crossings low water, erosion, exotic vegetation, natural areas/nature reserves, roads, sedimentation, small dams (farm).* **LARGE:** *Agricultural lands, grazing/trampling, urbanization, vegetation removal.*	C	C

11.4 RQOs FOR B82F-00128 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a C PES, has moderate ecological importance and SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the C PES. The recommended scenario does not influence this site.

11.4.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	*32.13*	*30.26*	*1.595*	*5.0*	*4.962*	*15.4*	*0.001*	*0.006*	*0.005*	*0.023*

11.4.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Little Letaba	**LARGE:** *Erosion, runoff/effluent: Urban areas, sedimentation, urbanization, vegetation removal.* **SERIOUS:** *Agricultural lands.*	C	C	*Riparian vegetation* *Instream biota* *Water quality*

Habitat and biota RQOs are provided in Table 11.1.

Table 11.1 B82F-00128: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone. It is assumed that 60% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*
Riparian zone longitudinal continuity	*Riparian zone fragmentation should not increase.*	*Zero increase in riparian zone fragmentation. The relationship between % alien cover and EC is hypothesised and testable.*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover).*
Aerial cover of alien plant species within the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category).*
FISH		
Indicators	**Narrative RQO**	**Numerical RQO**
PES *Desktop FRAI: 51.22%,D*	*Maintain PES of at least D.*	*Maintain the Fish PES in at least a D (FRAI ≥ 51%).*
Species richness: *10 species*	*Maintain fish species richness.*	*Maintain fish species richness. Do not allow more than 10% deviation from baseline (estimated at 10 species) estimated for SQ reach.*
Primary indicator species: *BMAR*	*Flows should be adequate to ensure suitable habitats for BMAR.*	*Ensure presence of BMAR in reach and FROC should not decrease >10% from baseline value (to be established should monitoring be implemented).*
Secondary indicator species: *Flow: MAR/LCYL* *Water quality: LCYL* *Substrate: LCYL* *Vegetation: VIV/MBRE*	*Maintain adequate water quality, substrate of good quality and vegetation as cover for fish.*	*Ensure the presence of the secondary indicator species and do not allow reduction of their present FROC.*
MACRO-INVERTEBRATES		
Indicators	**Narrative RQO**	
Hydropsychidae and Elmidae	*To maintain suitable conditions for these flow dependent species (moderate to rapid velocities: 0.3 - > 0.6 m/s) in the SIC biotope.*	
Coenagrionidae and Belostomatidae	*To maintain suitable conditions in the marginal vegetation for these key species.*	

11.4.3 Wetland RQOs

This zone has been noted for channelled valley bottom wetlands. Wetland RQOs are provided in Table 11.2.

Table 11.2 B82F-00128: Narrative and numerical wetland RQOs

Indicators	Narrative RQO	Numerical RQO
Wetland PES	*Maintain wetland EC of C/D.*	*Maintain wetland EC score above 59%.*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 1.5 and IHI score equal to or above 2.*

11.4.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 11.3.

Table 11.3 B82F-00128: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone) and vegetative cover (% aerial) along banks.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species (where possible) and express as percentage of riparian zone area.*
Fish	*FRAI (Kleynhans, 2007).*
Macro-invertebrates	*SASS 5 and MIRAI (Thirion, 2007).*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

11.5 RQOS FOR B82F-00137 (MODERATE PRIORITY – 2)

The RU is of moderate priority (Level 2) as it is in a D PES, has moderate ecological importance and SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. Due to the moderate ecological importance, the REC is set to maintain the D PES. The recommended scenario does not influence this site.

11.5.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
D	*13.64*	*12.42*	*0.063*	*0.5*	*1.319*	*9.7*	*0*	*0*	*0.001*	*0.008*

11.5.2 Water Quality RQOs

Source: *Water quality assessment conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b). The assessment conducted for EWR 5 (B82G-00135) was valid for the whole stretch of the upper Klein Letaba River up to Giyani.*
Model: *TEACHA and PAI models (DWAF, 2008).*

Users: *Informal settlements and subsistence irrigation.*
Water quality issue: *Elevated nutrients and turbidity.*

Table 11.4 B81F-00137: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.015 mg/L PO_4-P (aquatic ecosystems: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure that turbidity or clarity levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity during runoff events (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

11.5.3 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Little Letaba	**MODERATE:** *Crossings low water, exotic vegetation, natural areas/nature reserves, roads, sedimentation.* **LARGE:** *Agricultural lands, algal growth, erosion, runoff/effluent: Urban areas, grazing/trampling, urbanization, vegetation removal.*	**D**	**D**	*Riparian vegetation*
				Water quality

Habitat and biota RQOs are provided in Table 11.5.

Table 11.5 B82F-00137: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone. It is assumed that 60% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*
Riparian zone longitudinal continuity	*Riparian zone fragmentation should not increase.*	*Zero increase in riparian zone fragmentation.*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover).*

11.5.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 11.6.

Table 11.6 B82F-00137: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Water quality	*Data used for water quality assessments should be collected from B8H033Q01. Analysis of data and possible monitoring action should be based on biotic cues.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone (most likely to be desktop based but include more detail if available.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone) and vegetative cover (% aerial) along banks.*

11.6 GROUNDWATER RQOs

Groundwater RQOs cover IUA 8: Klein Letaba - B82E, B82F.

Narrative:

Groundwater use and resources: *Groundwater use is for informal settlements and subsistence irrigation. The stress index (Use/ aquifer recharge) is low and scope exists for increasing groundwater use.*

	B82E	B82F	Total
Irrigation (Mm^3/a)	*1.45*	*1.43*	*2.88*
Water Supply (Mm^3/a)	*0*	*0*	*0*
Total use (Mm^3/a)	*1.45*	*1.43*	*2.88*
Stress index	*0.18*	*0.1*	
Harvest potential (Mm^3/a)	*6.41*	*12.05*	*18.46*
Exploitation potential (Mm^3/a)	*4.49*	*8.44*	*12.92*
Recharge (Mm^3/a)	*8.32*	*14.84*	*23.16*
Aquifer recharge (Mm^3/a)	*8.05*	*14.3*	*22.35*
Allocatable groundwater (Mm^3/a)	*6.6*	*12.87*	*19.47*
Status	*C – Moderately modified*	*B - Largely natural*	

Borehole yields: *Borehole yields are moderate with 37% of boreholes having yields above 2 l/s. The median yield is over 1.2 l/s, hence there is potential for further developing groundwater supply.*

	B82E	B82F
N	*265*	*61*
Lower Quartile (l/s)	*0.5*	*0.6*
MEDIAN (l/s)	*1.21*	*1.32*
Upper Quartile (l/s)	*3.2*	*2.5*
Geometric Mean (l/s)	*1.31*	*1.25*
Yield >2 l/s (%)	*37.36*	*37.7*

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 0 - 1, or Ideal to Good water quality. Some poor quality boreholes with elevated nitrates exist, but they are less than 20% of the boreholes sampled.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B82E	34	33	9			76	100	54	15	26	10	4	109	87
B82F	84	91	3			178	100	114	32	51	25	7	229	86

>80%
60 - 80%
<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has a minor impact on baseflow in this IUA. This IUA provides less than 1% of baseflow in the Letaba, of which 60% originates from the regional aquifer, the remainder originating as interflow. Consequently, although abstraction impacts on baseflow, the impact on the Letaba system is minor. Abstraction has reduced baseflow by 10%. Recharge is lost primarily by evapotranspiration and groundwater baseflow reduction is 7% of abstraction.*

	B82E	B82F	Total
MAR (Mm^3/a)	11.29	22.59	33.88
Total Use (Mm^3/a)	1.45	1.43	2.88
Stress index	0.18	0.1	
Recharge (Mm^3/a)	8.32	14.84	23.16
Aquifer recharge (Mm^3/a)	8.05	14.3	22.35
Interflow (Mm^3/a)	0.27	0.54	0.81
Baseflow (Mm^3/a)	0.48	1.54	2.02
Groundwater water baseflow (Mm^3/a)	0.21	1	1.21
Present baseflow (Mm^3/a)	0.36	1.44	1.8
Present MAR reduction (Mm^3/a)	0.12	0.1	0.22
Increased abstraction (Mm^3/a)	4.96	10.62	15.58
Baseflow due to increased abstraction (Mm^3/a)	0	0.7	0.7
% contribution to total baseflow of the Letaba	0.74		

Numerical: *The Groundwater RQOs are provided in Table 11.6.*

Table 11.7 IUA 8 – B82E, B82F: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater is underutilised. Abstraction impacts significantly on baseflow, however the impact is local as the region is not a significant source of baseflow to the Letaba system. Abstraction can be increased depending on low flow requirements in the Klein Letaba.	Groundwater abstraction can be increased from 2.88 Mm^3/a to 18.46 Mm^3/a, with a 1.1 Mm^3/a reduction in baseflow.
Groundwater is underutilised. Abstraction impacts significantly on baseflow, however the impact is local as the region is not a significant source of baseflow to the Letaba system. Abstraction can be increased depending on low flow requirements in the Klein Letaba.	Groundwater abstraction can be increased from 2.88 Mm^3/a to 18.46 Mm^3/a, with a 1.1 Mm^3/a reduction in baseflow.

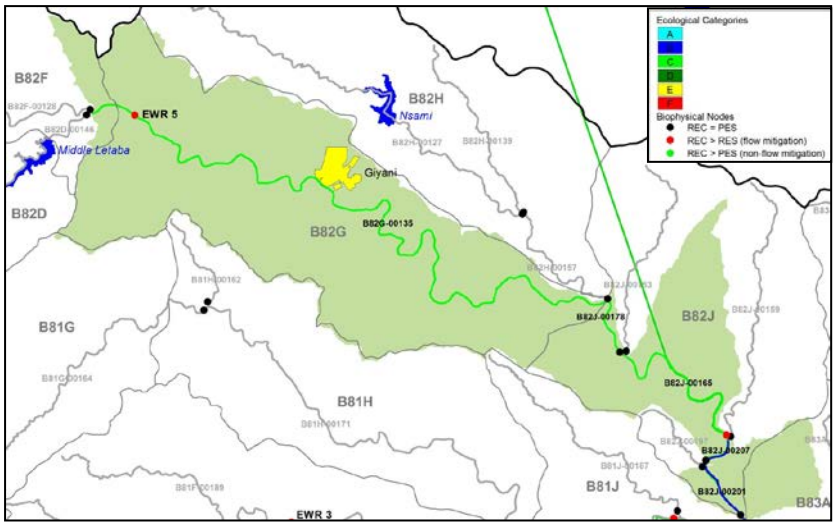
12 IUA 9: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

This IUA forms a logical unit as it can be managed from Middel Letaba Dam. However, management is limited as the outlet capacity is minimal, even for releases for base flows. Also, the dam hardly ever spills. It is possible however to make a small adjustment to the current structure that will allow for improvement in river releases. The tributary catchment (not affected by Middel Letaba Dam) has therefore been grouped in a separate IUA.

IUA 9 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 9: KLEIN LETABA DS FROM THE MIDDLE LETABA DAM



PRIORITY RATINGS

SQ	River	Priority rating
B82G-00135 (EWR 5)	*Little Letaba*	*3b*
*B82J-00165**	*Little Letaba*	*3a*
*B82J-00178**	*Little Letaba*	*3a*
*B82J-00201**	*Little Letaba*	*3a*
*B82J-00207**	*Little Letaba*	*3a*

** These SQs form part of RU EWR 5. Refer to Section 12.1.*

Water resource use

IUA 9 focuses on the remainder of the main channel of the Little Letaba River (SQs B82G-00135, B82J-00178, B82J-00165, B82J-00207 and B82J-00201) and excludes all its tributaries which fall into IUA 10. The IUA therefore starts at the confluence of the Middle and Little Letaba Rivers and ends at the confluence of the Little and Great Letaba Rivers. The IUA is regulated by upstream dams, mainly the Middel Letaba Dam. There are a number of river abstractions mainly by the urban/domestic sector from where return flows are also generated that enter the river systems. There is no surface water resource developments planned in the IUA.

The groundwater response unit falls in the Lowveld plains and Giyani-Gravelotte. The groundwater use is 10% - 25% of the aquifer recharge.

Water quality

There is a water quality hotspot around Giyani due to urban-related impacts, including the WWTW at Giyani. The water quality state is Fair to Poor, primarily due to elevated nutrients.

Economy

The economic activities are minimal and consist mainly of banana production that forms part of the primary sector.

EGSA

The IUA is very highly populated and dense closer settlement associated with the Giyani region of the former Gazankulu homeland dominate. The Giyani town is a formal urban area. Again the utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high. Along with the Tzaneen area this is possibly the most highly populated portion of the catchment. A portion of the eastern part of the IUA falls within the Kruger National Park. For these portions recreational and aesthetic aspects of EGSA utilisation is of importance but direct consumptive use is low.

River and wetland ecology

The IUA has a predominant C PES, with the exception of the last 2 SQs (B82J-00207 and B82J-00201), which are short sections that have a B PES. The last 3 SQs of the Klein Letaba River (B82J-00165, B82J-00207 and B82J-00201) form the boundary of the Kruger National Park (KNP). The Klein Letaba (at B82G-00135) has been outlined for notable wetlands, both for frequency of occurrence and diversity of types of wetlands, including thermal springs. This section also has notable non-riparian wetlands outlined as important in the NFEPA Wetcluster coverage (Nel et al., 2011).

12.1 RQOs FOR RU EWR 5 (B82G-00135; B82J-00165; B82J-00178; B82J-00201; B82J-00207) (HIGH PRIORITY – 3)

12.1.1 Flow RQOs

All the SQs in this IUA are combined in the RU EWR 5 reach which is represented by EWR 5. This IUA therefore forms one RU. The priority rating is High due to its high ecological importance and SCI and very high WRUI. Water quality is also one of the main drivers in this IUA. EWR 5 is situated on the Klein Letaba River, downstream of the confluence of the Middle Letaba River and Middle Letaba Dam.

EWR 5 is situated in B81G-00135. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. The flow RQO is provided below. Flow RQOs at other biophysical nodes in this RU are provided in Appendix A. It must be noted that these flows are a result of the recommended scenario's operating setup and if the operating rules change whilst still meeting the RQOs at EWR 5 these secondary flow RQOs will be different.

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

nMAR (MCM)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
			90%	60%	90%	60%
99.84	*55.85*	*55.94*	*0.015*	*0.030*	*0.034*	*0.069*

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	No of events	Months	Daily average	Duration

Flood Class (m^3/s)	No of events	Months	Daily average	Duration
CLASS I (8 - 12 m^3/s)	*3*	*Jan, Feb, Mar*	*8*	*2*
CLASS II (14 - 25 m^3/s)	*1*	*Feb*	*12*	*3*
CLASS IV (60 - 126 m^3/s)	*1*	*Mar*	*60*	*4*

12.1.2 Water quality RQOs

This assessment for water quality covers the stretch from Giyani along the length of the Klein Letaba.

Source: *Water quality assessment was conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b)*

Model: *TEACHA and PAI models (DWAF, 2008).*

Users (primary user is shown in bold text): **Dense urban (e.g. Giyani) and informal settlements.** *Limited subsistence and cultivated agriculture, with livestock. WWTWs and waste disposal sites.*

Water quality issue: *Elevated nutrients; urban effluents; increased turbidity.*

Narrative and Numerical: *Details provided in Table 12.1. Data used for water quality assessments should be collected from B8H033Q01. Analysis of data and possible monitoring action should be based on biotic cues. EcoSpecs and TPCs for a B Category are provided in Table 12.2 and Table 12.3.*

Table 12.1 B81B-00264: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than or equal to 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	*95^{th} percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity or clarity levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity during runoff events (aquatic ecosystems: driver).*
Meet faecal coliform and E. coli targets for recreational (full contact) use	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
Ensure that toxics are within Ideal limits or A categories.	*95^{th} percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

EcoSpecs and TPCs for Klein Letaba River upstream of Giyani (B82F-00128 and B82F-00137): *Information was based on DWAF (2006c). No water quality data are available for this area. Historical flow data are only available from B8H015, i.e. Klein Letaba at Rossbach (1970 – 1972). Due to similarities in land-use, this WQSU (WQSU 12, i.e. SQs B82F-00128 and B82F-00137) were combined with WQSU 13 (i.e. part of B82G-00135), i.e. up to Giyani (DWAF, 2006b). As WQSUs 12 and 13 were combined for the PES evaluation, EcoSpecs and TPCs are therefore valid for B82F-00128, B82F-00137 and B82G-00135 up to Giyani (Table 12.2).*

Table 12.2 Water quality EcoSpecs and TPCs for the Klein Letaba River upstream of Giyani

River: Klein Letaba upstream of Giyani		PES: B/C EC
Monitoring site: B8H033Q01		**Recommended scenario: C EC**
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 23 mg/L.*	*The 95th percentile of the data must be between 18.5 - 23 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be between 16 – 20 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 15 mg/L.*	*The 95th percentile of the data must be between 12 – 15 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 21 mg/L.*	*The 95th percentile of the data must be between 17 – 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 191 mg/L.*	*The 95th percentile of the data must be between 153 – 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be between 44 – 55 mS/m.*
pH	*The 5th percentile of the data must be between 5.9 to 6.5, and the 95th percentile between 8.0 to 8.8.*	*5th percentile of the data must not be less than 6.1.* *95th percentile of the data must not be greater than 8.6.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by no more than 2°C.*	*Unnatural deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes with temporary high sediment loads and turbidity during runoff events.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 0.25 mg/L.*	*The 50th percentile of the data must be between 0.2 – 0.25 mg/L.*
PO_4-P	*The 50th percentile of the data must be ≤ 0.075 mg/L.*	*The 50th percentile of the data must be between 0.06 – 0.075 mg/L.*
Response variables		
Chl-a phytoplankton [(b)]	*The 50th percentile of the data must be ≤ 20 mg/m^2.*	*The 50th percentile of the data must be between 16 – 20 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 52.5 mg/m^2.*	*The 50th percentile of the data must be between 42 – 52.5 mg/m$^{2.}$*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996a).*

(a) To be generated using TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

EcoSpecs and TPCs for Klein Letaba River downstream of Giyani (B82G-00135 below Giyani, B82J-00178, B82J-00165, B82J-00207, and B82J-00201): *Based on DWAF (2006b) these SQs (except B82G-00135) fall within Water Quality Sub-Unit 1 (Provided in Table 12.3).*

Table 12.3 Water quality EcoSpecs and TPCs for the Klein Letaba River downstream of Giyani

River: Klein Letaba downstream of Giyani		PES: B/C EC
Monitoring site: B8H033Q01		Recommended scenario: C EC
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 23 mg/L.*	*The 95th percentile of the data must be between 18.5 - 23 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be between 16 – 20 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 15 mg/L.*	*The 95th percentile of the data must be between 12 – 15 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 21 mg/L.*	*The 95th percentile of the data must be between 17 – 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 191 mg/L.*	*The 95th percentile of the data must be between 153 – 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be between 44 – 55 mS/m.*
pH	*The 5th percentile of the data must be between 5.9 to 6.5, and the 95th percentile between 8.8 to 9.2.*	*5th percentile of the data must not be less than 6.1.* *95th percentile of the data must not be greater than 9.0.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by no more than 2°C.*	*Unnatural deviation from the natural temperature range. Initiate baseline monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes with temporary high sediment loads and turbidity during runoff events.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 0.7 mg/L.*	*The 50th percentile of the data must be between 0.55 – 0.7 mg/L.*
PO_4-P	*The 50th percentile of the data must be ≤ 0.125 mg/L.*	*The 50th percentile of the data must be between 0.1 – 0.125 mg/L.*
Response variables		
Chl-a phytoplankton [(b)]	*The 50th percentile of the data must be ≤ 20 mg/m^2.*	*The 50th percentile of the data must be between 16 – 20 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 84 mg/m^2.*	*The 50th percentile of the data must be between 67 – 84 mg/m$^{2.}$*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF*	*An impact is expected if the 95th percentile of the data exceeds the CEV*

	(1996a).	*as stated in DWAF (1996a).*

(a) To be generated using TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

12.1.3 Habitat and biota RQOs (EcoSpecs)

12.1.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES of EWR 5, based on fish, is moderately modified, falling in a Category C and should not be allowed to deteriorate any further. The recommended flow scenario for this reach is expected to result in a slight deterioration in the PES but it should still remain within the same EC. The current species richness of 23 indigenous fish species (all species expected under natural conditions) should not be allowed to decrease. The recommended flow scenario is not expected to change the fish species richness of the reach but a slightly reduced FROC (distribution within a reach) is expected for various species (primarily related to alterations of the flood regime). Various fish species intolerant to different stressors or with a high preference for specific habitat features provide valuable indicators of change that should be used to monitor potential change. The primary indicator fish species for this reach is the sawfin suckermouth (CPAR), being an indicator of flow modification (fast flowing habitats), rocky substrate condition and water quality. Another important indicator for this reach is the largescale yellowfish (BMAR), providing indication of changes in flow (especially fast deep habitats) as well as the migratory success of species.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 12.4.*

Table 12.4 RU EWR 5: Fish EcoSpecs and TPCs

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
Metric: Ecological status				
PES	*Present ecological status of fish is in a C (68.7%).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC[1] of species.*	*A slight deterioration in the ecological conditions is expected but the fish will still remain in a C (63.3%). Although flow and thus habitat abundance will be better during dry and most of wet season when compared to the PES, the lack of floods result in deterioration of substrate quality and loss of pools (due to sedimentation related to reduction in floods), leading to a slight decrease in the FROC of many species.*
Metric: Species richness				
All indigenous species	*23 of the expected 23 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*	
Metric: Requirement for flowing water				
CPAR BMAR	*CPAR and BMAR have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*CPAR and/or BMAR absent during any survey OR present at FROC[1] of < 3 for CPAR and <2 for BMAR. (DWAF, 2006b: A minimum of 5 CPAR specimens should be sampled at 20% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes).*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*	
Metric: FD habitats				
CPAR BMAR	*CPAR and BMAR have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or BMAR absent during any survey OR present at FROC of < 3 for CPAR and < 2 for BMAR.*	*Reduced suitability (abundance & quality) of FD habitats (i.e. decreased flows, increased zero flows).*	
Metric: FS habitats				
CPAR LCYL	*CPAR and LCYL have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or LCYL absent during any survey OR present at FROC of < 3 for CPAR and < 3 for LCYL.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*	
Metric: Substrate				
LROS CPAR	*LROS and CPAR have a high requirement for FD habitats and are the most applicable indicator species for this habitat feature.*	*LROS and/or CPAR absent during any survey OR present at FROC of < 3 for LROS and < 3 for CPAR.*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.*	
Metric: Water quality intolerance				
LMOL	*LMOL and CPAR have a high*	*LMOL and/or CPAR absent during any survey OR*	*Decreased water quality*	

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
CPAR	*requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*present at FROC of < 3 for LMOL and < 3 for CPAR.*	*(especially flow related water quality variables such as oxygen).*	
Metric: Overhanging vegetation				
BVIV *BRAD*	*BVIV and BRAD have a high requirement for overhanging vegetation and are the most applicable indicator species for this habitat feature.*	*BVIV and/or BRAD absent during any survey OR present at FROC of < 3.5 for BVIV and < 3.5 for BRAD. (DWAF, 2006c: A minimum of 20 BVIV specimens should be sampled at 85% of sites during a survey, electrofishing for minimum 20 minutes/10 sweeps with 4m pole seine net.).*	*Significant change in overhanging vegetation habitats.*	
Metric: Instream vegetation				
TREN *BPAU*	*TREN and BPAU have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or BPAU absent during any survey OR present at FROC of < 3.5 for TREN and < 3.5 for BPAU.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).*	
Metric: Undercut banks				
SZAM *PPHI*	*SZAM and PPHI have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*SZAM and/or PPHI absent during any survey OR present at FROC of < 2 for SZAM and < 3.5 for PPHI.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*	
Metric: Water column				
MBRE *BANN*	*MBRE and BANN have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or BANN absent during any survey OR present at FROC of < 3.5 for MBRE and < 3.5 for BANN.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*	
Metric: SD habitats				
BANN *BUNI*	*BANN and BUNI have a high requirement for SD habitats and are the most applicable indicator species for this velocity depth category.*	*BANN and/or BUNI absent during any survey OR present at FROC of < 3.5 for BANN and < 3.5 for BUNI. (DWAF, 2006c: A minimum of 10 BUNI specimens should be sampled at 60% of sites during a survey, electrofishing for minimum 20 minutes/10 sweeps with 4 m pole seine net.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: SS habitats				
BRAD	*BRAD and BVIV have a high requirement for SS habitats and are*	*BRAD and/or BVIV absent during any survey OR present at FROC of < 3.5 for BRAD and < 3.5 for*	*Significant change in SS habitat suitability (i.e. increased flows,*	

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
BVIV	*the most applicable indicator species for this velocity depth category.*	*BVIV.*	*altered seasonality, increased sedimentation of slow habitats).*	
Metric: Migratory success[2]				
BMAR LMOL, etc.	*It is estimated that the catadromous eels have been lost from this reach but various potamodromous species (including BMAR) is still present.*	*Loss or decreased FROC potamodromous species (such as BMAR).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	
Metric: Alien fish species				
Presence of any alien/introduced spp.	*No alien/introduced species known or expected to be present in the SQ reach.*	*Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.*	*N/A*	
Primary indicator species: CPAR (BMAR)				
	CPAR estimated to be present at >25% of sites in SQ reach (DWA, 2013b) (to be verified).	**See relevant sections above for detail.**	**See relevant sections above for detail.**	

1, 2: Refer to Table 4.21.

12.1.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of a Lowveld river assemblage with seasonal traits. The ample alluvial sediment is dominating the habitats in this reach with marginal vegetation establishing on the marginal edges. Stones-in-current habitats in this reach are very limited. Although upstream dams and abstraction leads to very low flows and associated poorer water quality parameters, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario is in a D EC, which is lower than the PES of the river.*

Numerical: *Indicator taxa are provided in Table 12.5 and Table 12.6 provides EcoSpecs and TPCs for a D Category.*

Table 12.5 RU EWR 5: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*>0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 – 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 – 0.6*	*Cobbles*	*Moderate*
5	*Atyidae*	*N/A*	*Vegetation*	*Moderate*
6	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 5 is situated in B81G-00135, Little Letaba River is provided in Table 12.6. This RU consists of a large, shallow Lowveld river with low flows during the winter where alluvial substrate dominates with very little SIC habitat and marginal vegetation habitat important.

Table 12.6 RU EWR 5: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs
To ensure that the SASS 5 scores and ASPT values occur in the following range: SASS 5 score: >100; ASPT value: > 5.0.	*SASS 5 scores less than 110 and an ASPT less than 5.0.*
To ensure that the MIRAI score remains within the range of a D category (42% – 57%).	*A MIRAI score of 50% or less.*
To maintain suitable flow velocity (>0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance B).* ▪ *Trichorythidae (Abundance A).*	*Both these two taxa missing in two consecutive surveys.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain surface area (cobbles) to support the following flow-dependent taxa: ▪ *Heptageniidae (Abundance A).* ▪ *Elmidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys.*
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Atyidae (Abundance A).* ▪ *Coenagrionidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys.*
To maintain suitable conditions for the following six key taxa: ▪ *Hydropsychidae* ▪ *Trichorythidae* ▪ *Heptageniidae*	*Presence of less than three of the six key taxa listed in any survey.*

EcoSpecs	TPCs
▪ *Elmidae* ▪ *Atyidae* ▪ *Coenagrionidae*	
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Gomphidae, Simuliidae and Baetidae). To ensure that no group consistently dominates the fauna, defined as D abundance (> 1000) over more than two consecutive surveys.	*Any taxon occurring in an abundance of > 1000 for two consecutive surveys.*

12.1.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall Present Ecological State (as at October 2013) for riparian vegetation was a Category C, comprising the marginal zone in a Category C, the lower zone in Category C/D and the upper zone in a Category C. The recommended scenario results in a C/D EC for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and shall be maintained as viable populations: B. salicina, C. imberbe and P. violacea. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2013. As such agricultural activities shall not encroach into the riparian zone or cross the riparian zone boundary. Agricultural lands currently within the riparian zone shall not expand or intensify.*

Numerical: *EcoSpecs and TPCs for a C/D Category are provided in Table 12.7.*

Table 12.7 RU EWR 5: Riparian vegetation EcoSpecs and TPCs

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Vegetation cover				
Marginal Zone	*Maintain marginal hydrophyte fringe and Phragmites along the active channel and Cyperus marginatus patches in places*	*Maintain marginal hydrophyte fringe and Phragmites along the active channel and C. marginatus patches in places.*	*Marginal fringe absent; Phragmites fringe visibly (fixed photo) increasing in abundance/cover; C. marginatus absent.*	*Adapted from DWAF (2006c), fringe cover (either reeds or woody overhang) is important habitat for instream and riparian fauna.*
Secondary channels	*Maintain between 25 and 50% marginal hydrophyte cover in secondary channels during summer*	*Maintain between 25% and 50% marginal hydrophyte cover in secondary channels during summer.*	*Marginal hydrophyte cover in secondary channels less than 25% OR more than 50% in summer.*	*Adapted from DWAF (2006c).*
Lower Zone	*Maintain Ficus sycomorus and Combretum erythrophyllum cover.*	*Maintain F. sycomorus and C. erythrophyllum cover.*	*Measurable decrease in either population; failure to recover following large floods.*	*Adapted from DWAF (2006c), active channel woody component is important habitat for instream and riparian fauna; both species depend on base flows, bank storage and flooding.*
Metric: Species composition				
Lower Zone	*Maintain at least 14 indigenous riparian tree species.*	*Maintain at least 14 indigenous riparian tree species.*	*Absence of any of the following: Co. erythrophyllum or F. sycomorus*	*Adapted from DWAF (2006c).*
Upper zone	*Maintain Diospyros mespiliformis, B. salicina, C. imberbe, P. violacea and Trichelia emetica*	*Maintain D. mespiliformis, B. salicina, C. imberbe, P. violacea and T. emetica populations.*	*Visible decrease in D. mespiliformis, B. salicina, C. imberbe, P. violacea and T. emetica*	*Adapted from DWAF (200c) - typical upper zone species relying on bank storage, its demise a possible indication of reduced bank storage.*

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
	populations.		*cover/abundance.*	
Metric: Alien invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 30%.*	*Perennial alien plant species aerial cover less than 30%.*	*Increases in alien perennial species cover above 30%.*	*See hypothesis for Lowveld rivers (alien invasion) (electronic information).*
Metric: Indigenous riparian woody cover				
Marginal Zone	*Riparian woody species cover not absent and not more than 80%.*	*Riparian woody species cover not absent and not more than 80%.*	*An increase in riparian woody cover above 80% OR an absence of woody riparian species.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Lower Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not less than 5% and not more than 80%.*	*An increase in riparian woody cover above 70% OR a decrease below 5%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 20% and not more than 80%.*	*Riparian woody species cover not less than 20% and not more than 80%.*	*An increase in riparian woody cover above 80% OR a decrease below 20%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not less than 10%.*	*Reed cover not less than 10%.*	*A decrease in reed cover below 10%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover between 10% and 90%.*	*Reed cover not absent.*	*A decrease in reed cover below 10% OR and increase above 90%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover less than 50%.*	*Reeds cover less than 50%.*	*An increase in reed cover above 50%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Metric: Riparian zone integrity				
Riparian zone	*Zero expansion of agriculture within the riparian zone.*	*Zero expansion of agriculture within the riparian zone.*	*An increase of the spatial extent of agriculture WITHIN the riparian zone.*	*Desktop assessment of area of interest; Riparian delineation required. Status quo should be calculated (% of riparian zone that is not forestry or agriculture) and used as base against which to assess change.*
Metric: Longitudinal riparian zone continuity				
Riparian zone	*Zero increase in riparian zone longitudinal fragmentation.*	*Zero increase in riparian zone longitudinal fragmentation.*	*An increase in the longitudinal fragmentation of the riparian zone.*	*Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover and use as base against which to assess change.*

12.1.4 Wetland RQOs

Narrative:

A wetland (thermal spring) of moderate importance occurs in quaternary catchment B82G and is a NFEPA priority wetland. Maintaining the wetland in its current condition is outlined below:

- *General: The wetland should remain intact and the PES should not deteriorate. There should be no encroachment of agricultural activities into the wetland.*
- *Geomorphology: No furrows, canals or excavations may be constructed nor may dredging activities occur within intact wetlands.*
- *Vegetation: Species composition and vegetative cover should be maintained such that the wetland EC will not deteriorate. Woody invasive alien species should not increase in cover or abundance within wetlands.*

Numerical: *Wetland RQOs are provided in Table 12.8.*

Table 12.8 Wetlands in SQ B82G-00135: Possible monitoring actions and tools

Subcomponent indicator	Narrative RQO	Numerical RQO	Possible monitoring action and tools
Wetland PES	*Maintain wetland EC of C/D.*	*Maintain wetland EC score above 59%.*	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*
Integrated wetland importance and sensitivity and IHI	*Maintain High EI.*	*Maintain Median EI score equal to or above 1.5 and IHI score equal to or above 2.*	

12.2 GROUNDWATER RQOs

Groundwater RQOs cover IUA 9: Klein Letaba downstream to confluence with Nsama - B82G.

Narrative:

Groundwater use and resources: *The main landuse is dense urban settlements (e.g. Giyani) and informal settlements (i.e. limited subsistence and cultivated agriculture, with livestock). Groundwater use is low. The stress index (use/ aquifer recharge) is low and scope exists for increasing groundwater use.*

	B82G
Irrigation (Mm^3/a)	*0.06*
Water Supply (Mm^3/a)	*0*
Total use (Mm^3/a)	*0.06*
Stress index	*0.06*
Harvest potential (Mm^3/a)	*11.02*
Exploitation potential (Mm^3/a)	*7.72*
Recharge (Mm^3/a)	*10.8*
Aquifer recharge (Mm^3/a)	*10.75*
Allocatable groundwater (Mm^3/a)	*10.15*
Status	*B - Largely natural*

Borehole yields: *Borehole yields are high with 53% of boreholes having yields above 2 l/s, and 25% above 4.4 l/s. The median yield is over 2.5 l/s, hence there is potential for further developing groundwater supply.*

	B82G
N	*155*
Lower Quartile (l/s)	*0.8*
MEDIAN (l/s)	*2.5*
Upper Quartile (l/s)	*4.43*
Geometric Mean (l/s)	*1.79*
Yield >2 l/s (%)	*53.55*

Number of boreholes:

- *>75%*
- *50 - 75%*
- *25 - 50%*
- *<25%, geometric mean less than 1 l/s*

Groundwater quality: *Ground water is generally of DWA Class 1, or Good water quality, however, over 20% of boreholes are not potable due to elevated nitrates.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B82G	4	69	58	8	1	140	94	111	15	40	30	16	212	78

>80%
60 - 80%
<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has a minor impact on baseflow in this IUA. This IUA provides very minor baseflow to the Letaba, of which only 17% originates from the regional aquifer, the remainder originating as interflow. Consequently, although abstraction impacts on baseflow, the impact on the Letaba system is minor. Recharge is lost primarily by evapotranspiration and groundwater baseflow reduction by abstraction is minor.*

	B82G
MAR (Mm^3/a)	15.21
Total Use (Mm^3/a)	0.60
Stress index	0.60
Recharge (Mm^3/a)	10.80
Aquifer recharge (Mm^3/a)	10.75
Interflow (Mm^3/a)	0.05
Baseflow (Mm^3/a)	0.06
Groundwater water baseflow (Mm^3/a)	0.01
Present baseflow (Mm^3/a)	0.05
Present MAR reduction (Mm^3/a)	0.01
Increased abstraction (Mm^3/a)	10.41
Baseflow due to increased abstraction (Mm^3/a)	0
% contribution to total baseflow of the Letaba	0.02

Numerical: *The Groundwater RQOs are provided in Table 12.9.*

Table 12.9 IUA 9 – B82G: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater use is low and can be utilised up to the Harvest Potential with little to no impact on baseflow.	Groundwater abstraction can be increased from 0.6 Mm^3/a to 11.02 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.

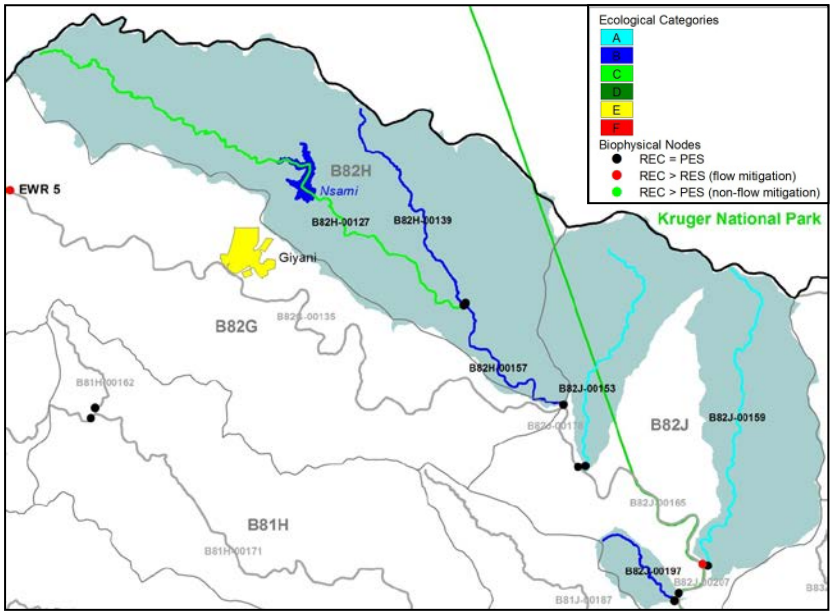
13 IUA 10: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

This IUA consists of the Little Letaba tributaries downstream of the Middle Letaba Dam. They are in a reasonable ecological state and all impacts are non-flow related. As scenarios that include the Middle Letaba Dam operation will not impact on these tributaries, they have been placed in a separate IUA.

IUA 10 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 10: LOWER KLEIN LETABA TRIBUTARIES



PRIORITY RATINGS

SQ	River	Priority rating
B82H-00127	*Nsama*	*2*
B82H-00139	*Magobe*	*1a*
B82H-00157	*Nsama*	*2*
B82J-00153	*Nalatsi*	*1b*
B82J-00159	*Byashishi*	*1b*
B82J-00197	*Ka-Malilibone*	*1a*

Water resource use

This ecological zone includes the ephemeral tributaries (5 SQs) in the lower Klein Letaba up to the KNP boundary. The IUA is regulated by the Nsami Dam. Water is mainly supplied to the urban and irrigation sectors. Return flows from the urban sector enter the river systems resulting in a reduction in water quality. There is no future surface water developments planned in the IUA. There is possibility for future groundwater development in the area, but the locality of the groundwater resources relative to potential users and the viability for development needs to be confirmed.

The groundwater response unit falls within the Alluvial response unit within the KNP. No use is known of.

Water quality

Subsistence agriculture dominates in this area, with rural communities and cattle grazing impacting on water quality of the lower Nsama River, especially during the dry season. Washing, agriculture and overgrazing take place within the riparian zone. Water quality state is Good to Fair, with no water quality hotspots identified.

Economy

The economic activities are minimal and consist mainly of banana production that forms part of the primary sector.

EGSA

The western portion of the IUA is highly populated and again dense closer settlements associated with the former Gazankulu homeland dominate. The utilisation of EGSA is likely to be constrained given population density but the importance, given the profile of the population in the IUA, is likely to be high. The lower (eastern) portion is located within the KNP. For these portions recreational and aesthetic aspects of EGSA utilisation is of importance but direct consumptive use is low.

River and wetland ecology

The Nsama River including the Magobe tributary (3 SQs) are surrounded by rural settlements with associated impacts (overgrazing and riparian vegetation removal) with a PES ranging from a C to a B, while the Nalatsi and Byashishi originates in the KNP with only the lower reaches running through rural areas. Due to the protection within the KNP for most of its reach, the river is in an A PES.

The Nsama River (B82H-00127) is the only SQ that has been outlined for notable wetlands, both for frequency of occurrence and diversity of types of wetlands.

13.1 RQOs FOR B82H-00127 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it has C PES, moderate ecological importance, moderate SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a C PES for the EcoStatus and due to the moderate ecological importance, the REC is set to maintain the PES REC. The recommended scenario does not impact on this RU, therefore the RQOs is set to maintain the REC of a C.

13.1.1 Flow RQOs

Source: *DWA (2013b).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	EWR
C	*6.91*	*4.42*	*0.07*	*1*	*0.73*	*10.6*	*River ephemeral - only flood requirements*

13.1.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Nsama	**MODERATE***: Agricultural lands, crossings low water, exotic vegetation, grazing/trampling, vegetation removal.* **LARGE:** *Runoff/effluent: Urban areas, urbanization.*	**C**	**C**	*Riparian vegetation*

Habitat and biota RQOs are provided in Table 13.1.

Table 13.1 B82H-00127: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone. It is assumed that 60% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*
Riparian zone longitudinal continuity	*Riparian zone fragmentation should not increase.*	*Zero increase in riparian zone fragmentation.*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover). The relationship between % alien cover and EC is hypothesised and testable.*
Aerial cover of alien plant species in the riparian zone	*Perennial alien plant species aerial cover within the riparian zone should conform to the desired EC.*	*Perennial alien plant species aerial cover within the riparian zone should be less than 30% (requirement applicable to C Category).*

13.1.3 Wetland RQOs

The Nsama River (B82H-00127) is the only SQ that has been outlined for notable wetlands, both for frequency of occurrence and diversity of types of wetlands. Wetland RQOs are provided in Table 13.2.

Table 13.2 B82H-00127: Narrative and numerical wetland RQOs

Indicators	Narrative RQO	Numerical RQO
Wetland PES	*Maintain wetland EC of C.*	*Maintain wetland EC score above 70%.*
Integrated wetland importance and sensitivity and IHI	*Maintain Moderate EI.*	*Maintain Median EI score equal to or above 1.5 and IHI score equal to or above 1.6.*

13.1.4 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 13.2.

Table 13.3 B82H-00127: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*B8R009: Gauge downstream of Nsami Dam wall. Some challenges with metering at the dam. Unsure about the accuracy of the spill. Only relevant for section downstream of dam wall.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).* ▪ *And vegetation cover (% aerial) along banks.* ▪ *Use satellite imagery and field visits to estimate % aerial cover of perennial alien plant species and express as percentage of riparian zone area.*
Wetlands	*Conduct periodic desktop wetland PES, EIS and IHI assessments using newly available data (including Google Earth imagery).*

13.2 RQOs FOR RU B82H-00139 (LOW PRIORITY - 1)

The RU is of LOW priority (Level 2) as it has B PES, moderate ecological importance, moderate SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a B PES for the EcoStatus and as it is in a good state, the REC is set to maintain the PES. The recommended scenario does not impact on this RU, therefore the RQOs is set to maintain the REC of a B.

13.2.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	EWR
B	*3.1*	*3.1*	*0.021*	*0.7*	*0.463*	*14.9*	*River ephemeral - only flood requirements*

13.2.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Magobe	**MODERATE:** *Agricultural lands, crossings low water, erosion, exotic vegetation, runoff/effluent: Urban areas, Grazing/trampling, urbanization.* **LARGE:** *Vegetation removal.*	**B**	**B**

13.3 RQOs FOR B82H-00157 (MODERATE PRIORITY - 2)

The RU is of moderate priority (Level 2) as it has B PES, moderate ecological importance, low SCI and high water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity.

This RU is in a B PES for the EcoStatus and as it is in a good state, the REC is set to maintain the PES. The recommended scenario does not impact on this RU, therefore the RQOs is set to maintain the REC of a B.

13.3.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B	*11.72*	*9.21*	*0.202*	*1.7*	*1.683*	*14.4*	*0*	*0*	*0*	*0.002*

13.3.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC	Component indicator
Nsama	**MODERATE:** *Agricultural lands, erosion, natural areas/nature reserves, sedimentation, grazing/trampling, vegetation removal.*	**B**	**B**	*Riparian vegetation*

Habitat and biota RQOs are provided in Table 13.4.

Table 13.4 B82H-00157: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone boundary	*Agricultural activities should not encroach into the riparian zone or cross the riparian zone boundary.*	*Zero increase of agricultural activities within the riparian zone. It is assumed that 80% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*
Riparian zone longitudinal continuity	*Riparian zone fragmentation should not increase.*	*Zero increase in riparian zone fragmentation.*
Vegetative cover along riparian zone banks	*Vegetative cover along riparian zone banks should be maintained in order to provide bank stability and prevent erosion.*	*Vegetative cover along riparian zone banks should not be less than 60% (aerial cover)* *Note: It is assumed that 80% cover for this particular region and particular vegetation unit is realistic (and functional) but the hypothesis is testable.*

13.3.3 Monitoring actions and tools

It is unlikely that monitoring will take place at RUs with moderate priority. However, acknowledging that future development could require monitoring to take place, broad guidelines for monitoring actions and tools that could be used are provided in Table 13.5.

Table 13.5 B82H-00157: Possible monitoring actions and tools

Component	Monitoring actions and tools
Flow	*No relevant gauge.*
Habitat	*RHAM (visual) (DWA, 2009).*
Riparian vegetation	▪ *Delineate and digitise riparian zone.* ▪ *Use satellite imagery (such as Google Earth) to assess agriculture in relation to riparian zone (within zone).* ▪ *And vegetation cover (% aerial) along banks.*

13.4 RQOS FOR B82J-00153, B82J-00159 (LOW PRIORITY - 1)

These RUs fall in Reserve areas in its totality. They are therefore largely protected and in a very good PES. These rivers are non-perennial and mostly ephemeral (i.e. the rivers only flow when it rains and do not maintain a baseflow). The only Ecosystem Services associated with these rivers are linked to tourism. As the water resource is protected, and the water resource potential is extremely low, the WRUI is a zero. The recommended scenario will have no impacts on these rivers. These RUs are therefore all of low priority and only the REC are provided as the broadest of habitat RQOs.

The habitat RQOs are provided in Table 13.6 as the REC. The broad implications are that no use should be allowed and that the REC must be maintained.

Table 13.6 B82J-00153 and B82J-00159: Habitat RQOs provided as the REC

RU (SQ)	River	Level of Impacts	PES	REC
B82J-00153	Nalatsi	None	A	A
B82J-00159	Byashishi	None	A	A

13.5 RQOs FOR B82J-00197 (LOW PRIORITY - 1)

The RU is of Low priority (Level 1) as it has B PES, moderate ecological importance, moderate SCI and low water resource use importance. The detail of available information also plays a role and there is no EWR site situated in the vicinity. This RU is in a B PES for the EcoStatus and as it is in a good state, the REC is set to maintain the PES. The recommended scenario does not impact on this RU, therefore the RQOs is set to maintain the REC of a B.

13.5.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full EWR rule is provided in Appendix A.

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	EWR
B	0.66	0.64	0.024	3.6	0.091	13.7	River ephemeral - only flood requirements

13.5.2 Habitat and Biota RQOs (EcoSpecs)

River	Level of impact	PES	REC
Ka-Malilibone	**SMALL:** *Algal growth, Crossings low water, erosion, exotic vegetation, inundation, small dams (farm), grazing/trampling, vegetation removal.* **MODERATE:** *Abstraction (run-of river)/increased flows, agricultural lands, natural areas/nature reserves, sedimentation.*	B	B

13.6 GROUNDWATER RQOs

Groundwater RQOs cover Part of IUA 9 and IUA 10: NSAMA and Klein Letaba downstream to confluence with Letaba - B82H, B82J.

Narrative:
Groundwater use and resources: *Only minor subsistence use exists in this catchment. The stress index (Use/ aquifer recharge) is very low and scope exists for increasing groundwater use.*

	B82H	B82J	Total
Irrigation (Mm^3/a)	0.16	0	0.16
Water Supply (Mm^3/a)	0	0	0
Total use (Mm^3/a)	0.16	0	0.16
Stress index	0.02	0	0.02
Harvest potential (Mm^3/a)	8.47	6.42	14.89
Exploitation potential (Mm^3/a)	5.93	4.49	10.42
Recharge (Mm^3/a)	8.55	9.27	17.82
Aquifer recharge (Mm^3/a)	8.52	9.27	17.79
Allocatable groundwater (Mm^3/a)	8.36	9.27	17.63

	B82H	B82J	Total
Status	A – Unmodified	A – Unmodified	

Borehole yields: *Borehole yields are high with 41-53% of boreholes having yields above 2 l/s, and 25% above 3.3 l/s. The median yield is over 1.5 l/s, hence there is potential for further developing groundwater supply.*

	B82H	B82J
N	73	23
Lower Quartile (l/s)	0.74	0.7
MEDIAN (l/s)	1.5	2.3
Upper Quartile (l/s)	3.3	3.3
Geometric Mean (l/s)	1.4	1.64
Yield >2 l/s (%)	41.1	52.17

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 2, or Marginal water quality. Significant occurrences of elevated nitrates also exist in B82H.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B82H	3	17	30	1		51	98	15	7	13	16	8	59	59
B82J		2	22			24	100	22	4	4	3	4	37	81

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has a minor impact on baseflow in this IUA. This IUA provides very minor baseflow to the Letaba, of which 40% originates from the regional aquifer, the remainder originating as interflow. Consequently, although abstraction impacts on baseflow, the impact on the Letaba system is minor. Recharge is lost primarily by evapotranspiration and groundwater baseflow reduction by abstraction is minor.*

	B82H	B82J	Total
MAR (Mm^3/a)	11.71	14.36	26.07
Total Use (Mm^3/a)	0.16	0	0.16
Stress index	0.02	0	0.02
Recharge (Mm^3/a)	8.55	9.27	17.82
Aquifer recharge (Mm^3/a)	8.52	9.27	17.79
Interflow (Mm^3/a)	0.03	0	0.03
Baseflow (Mm^3/a)	0.04	0.01	0.05
Groundwater water baseflow (Mm^3/a)	0.01	0.01	0.02
Present baseflow (Mm^3/a)	0.04	0.01	0.05
Present MAR reduction (Mm^3/a)	0	0	0
Increased abstraction (Mm^3/a)	8.31	6.42	14.73
Baseflow due to increased abstraction (Mm^3/a)	0	0	0

	B82H	B82J	Total
% contribution to total baseflow of the Letaba	0.02		

Numerical: *The Groundwater RQOs are provided in Table 13.7.*

Table 13.7 Part of IUA 9 and IAU 10 – B82H, B82J: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater is underutilised and can be utilised up to the Harvest Potential with little to no impact on baseflow.	*Groundwater abstraction can be increased from 0.16 Mm^3/a to 14.89 Mm^3/a, with a 0.05 Mm^3/a reduction in baseflow.*

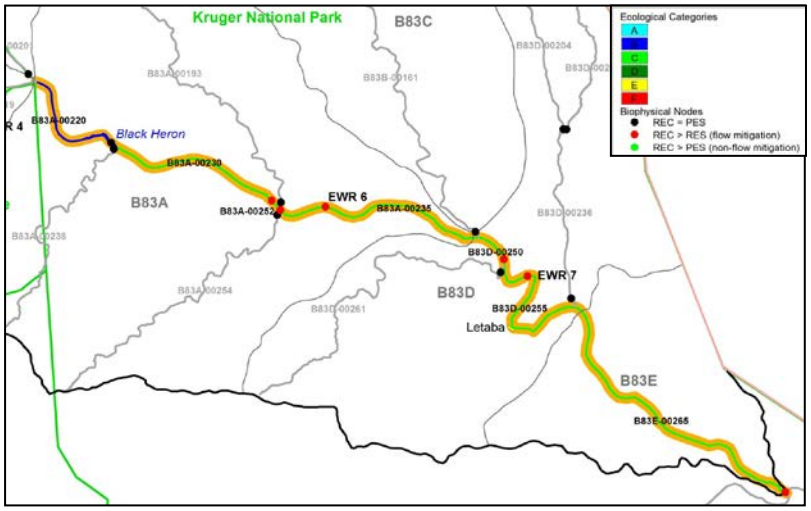
14 IUA 11: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The IUA overview and description is provided below. This section of river is also a main river IUA because the operation of the Letaba River is distinctly different to the ephemeral tributaries in the KNP. The management of upstream storage structures (Tzaneen, Middel Letaba and proposed Nwamitwa dams) will influence the flow in this IUA and required extensive scenario analyses to find a balance between use and protection.

IUA 11 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 11: LETABA MAIN STEM IN THE KNP



PRIORITY RATINGS

SQ	River	Priority rating
B83A-00220	*Letaba*	*3a*
B83A-00230	*Letaba*	*3a*
B83A-0235	*Letaba*	*3a*
B83A-00252	*Letaba*	*3a*
B83D-00255 (EWR 7)	*Letaba*	*3b*
B83E-00265	*Letaba*	*3a*

Water resource use

The entire portion is located within the KNP and comprises the main Letaba River only. The Letaba River main stem in the IUA is regulated by upstream dams in the catchment. There are no major dams and there is also no surface water developments planned in the IUA. The groundwater response unit falls within the Lowveld plain and Lebombo response unit within the KNP. Use is negligible.

Water quality

Few impacts are found in this reach although the water quality state is still Fair to Good due to upstream impacts.

Economy

The main economic activity is eco-tourism that forms part of the tertiary sector.

EGSA

The entire portion is located within the KNP. For these portions recreational and aesthetic aspects of ecological goods and services utilisation is of importance but direct consumptive use is low.

River and wetland ecology

This ecological zone comprises the lower Letaba from the Klein Letaba confluence to the Mozambique border. Although the main stem runs through a national park, lower flows due to abstraction and dams upstream, renders the 6 SQs mostly in a C PES. B83D-00255 has a B PES (well conserved within KNP).

One SQ has been outlined for notable wetlands: B83D-00255 (Letaba River) Floodplain wetlands.

14.1 RQOS FOR RU EWR 7 (B83D-00255; B83A-00220; B83A-00230; B83A-0235; B83A-00252; B83E-00265) (HIGH PRIORITY – 3)

All the SQs in this IUA are combined in the RU EWR 7 which is represented by EWR 7. This IUA therefore forms one RU. The priority rating is High due to its high ecological importance, SCI and WRUI. EWR 7 is situated in the KNP, and due to its position at the end of the system, forms an important role in the operational management of the system and is the end monitoring point for the KNP to ensure that EWRs are met.

EWR 7 is situated in B83D-00255 near Letaba Camp. The RU is managed (by implementing the recommended scenario) to cater for the EWR and other users. This flow RQO is provided as monthly flow durations. Flow RQOs at other biophysical nodes in this RU are provided in Appendix A. It must be noted that these flows are a result of the recommended scenario's operating rules and if those change whilst still meeting the RQOs at EWR 1, these secondary flow RQOs will be different. Deviations from the flow durations can be allowed but the ranges should be determined as part of the implementation and operating rules for the scenario. Information derived from flow monitoring carried out over rolling five year periods can be used. The release operation for the river reach should be incorporated in the existing Letaba Real Time Reserve Model.

14.1.1 Flow RQOs

Source: *DWA (2013c).*
Model: *RDRM (Hughes et al., 2013).*

A summary of the flow RQOs are provided below and the full flow duration table is provided in Appendix A.

nMAR (MCM)	Total flows (MCM)	Total (%nMAR)	Oct		Apr	
			90%	60%	90%	60%
646	318.74	49.34	0.523	0.554	0.696	1.549

The operating rule for the recommended scenario includes the following EWR flood allocation.

Flood Class (m^3/s)	No of events	Months	Daily average	Duration
CLASS I (5 - 8 m^3/s)	1	Jan	6	3
CLASS II (10 - 30 m^3/s)	1	Jan	15	4
Class III (80 - 160 m^3/s)	2	Feb	120	6
CLASS IV (300 - 550 m^3/s)	1	Feb		8

14.1.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Letaba Reserve study (DWAF, 2006b)*
Model: *TEACHA and PAI models (DWAF, 2008).*
Users: *Protected land or conservation area, i.e. the KNP.*
Water quality issue: *Nutrient and salt elevations and parameters such as increased turbidity linked to land use (i.e. irrigation and settlements) outside of the KNP.*
Narrative and Numerical: *Details provided in Table 14.1. Data used for water quality assessments should be collected from B8H028Q01. Analysis of data and possible monitoring action should be based on biotic cues. EcoSpecs and TPCs for a B Category are provided in Table 14.2.*

Table 14.1 B83D-00255: Narrative and numerical water quality RQOs

Water quality narrative RQO	Water quality numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than or equal to 0.025 mg/L PO4-P (aquatic ecosystems: driver).*
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	*95th percentile of the data must be less than or equal to 55 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity or clarity levels stay within Ideal limits.	*A small change from natural state (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics. Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 14.2 Water quality EcoSpecs and TPCs

River: Letaba		**PES: B EC**
Monitoring site: B8H028Q01		**Recommended scenario: B EC**
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 23 mg/L.*	*The 95th percentile of the data must be between 18.5 - 23 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be between 16 – 20 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 30 mg/L.*	*The 95th percentile of the data must be between 24 – 30 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 57 mg/L.*	*The 95th percentile of the data must be between 46 – 57 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 191 mg/L.*	*The 95th percentile of the data must be between 153 – 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be between 281 – 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be between 44 – 55 mS/m.*
pH	*The 5th percentile of the data must be between 6.5 to 8.0, and the 95th percentile between 8.0 to 8.8.*	*5th percentile of the data must not be less than 6.7.* *95th percentile of the data must not be greater than 8.6.*
Temperature	*Moderate and infrequent deviation from the natural temperature range. Vary by*	*Unnatural deviation from the natural temperature range. Initiate baseline*

	no more than 2°C.	*monitoring.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*5th percentile of the data must be 7.2 – 7.0 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Small deviation from natural conditions.*	*Small deviation from the natural conditions. Initiate baseline monitoring.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 0.25 mg/L.*	*The 50th percentile of the data must be between 0.2 – 0.25 mg/L*
PO_4-P	*The 50th percentile of the data must be ≤ 0.025 mg/L.*	*The 50th percentile of the data must be between 0.02 – 0.025 mg/L*
Response variables		
Chl-a phytoplankton [(b)]	*The 50th percentile of the data must be ≤ 15 mg/m^2.*	*The 50th percentile of the data must be between 12 – 15 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 21 mg/m^2.*	*The 50th percentile of the data must be between 17 – 21 mg/m^2.*
Toxics		
Toxics listed in DWA (2008)	*The 95th percentile of the data must be within the A category boundaries.*	*The 95th percentile of the data must be within the A category boundaries.*
Other	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996a).*

(a) To be generated using TEACHA when the TPC for EC is exceeded or salt pollution expected.
(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

14.1.3 Biota and habitat RQOs (EcoSpecs)

14.1.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES of EWR 7, based on fish, is moderately modified, falling in a category C and should ideally not be allowed to deteriorate any further. The recommended flow scenario for this reach is expected to result in a notable deterioration in the PES that will cause a decrease of the fish into a lower C/D EC. The current relatively high species richness of 29 indigenous fish species of an estimated 32 naturally occurring species should not be allowed to decrease further. The recommended flow scenario is not expected to change the fish species richness of the reach but a reduced frequency of occurrence (distribution within a reach) is expected for most species (primarily related to alterations of the flood regime). Various fish species intolerant to different stressors or with a high preference for specific habitat features provide valuable indicators of change that should be used to monitor potential change. The primary indicator fish species for this reach is the sawfin suckermouth (CPAR), providing a measure of flow modification (fast flowing habitats), rocky substrate condition and water quality. Another important indicator for this reach is the largescale yellowfish (BMAR), providing indication of changes in flow (especially fast deep habitats) as well as the migratory success of species.*

Numerical: *EcoSpecs and TPCs for a C/D Category are provided in Table 14.3.*

Table 14.3 RU EWR 7: Fish EcoSpecs and TPCs

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
Metric: Ecological status				
PES	*Present ecological status of fish is in a C (64.4%).*	*Decrease of PES into a lower EC than PES.*	*Any deterioration in habitat that results in decrease in FROC[1] of species.*	*A notable deterioration in the ecological conditions are expected under this scenario with the fish decreasing from a C to a C/D. Although base flows will be suitable during wet and dry season, decrease in floods will result in loss of pools (sedimentation) and although riffle/rapid habitats are limited, the quality of these will also be reduced due to lack of flushing. A reduced FROC is expected for most of the fish species and especially those with a preference for flowing conditions.*
Metric: Species richness				
All indigenous species	*29 of the expected 32 indigenous fish species estimated to be present in the reach under PES (to be verified).*	*20% decrease in species richness.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*	
Metric: Requirement for flowing water				
LCON LMOL	*LCON and LMOL have a high requirement for flow during all life stages and are the most applicable indicator species for flow modification.*	*LCON and/or LMOL absent during any survey OR present at FROC[1] of < 3 for LCON and < 4.5 for LMOL.*	*Reduced suitability (abundance and quality) of flowing habitats (i.e. decreased flows, increased zero flows, and altered seasonality).*	
Metric: FD habitats				
LCON CPAR	*LCON and CPAR have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*LCON and/or CPAR absent during any survey OR present at FROC of < 3 for LCON and < 3.5 for CPAR. (DWAF 2006C: A minimum of 10 CPAR specimens should be sampled at 70% of sites during a survey of FS and FD, electrofishing for minimum 20 minutes)*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows).*	
Metric: FS habitats				
CPAR LCYL	*CPAR and LCYL have a high requirement for FD habitats and are the most applicable indicator species for this velocity-depth category.*	*CPAR and/or LCYL absent during any survey OR present at FROC of < 3.5 for CPAR and < 4.5 for LCYL.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows).*	
Metric: Substrate				

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
LCON LROS	*LCON and LROS have a high requirement for FD habitats and are the most applicable indicator species for this habitat feature.*	*LCON and/or LROS absent during any survey OR present at FROC of < 3 for LCON and < 3 for LROS.*	*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates.*	
Metric: Water quality intolerance				
MMAC LMOL	*MMAC and LMOL have a high requirement for unmodified water quality and are the most applicable indicator species for water quality deterioration.*	*MMAC and/or LMOL absent during any survey OR present at FROC of < 3 for MMAC and < 4.5 for LMOL.*	*Decreased water quality (especially flow related water quality variables such as oxygen).*	
Metric: Overhanging vegetation				
PPHI TREN	*PPHI and TREN have a high requirement for overhanging vegetation and are the most applicable indicator species for this habitat feature.*	*PPHI and/or TREN absent during any survey OR present at FROC of < 3 for PPHI and < 5 for TREN.*	*Significant change in overhanging vegetation habitats.*	
Metric: Instream vegetation				
TREN	*TREN and have a high requirement for instream (aquatic) vegetation and are the most applicable indicator species for this habitat feature.*	*TREN and/or absent during any survey OR present at FROC of < 5 for TREN.*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).*	
Metric: Undercut banks				
MMAC PCAT	*MMAC and PCAT have a high preference for undercut banks and rootwads and are the most applicable indicator species for this habitat feature.*	*MMAC and/or PCAT absent during any survey OR present at FROC of < 3 for MMAC and < 3 for PCAT.*	*Significant change in undercut bank and rootwads habitats (e.g. bank erosion, reduced flows).*	
Metric: Water column				
MBRE HVIT	*MBRE and HVIT have a high requirement for water column as habitat and are the most applicable indicator species for this habitat feature.*	*MBRE and/or HVIT absent during any survey OR present at FROC of <4 for MBRE and < 3.5 for HVIT. (DWAF 2006b: A minimum of 3 HVIT specimens should be sampled at 50% of sites during a survey using appropriate methods).*	*Reduction in suitability of water column (i.e. increased sedimentation of pools, reduced flows).*	
Metric: SD habitats				
BANN BUNI	*BANN and BUNI have a high requirement for SD habitats and are the most applicable indicator species for this velocity depth category.*	*BANN and/or BUNI absent during any survey OR present at FROC of < 3.5 for BANN and < 3.5 for BUNI.*	*Significant change in SD habitat suitability (i.e. increased or decreased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: SS habitats				

	PES			Recommended flow scenario (Sc 11)
	SQ Reach			
Indicator	**EcoSpecs/RQOs**	**TPC (Biotic)**	**TPC (Habitat)**	**EcoSpecs/RQOs**
BRAD BVIV	*BRAD and BVIV have a high requirement for SS habitats and are the most applicable indicator species for this velocity depth category.*	*BRAD and/or BVIV absent during any survey OR present at FROC of < 3.5 for BRAD and < 3.5 for BVIV.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats).*	
Metric: Migratory success[2]				
BMAR LMOL, etc.	*It is estimated that the catadromous eels have been lost from this reach but various potamodromous species (including BMAR) is still present.*	*Loss or decreased FROC potamodromous species (such as BMAR). (DWAF, 2006C: A minimum of 20 BMAR specimens should be sampled at 100% of sites during a survey, using appropriate methods).*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	
Metric: Alien fish species				
Presence of any alien/introd. spp.	*No alien/introduced species known or expected to be present in the SQ reach.*	*Presence of any additional alien/introduced species or increase in abundance and distribution of existing species.*	*N/A.*	
CPAR (BMAR)	**CPAR estimated to be present at > 25% of sites in SQ reach (2013) (to be verified).**	**See relevant sections above for detail.**	**See relevant sections above for detail.**	

1, 2: Refer to Table 4.21.

14.1.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The macro-invertebrate community should be representative of a Lowveld river assemblage. The habitats in the river are dominated by alluvial sediments and have marked seasonal differences in flows. The ample alluvial sediment is dominating the habitats in this reach with marginal vegetation establishing on the marginal edges. SIC habitats in this reach are very limited. Although upstream abstraction leads to very low flows and associated poorer water quality parameters, the EcoSpecs are set to retain some diversity and integrity. The recommended scenario will reduce the PES of a C to a C/D EC, which will impact adversely on the integrity of the river reach.*

Numerical: *Indicator taxa are provided in Table 14.4 and Table 14.5 provides EcoSpecs and TPCs for a C/D Category.*

Table 14.4 RU EWR 7: Macro-invertebrate indicator taxa

Indicator Group	Families	Velocity (m/s)	Substratum	Water quality
1	*Hydropsychidae*	*>0.6*	*Cobbles*	*High*
2	*Libellulidae*	*0.3 – 0.6*	*Cobbles*	*Low*
3	*Coenagrionidae*	*0.3 – 0.6*	*Vegetation*	*Low*
4	*Atyidae*	*N/A*	*Vegetation*	*Moderate*
5	*Gomphidae*	*0.3 – 0.6*	*Sand*	*Low*

A summary of macro-invertebrate EcoSpecs and TPCs for EWR 7 is situated in B83D-00255, Letaba River is provided in Table 14.5. This RU consists of a large Lowveld river with moderate flows during the winter where alluvial substrate dominates with some SIC habitat and marginal vegetation habitat important.

Table 14.5 RU EWR 7: Macro-invertebrate EcoSpecs and TPCs

EcoSpecs	TPCs	Recommended scenario: C/D EC
To ensure that the SASS 5 scores and ASPT values occur in the following range: SASS 5 score: >70; ASPT value: >4.0.	*SASS5 scores less than 75 and an ASPT less than 4.5.*	*The lower flows during winter will have an impact on the macro-invertebrate habitat and water quality. This will impact on the species preferring flow velocity (>0.6 m/s) and species requiring high water quality parameters.*
To ensure that the MIRAI score remains within the range of a C Category (62% – 78%).	*A MIRAI score of 65% or less.*	*The EcoSpecs will reduce to accommodate the lower MIRAI score of 60% or less.*
To maintain suitable flow velocity (>0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Hydropsychidae (Abundance A).*	*Hydropsychidae missing in two consecutive surveys or present as a single individual in two consecutive surveys where the SIC habitat is available.*	*Since stones-in-current habitat is restricted in the reach, Hydropsychidae might disappear from the system and the EcoSpec for the 0.3 – 0.6 m/s flow velocity will take its place.*
To maintain suitable flow velocity (0.3 – 0.6 m/s) and to maintain clean, un-embedded surface area (cobbles) to support the following flow-dependent taxa: ▪ *Libellulidae (Abundance A).* ▪ *Coenagrionidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*	*Although these taxa will be stressed even more, it is not expected that they will disappear and this EcoSpec can still be used.*

EcoSpecs	TPCs	Recommended scenario: C/D EC
To maintain sufficient quantity and quality of inundated vegetation to support the following vegetation-dwelling taxa: ▪ *Atyidae (Abundance A).* ▪ *Coenagrionidae (Abundance A).*	*Any one of these two taxa missing in two consecutive surveys or any one of these two taxa present as a single individual in two consecutive surveys.*	*Although this habitat will be stressed even more, it is not expected that the indicator species will disappear and this EcoSpec can still be used.*
To maintain suitable conditions for the following five key taxa: ▪ *Hydropsychidae* ▪ *Libellulidae* ▪ *Coenagrionidae* ▪ *Atyidae* ▪ *Gomphidae*	*Presence of less than three of the five key taxa listed in any survey.*	*Since Hydropsychidae might disappear during this scenario, the EcoSpecs might change as follows:* *To maintain suitable conditions for the following four key taxa:* ▪ *Libellulidae* ▪ *Coenagrionidae* ▪ *Atyidae* ▪ *Gomphidae*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa at B abundance (e.g. Baetidae, Caenidae and Thiaridae). To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.	*Any taxon occurring in an abundance of > 1000 for two consecutive surveys.*	*The EcoSpecs should not change:* *Any taxon occurring in an abundance of > 1000 for two consecutive surveys.*

14.1.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES (as at October 2013) for riparian vegetation was a Category C, comprising the marginal zone in a Category C, the lower zone in category C and the upper zone in a Category B. This is also the EC under the recommended scenario for the site. Vegetation cover (woody and non-woody) shall be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species shall be kept in check so as not to cause the EC to deteriorate. Similarly, species composition within the riparian zone shall reflect specifications in keeping with the EC. The following tree species that are nationally protected occur within the reach, and shall be maintained as viable populations: Balanites maughamii subsp. maughamii, B. salicina, C. imberbe and P. violacea. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2013. As such no additional roads shall be constructed within the riparian zone.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 14.6.*

Table 14.6 EWR 7 Riparian vegetation EcoSpecs and TPC

Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
Metric: Vegetation Cover				
Marginal Zone	*Maintain marginal hydrophyte fringe and Phragmites along the active channel and C. marginatus, Cynodon dactylon and Leersia hexandra patches in places.*	*Maintain marginal hydrophyte fringe and Phragmites along the active channel and C. marginatus, C. dactylon and L. hexandra patches in places.*	*Marginal fringe largely absent; Phragmites fringe visibly (fixed photo) decreasing/increasing in abundance/cover; C. marginatus, L. hexandra or C. dactylon absent.*	*Adapted from DWAF (2006C), fringe cover (either reeds, sedge or grassed overhang) is important habitat for instream and riparian fauna, and requires low flows for survival.*
Lower Zone	*Presence of some obligate riparian tree species*	*Presence of some obligate riparian tree species*	*Absence of obligate riparian trees OR failure to recover after large*	*Adapted from DWAF (2006c).*

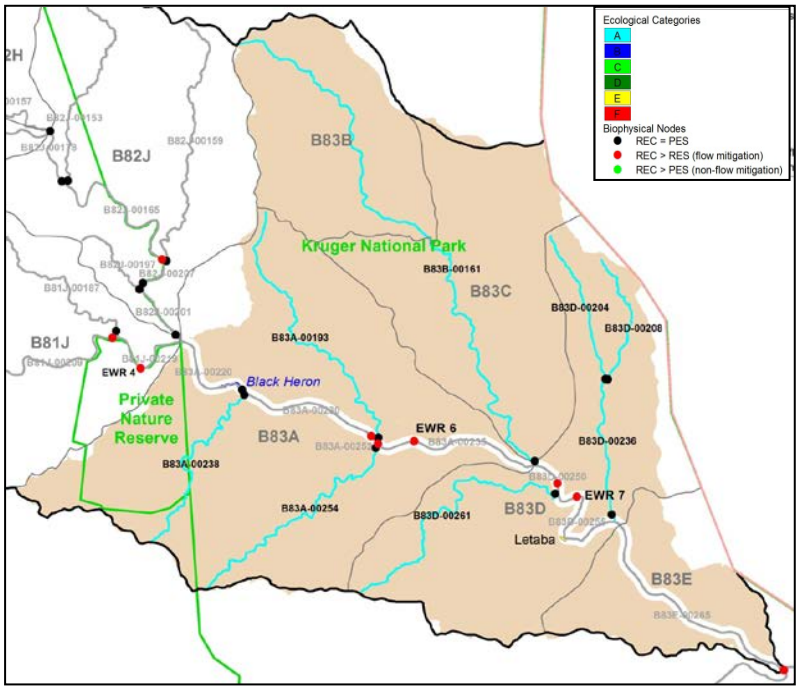
Zone assessed	EcoSpecs (PES)	EcoSpecs (Sc 11)	TPC (for PES)	Note
			floods	
Upper Zone	*Maintain B. maughamii subsp. maughamii, B. salicina, C. imberbe, P. violacea, and Combretum microphyllum populations.*	*Maintain B. maughamii subsp. maughamii, B. salicina, C. imberbe, P. violacea, and C. microphyllum populations.*	*Visible decrease or absence of B. maughamii subsp. maughamii, B. salicina, C. imberbe, P. violacea, and C. microphyllum cover/abundance; mortality of C. imberbe adults.*	*Adapted from DWAF (2006b).*
Metric: Alien Invasion				
Riparian zone	*Perennial alien plant species aerial cover less than 10%.*	*Perennial alien plant species aerial cover less than 10%.*	*Increases in alien perennial species cover above 10%.*	*See hypothesis for Lowveld rivers (alien invasion), but altered due to occurrence within a National Park (electronic information).*
Metric: Indigenous Riparian Woody Cover				
Marginal Zone	*Riparian woody species cover not absent and not more than 80% (goal for marginal zone in Category C).*	*Riparian woody species cover not less than 5% and not more than 70% (goal for marginal zone in Category B/C).*	*An increase in riparian woody cover above 80% OR an absence of woody riparian species.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Lower Zone	*Riparian woody species cover not less than 5% and not more than 70%.*	*Riparian woody species cover not less than 5% and not more than 70%.*	*An increase in riparian woody cover above 70% OR a decrease below 5%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Riparian woody species cover not less than 30% and not more than 60%.*	*Riparian woody species cover not less than 20% and not more than 80%.*	*An increase in riparian woody cover above 60% OR a decrease below 30%.*	*See hypothesis for Lowveld rivers (woody vegetation) (electronic information).*
Metric: *Phragmites* (reed) cover				
Marginal Zone	*Reed cover not less than 10%.*	*Reed cover not less than 20%.*	*A decrease in reed cover below 10%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Lower Zone	*Reed cover between 10% and 90%.*	*Reed cover between 10% and 90%.*	*A decrease in reed cover below 10% OR and increase above 90%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Upper Zone	*Reeds cover less than 40%.*	*Reeds cover less than 50%.*	*An increase in reed cover above 40%.*	*See hypothesis for Lowveld rivers (reeds) (electronic information).*
Metric: Riparian zone integrity				
Riparian zone	*Zero expansion of agriculture or forestry within the riparian zone.*	*Zero expansion of agriculture or forestry within the riparian zone.*	*An increase of the spatial extent of forestry or agriculture WITHIN the riparian zone.*	*Desktop assessment of area of interest; riparian delineation required; status quo should be calculated (% of riparian zone that is not forestry or agriculture) and used as base against which to assess change.*
Metric: Longitudinal riparian zone continuity				
Riparian zone	*Zero increase in riparian zone longitudinal fragmentation.*	*Zero increase in riparian zone longitudinal fragmentation.*	*An increase in the longitudinal fragmentation of the riparian zone.*	*Use satellite imagery to calculate % of riparian longitudinal axis that has woody cover and use as base against which to assess change.*

15 IUA 12: RESOURCE QUALITY OBJECTIVES

The IUA overview and description is provided below.

The IUA overview and description is provided below. IUA 12 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA 12: LETABA TRIBUTARIES IN THE KNP



PRIORITY RATINGS

SQ	River	Priority rating
B83A-00193	*Shipikani*	*1b*
B83A-00238	*Nharhweni*	*1a*
B83A-00254	*Ngwenyeni*	*1b*
B83B-00161	*Tsende*	*1b*
B83D-00204	*Manyeleti*	*1b*
B83D-00208	*Makhadzi*	*1b*
B83D-00261	*Nwanedzi*	*1b*
B83D-00236	*Makhadzi*	*1b*

Water resource use

IUA 12 consists of all the tributaries of the Letaba downstream from the Klein Letaba confluences within the KNP. The storage regulation is low in the IUA with no major dams present in the area. There are also no major surface or groundwater developments planned in the IUA.

Water quality

As all these rivers are in the KNP, water quality will be Good.

Economy

The main economic activity is eco-tourism that forms part of the tertiary sector.

EGSA

The entire portion is located within the Kruger National Park or private game reserves. For these portions recreational and aesthetic aspects of ecological goods and services utilisation is of importance but direct consumptive use is low.

River and wetland ecology

The 8 SQs of the tributaries to the Letaba all originate in the KNP and are largely natural, displaying ECs of mostly A and one B. The Tsende River is dominated by channelled valley-bottom wetlands and has an A/B PES (well conserved within KNP).

15.1 RU PRIORITY

All these RUs fall into the KNP in its totality, i.e. the sources of the rivers are situated in the KNP. They are therefore largely protected and in a very good PES. These rivers are all non-perennial,

mostly ephemeral (i.e. the rivers only flow when it rains and do not maintain a baseflow). The only Ecosystem Services associated with these rivers are linked to tourism. As the water resource is protected, and the water resource potential is extremely low, the WRUI is a zero. The recommended scenario will have no impacts on these rivers. These RUs are therefore all of low priority and only the REC are provided as the broadest of habitat RQOs.

15.2 HABITAT RQOs

The habitat RQOs are provided in Table 15.1 as the REC. The broad implications are that no use should be allowed and that the REC must be maintained in this IUA.

Table 15.1 Habitat RQOs provided as the REC

RU (SQ)	River	Level of Impacts	PES	REC
B83A-00193	*Shipikani*	**SMALL:** *Crossings low water, inundation, roads, small dams (farm), vegetation removal.*	**A**	**A**
B83A-00238	*Nharhweni*	**SMALL:** *Inundation, roads, small dams (farm), vegetation removal.* **MODERATE:** *Recreation.*	**A**	**A**
B83A-00254	*Ngwenyeni*	**SMALL:** *Crossings low water, roads, vegetation removal.*	**A**	**A**
B83B-00161	*Tsende*	**SMALL:** *Inundation, large dams, roads, grazing/trampling, vegetation removal.*	**B**	**B**
B83D-00204	*Manyeleti*	**SMALL:** *Inundation, Small dams (farm), vegetation removal.*	**A**	**A**
B83D-00208	*Makhadzi*	**SMALL:** *Crossings low water, roads, grazing/trampling, vegetation removal.*	**A**	**A**
B83D-00261	*Nwanedzi*	**SMALL:** *Crossings low water, erosion, roads, grazing/trampling, vegetation removal.*	**A**	**A**
B83D-00236	*Makhadzi*	**SMALL:** *Crossings low water, inundation, roads, vegetation removal.*	**A**	**A**

15.3 GROUNDWATER RQOs

Groundwater RQOs cover IUA 12: Letaba in the KNP - B83A, B83B, B83C, B83D and B83E.

Narrative:

Groundwater use and resources: *Land-use is protected land or conservation area, i.e. the Kruger National Park hence no groundwater development takes place.*

	B83A	B83B	B83C	B83D	B83E	Total
Irrigation (Mm^3/a)	*0*	*0*	*0*	*0*	*0*	*0*
Water Supply (Mm^3/a)	*0*	*0*	*0*	*0*	*0*	*0*
Total use (Mm^3/a)	*0*	*0*	*0*	*0*	*0*	*0*
Stress index	*0*	*0*	*0*	*0*	*0*	*0*
Harvest potential (Mm^3/a)	*12.08*	*3.51*	*4.74*	*6.64*	*2.48*	*29.44*
Exploitation potential (Mm^3/a)	*8.46*	*2.46*	*3.32*	*4.65*	*1.49*	*20.36*
Recharge (Mm^3/a)	*11.77*	*5.71*	*7.7*	*7.88*	*3.11*	*36.15*
Aquifer recharge (Mm^3/a)	*11.77*	*5.71*	*7.7*	*7.88*	*3.11*	*36.15*
Allocatable groundwater (Mm^3/a)	*11.77*	*5.71*	*7.7*	*7.88*	*3.11*	*36.15*
Status	*A – Unmodified*	*A – Unmodified*	*A – Unmodified*	*A – Unmodified*	*A – Unmodified*	

Borehole yields: *Borehole yields are high with over 40% of boreholes having yields above 2 l/s, and 25% above 3 l/s. The median yield is over 1.5 l/s.*

	B83A	B83B	B83C	B83D	B83E
N	30	32	23	34	4
Lower Quartile (l/s)	1.0025	0.7	1.11	0.77	0.395
MEDIAN (l/s)	1.8	1.54	2.06	1.22	1.17
Upper Quartile (l/s)	3.8	3.64	4.75	2.62	1.92
Geometric Mean (l/s)	1.45	1.48	2.03	1.26	0.77
Yield >2 l/s (%)	43.33	43.75	56.52	41.18	25

Number of boreholes:

>75%

50 - 75%

25 - 50%

<25%, geometric mean less than 1 l/s

Groundwater quality: *Ground water is generally of DWA Class 0, or Ideal water quality. Since no vegetation removal has occurred and no contaminant sources exist, nitrate levels are also of Class 0.*

Catchment	TDS - Class						Potable	Nitrates - Class						Potable
	0	1	2	3	4	N	%	0	1	2	3	4	N	%
B83A		2	19	1		22	95	24					24	100
B83B		9	9	1		19	95	34					34	100
B83C		7	5			12	100	12					12	100
B83D	1	1	12			14	100	16	1				17	100
B83A		2	19	1		22	95	24					24	100

>80%

60 - 80%

<60%,

Groundwater contribution to baseflow: *Groundwater abstraction has a minor impact on baseflow in this IUA. This IUA provides very minor baseflow to the Letaba, of which 100% originates from the regional aquifer during exceptionally wet periods. Consequently, although abstraction impacts on baseflow, the impact on the Letaba system is minor. Recharge is lost primarily by evapotranspiration and groundwater baseflow reduction by abstraction is minor.*

	B83A	B83B	B83C	B83D	B83E	Total
MAR (Mm^3/a)	19.63	7.42	10	10.31	4.73	52.09
Total Use (Mm^3/a)	0	0	0	0	0	0
Stress index	0	0	0	0	0	0
Recharge (Mm^3/a)	11.77	5.71	7.7	7.88	3.11	36.15
Aquifer recharge (Mm^3/a)	11.77	5.71	7.7	7.88	3.11	36.15
Interflow (Mm^3/a)	0	0	0	0	0	0
Baseflow (Mm^3/a)	0.01	0	0.01	0	0	0.02
Groundwater water baseflow (Mm^3/a)	0.01	0	0.01	0	0	0.02
Present baseflow (Mm^3/a)	0.01	0	0.01	0	0	0.02
Present MAR reduction (Mm^3/a)	0	0	0	0	0	0
Increased abstraction (Mm^3/a)	12.08	3.51	4.74	6.64	2.48	29.44
Baseflow due to increased abstraction (Mm^3/a)	0	0	0	0	0	0
% contribution to total baseflow of the Letaba	0.01					

Numerical: *The Groundwater RQOs are provided in Table 15.2.*

Table 15.2 IUA 12 – B83A, B83B, B83C, B83D, B83E: Groundwater RQOs

Groundwater narrative RQO	Groundwater numerical RQO
Groundwater is underutilised and can be utilised up to the Harvest Potential with little to no impact on baseflow.	*Groundwater abstraction can be increased to 29.44 Mm^3/a, with a 0.02 Mm^3/a reduction in baseflow.*

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17 APPENDIX A: REPORT COMMENTS

Page &/ or section	Comments	Changes made?	Author comment
KNP comments, 15 May 2014			
Point iv, pg 2	*Despite the recommended operational Scenario no.10 to maintain even a PES lower C, this still requires a very well co-ordinated management system, in order to time the various high and low flow releases for the EWR. As pointed out at the PSC3, the timing of high flow releases especially will be key to the viability of the PES. This is in terms of timing for important fish migrations. The timing of migratory periods for spawning of different fish and aquatic species (the catadromous eels of the Anguilla family, the catadromous macro crustaceans of the genus Macrobrachium and various potamodromous species, most importantly from the genera Hydrocynus, Labeobarbus, Barbus and Labeo) should be considered in relation to the natural hydrological cycle of the Letaba River. This aspect is of particular importance as the Letaba River flows vary considerably between the wet and dry seasons. The suggested three high flow releases from the large Tzaneen and Nwamitwa Dams should be made when the different biota in the river normally undertake their upstream migrations. Many species take their cue or embark on their migration from freshets during the first rains in spring (Sep - Oct) through to high-flows in summer (Dec - Mar), these coincide with an increase in temperature and in particular with an increase in flow. Additionally, certain fish species are fractional spawners with two spawning events per annum (Fouche, 2009). Tributaries are important breeding sites therefore releases should coincide with high-flows in tributaries. The persistence of flows is equally important as the life cycle stages of various fish species require a minimum flow-depth and velocity. Thus, if these cues for upstream spawning migrations are delayed as a result of ineffective or mistimed high flow releases, spawning of many fish and aquatic biota success could be compromised (see Bok et al., 2007). This will result in an increased threat to endangered and vulnerable species and as well threaten many local community livelihoods who depend on fish as a protein source for their survival. Thus:*	*No- clarification provided*	*The hydrological modelling was carried out with low and high flow requirements specified in the form of flow frequency distributions at the respective EWR sites – one distribution for each month of the year. The trigger (independent variable) to select what flow to release in a particular month is derived from the equivalent natural flow frequency distribution of the particular month.* *The specified flows for Scenario 10 are therefore variable and the flow pattern 'mimic' the natural pattern.* *One of the recommendations from the study is the need to incorporate the flow requirements of Scenario 10 into the Ecological Release Operating Model of the Letaba River System. This model was developed for the DWA to assist with the release operation in the river system and was applied in the past. The model and application procedures are described in the report "Development And Pilot Implementation of a Framework to Operationalise The Reserve: Main Report (July 2009)" as well as supporting documentation.* *It is however acknowledged that the model focusses on the implementation of base (low) flows and not floods. Operating rules will have to be set to comply with the requirements which SANPARKS have so clearly set out. This will be done as part of the overall operating rules that will be designed once the dam is built and has to be done in an integrated fashion with other*

Page &/ or section	Comments	Changes made?	Author comment
	a. It was not clear how these releases will be timed and calculated. For example, should the system require a spring high release at the beginning of the hydrological year (Oct - Sept) how and when does a dam manager make this decision should the dam be at less than 100% capacity and long-term climate forecasts uncertain? b. This also requires clear operational guidelines to follow and formalised feedback system between downstream stakeholders and the dam bailiff (see 1.iii).		users.
Point vii,pg 3	In terms of monitoring the RQOs, the system of using the 95th %-ile is a robust one for reflection over the medium to long term (e.g. >12 months or >12 data points). However we doubt whether this system allows for real time and short-term monitoring in order to effect a management response in the river system e.g. to a spike in nutrient load or pollutants (and thereto flush the system perhaps with a release from a dam). It is recommended that whilst this percentile system should still form the basis for the Management Class, a rapid response system should be factored in also i.e. using thresholds as is the case in other river systems (See our comments in Annexure A).	No – clarification provided	Note that the intention is to build on the existing database of water quality information so that a summary statistic (e.g. the 95th %ile) can be calculated and assessed at any time. It is therefore important to note the monitoring point used for the assessment, e.g. for EWR 7 use data from DWA gauging weir B8H028Q01. Short-term impacts of pollutant slugs will need to be identified through biological monitoring.
Point viii, pg 4	A general query related to the groundwater RQOs is whether the role of groundwater contributions to base flow has a hydrochemical role to play in the river system downstream of the Tzaneen and Nwamitwa Dams. Perhaps in terms of increasing the assimilative capacity of the river system. In which case, since these dams will effectively store a significant proportion of groundwater that would otherwise have returned to the river system, would 'hydrochemical' releases be factored into the operations of said dams (and thereby impacting on the yield of the system)?. We hope that the WQSAM integrated water quality modelling study commencing on the Crocodile River will shed some light on such factors, in due course, and should perhaps be considered in the Letaba also.	No – clarification provided	The WQSAM model will be tested for evaluating water quality consequences of scenarios in the Crocodile catchment. The Groundwater has a relatively low Total Dissolved Solids, with the possible exception of irrigation return flows. Groundwater is generally lower in Dissolved Oxygen than surface water so does not greatly enhance assimilative capacity for nutrients and biological contaminants, which require oxygen to be attenuated.
Appendix A; Nutrients	EWR 4 and 7: RQOs TIN and PO_4, Would prefer NO_3, NH_4, and PO_4- consistent with Olifants, i.e. the RQOs should be as follows: NO_3: C category: ≤ 0.25 mg/L N NH_4: C category: ≤ 15 ug/L PO_4: C category: ≤ 0.02 mg/L P	No – clarification provided	RQOs were not assessed in terms of the Olifants study, but specifically for the Letaba. Note that limits are specific to the catchment and reach being evaluated, and should not be extrapolated without justification. Limits are also provided according to the

Page &/ or section	Comments	Changes made?	Author comment
			required methods (DWA, 2008), which specify TIN-N. The calculation to achieve TIN-N is specified. Note that DWA (2008) does not specify a C category for NH_4-N. *Note that TIN-N = NO_3-N + NO_2-N + NH_4-N if available), as measured by DWA.* *<u>For EWR 4 and EWR 7:</u> The EcoSpec for TIN-N is ≤0.25 mg/L, and for PO_4-P is ≤0.025 mg/L, which is consistent with KNP requirements.*
Appendix A; Salts	*EWR 4 and 7: Currently broken up into different SO_4 salts. Consider combining.* *EC should change from a D to C category*	*No – clarification provided*	*For the Ecological Reserve, DWAF (2008) present state ratings are provided for Electrical Conductivity and aggregated salts and not for SO_4.* *<u>For EWR 4 and EWR 7:</u> The EcoSpec for Electrical Conductivity is as follows: The 95th percentile of the data must be ≤ 55 mS/m, which is a B category (DWAF, 2008), and not a D category.*
Appendix A; System Variables	*EWR 4 and 7: pH must not fall below 6.5.*	*Yes, for EWR 4*	*EWR 4: Changed.* *EWR 7: Already specified the 5th percentile must be between 6.5 and 8.0.* *Note the categories specified by the KNP for pH, temperature and DO are incorrect. See DWAF (2008) for categories.*
Appendix A; Toxics	*Agree with set limits. Should not exceed the CEV as stated by DWAF (1996).* *Are there labs that can test the low levels specified?*	*No*	*The CEV was provided rather than the TWQR, specifically due to the low levels specified in DWAF (1996). It is agreed that analytical laboratories in SA generally cannot measure such low levels. Water quality guidelines need to be revised and take SA's analytical capabilities into consideration.* *Note the following comments on KNP specified limits:*

Page &/ or section	Comments	Changes made?	Author comment
			Fluoride: Specified = ≤0.75 mg/L, i.e. TWQR and not the CEV. CEV and A cat boundary = 1.5 mg/L *Arsenic: CEV = 20 µg/L* *Manganese: CEV = 0.37 mg/L* *Selenium: Specified = ≤ 2 µg/L, i.e. TWQR and not the CEV. CEV = 5 µg/L* *Zinc: Specified = ≤ 2 µg/L, i.e. TWQR and not the CEV. CEV = 3.6 µg/L* *Atrazine: Specified = ≤ 10 µg/L, i.e. TWQR and not the CEV. CEV = 19 µg/L* *NB: Add NH_3-N to toxics list. EWR 4 and 7; limits for a B category river is 0.044 mg/L (DWAF, 2008).*
Appendix A; Pathogens	*EWR 4 and 7: Currently no limits set.* *E.coli: C category: < 1/100 ml.* *Total coliform count: C category: < 10/100 ml.* *Please check DWA ranges as total coliforms <E.coli.*	*No – have used recreational (full contact) guidelines (see Author Comment).* *Yes – have added E.coli targets for full-contact recreational use for relevant sites (not to EWR sites – see Author Comment).*	*Ecological Specifications are not provided for pathogens as pathogens are considered for human health and not for aquatic ecosystems.* *Pathogens are specified in the RQOs as faecal coliform targets for recreational (full contact) use only, as domestic use from the river before primary treatment was not considered (see approach in the RQO document for the study).* *Microbial compliance targets for WWTW were also not specified as numerical RQOs, as these would be specified in the water use license for the discharge.*
Appendix A; Response Variables	*EWR 4 and 7: Not the same values as in the recon strategy – are these values considered mesotrophic?*	*Clarification provided.*	*RQOs will override values provided in the recon strategy.* *EWR 4: Phytoplankton and periphyton values are specified for a B category river.* *EWR 7: Phytoplankton and periphyton values are specified for a B/C category river.*
Comments from W Du Toit DWA WRIM			
Groundwater RQOs	*It is not certain where the Exploitation and Recharge values used in the report come from as it could not be traced back to the GRA II data. The same applies to the interflow, baseflow and*	*An explanation of how the figures were derived was*	*The recharge values were not taken from GRAII as these are not reconciled with observed baseflows under present state conditions. Data*

Page &/ or section	Comments	Changes made?	Author comment
	groundwater baseflow. I was under the impression that groundwater baseflow and recharge values used in reserve calculations are the GRA II values.	*added to the final report in Section 3.3.*	*on surface and groundwater use obtained from the verification and validated climatic data, together with hydrological parameters were entered into the WRSM2000 model to quantify surface and groundwater resources and interactions, such as recharge and baseflow and evapotranspiration from shallow groundwater. The model was run from 1920 - 2010 and calibrated against DWA flow gauging data, dam volumes, and compared to recharge data such as in GRA II. Where GRAII figures on recharge cannot generate baseflow to match observed data, the calibrated data was used to ensure surface and groundwater data match. For groundwater, calibration included calibrating recharge, aquifer recharge and interflow to fit observed low flows, and flow depletion due to abstraction.* *The abstraction and afforestation was removed and WRSM2000 was run under virgin conditions. Data was extracted from the model to determine the ground balance in terms of recharge, aquifer recharge, interflow, groundwater baseflow and evapotranspiration, both under virgin conditions and with groundwater abstraction at present day levels.*
	Limpopo has with assistance of University of North West (Reinier Dennis) calculated the recharge and Aquifer Firm Yield (AFY) using the chloride method on the GRIP data. We have also through GRIP estimated the total groundwater use per quaternary which includes all schedule 1, registered and unregistered use. The idea was to improve on the GRA II and WARMS values respectively. I have in the attached RQOinfopack report inserted rows in all of the tables and provided the Total use, AFY (provided under "Exploitation Potential") and Aquifer recharge as we obtained it from the above mentioned actions. The idea is to highlight the differences in the values that we have and what is provided in the report. <u>Comments below are based on these differences</u>.	*No*	*The aquifer firm yield data provided does not reconcile with the calibrated hydrology and would result in an inability to calibrate baseflow with gauging weir time series and dam storage volumes.* *The Reconciliation strategy for the Letaba Luvuvhu utilised groundwater use data obtained from a high resolution validation and verification study. This is the data that was utilised, as it corresponds to the data being utilised in the reconciliation strategy. The final numbers in splitting water supply use between surface and groundwater sources are still being finalised and can only be added to the RQOs at a later stage.*

Page &/ or section	Comments	Changes made?	Author comment
	No explanation is provided in the report highlighting the difference between Recharge and Aquifer recharge and the difference between baseflow and present baseflow. Interflow is the difference between these two and Groundwater baseflow the difference between baseflow and interflow and lastly the present MAR reduction the difference between baseflow and present baseflow. To obtain a clear understanding of the above and the conclusions drawn from this and to provide informed comments will require explanation where and how the values provided was obtained. <u>It is extremely important that consensus is reached on the values provided before any of the Groundwater narrative RQOs and Groundwater numerical RQO will be accepted by Limpopo.</u>		*Aquifer recharge is only the volume of recharge that enters the regional aquifer. Recharge is total recharge, much of which is lost from springs in high lying areas as interflow.* *Baseflow is the volume of baseflow under naturalised conditions. Present baseflow is the mean annual volume of baseflow that results when the WRSM model is run with present day groundwater abstraction for the period 1920-2010.* *Interflow is the volume of baseflow generated before recharge reaches the regional aquifer and equates to discharge from springs, and volumes of recharge the regional aquifer cannot accept. It generally provides a much more rapid response to rainfall than groundwater baseflow, which is lagged through the regional aquifer and has far lower variability.* *The volumes of interflow and groundwater baseflow generated were calibrated against gauging weir and dam volume data. The calibrated results include afforestation, AIPs, and surface and groundwater use as a variable time series, hence cannot be used to derive mean annual values since flows are not static in time. For this reason calibrated flows are naturalised by removing water use. A long term static water use is then added for the period of 1920 - 2010 to derive mean annual impacts of present day abstraction.*