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Water and Sanitation
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DEPARTMENT OF WATER AND SANITATION
CHIEF DIRECTORATE: WATER ECOSYSTEMS

THE DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE INKOMATI WATER MANAGEMENT AREA

RESOURCE QUALITY OBJECTIVES

Report Number: RDM/WMA05/00/CON/CLA/0414

DECEMBER 2014

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DEPARTMENT OF WATER AND SANITATION
CHIEF DIRECTORATE: WATER ECOSYSTEMS

THE DETERMINATION OF WATER RESOURCE CLASSES AND ASSOCIATED RESOURCE QUALITY OBJECTIVES IN THE INKOMATI WATER MANAGEMENT AREA

RESOURCE QUALITY OBJECTIVES: DRAFT

Report Number: RDM/WMA5/00/CON/CLA/0414

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EXECUTIVE SUMMARY

INTRODUCTION

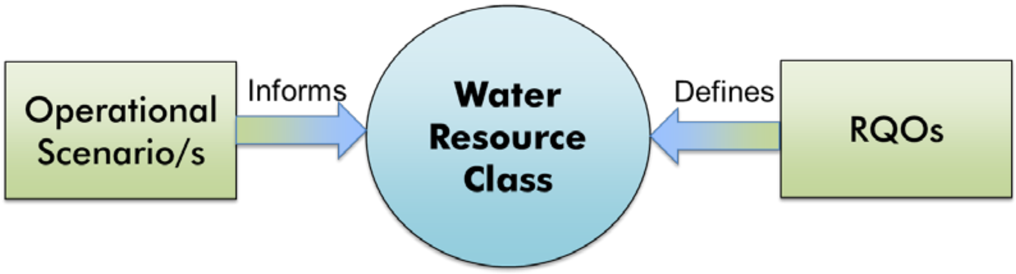
The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study during 2013 for the provision of professional services to undertake the determination of water resource classes and associated Resource Quality Objectives (RQOs) in the Inkomati Water Management Area (WMA). IWR Water Resources was appointed as the Professional Service Provider (PSP) to undertake this study which is managed by Rivers for Africa for IWR Water Resources.

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.*

RESOURCE QUALITY OBJECTIVES

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".

Operational scenarios, Water Resource Classes and RQOs are inherently linked as operational scenarios (Sc) to inform the Water Resource Class and RQOs define and/or describe the Water Resource Class (Figure below).



Links between RQOs and the Water Resource Class and operational scenarios

SUMMARY OF RQO RESULTS

Table 1 - 3 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 (February) and dry (October) month.

Table 1 RIVERS: Summary of key hydrological RQOs of the KOMATI RIVER System in the Inkomati catchment (X1)1

RU	Biophysical node	River	TEC*	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)	October (m^2/s)		Feb (m^2/s)	
							Mean of monthly flows at the indicated frequency[3].			
							90%	60/70%	90%	60/70%
IUA X1-1										
RU K1	X11A-01300		B	1.7	18.1	28.1	0.001	0.002	0.003	0.007
	X11A-01354		C	3.9	15.1	24.5	0.003	0.01	0.005	0.016
	X11A-01358	Vaalwaterspruit	C	6.6	17.3	26.8	0.011	0.014	0.018	0.026
	X11A-01248	Vaalwaterspruit	C	26.3	14.2	23.5	0.022	0.05	0.048	0.081
	X11A-01295	Vaalwaterspruit	C	15.4	18.2	27.2	0.012	0.035	0.023	0.058
RU K2	X11B-01370	Boesmanspruit	B	4.8	19	28.8	0.009	0.014	0.017	0.023
	X11B-01361		B/C	4.2	16	27	0.004	0.009	0.007	0.016
	X11B-01272	Boesmanspruit	C	51.4	17.3	26.8	0.051	0.133	0.083	0.191
IUA X1-2										
MRU Komati B	X11G-01142 EWR K1	Komati	C	158.6	16.1	27.5	0.254	0.374	0.618	0.779
IUA X1-3										
RU K3	X11C-01147	Witkloofspruit	C	11.4	13.5	22.1	0.015	0.022	0.025	0.041
	X11D-01129	Klein-Komati	C	21	19.2	27.4	0.027	0.056	0.107	0.122
	X11D-01137	Waarkraalloop	C	11.7	18.6	27.3	0.035	0.037	0.029	0.061
RU K4	X11E-01237	Swartspruit	B	14.8	25.6	35.5	0.049	0.057	0.067	0.111
RU K5	X11F-01133	Bankspruit	B	6.5	20.3	30.8	0.019	0.022	0.026	0.064
	X11G-01143	Gemakstroom	C	10.4	17.5	26.1	0.028	0.031	0.032	0.051
RU K6	X11G-01188	Ndubazi	B	17.4	24.9	34.9	0.055	0.063	0.067	0.145
IUA X1-4										
MRU Komati G	X11J-01106 EWR G1	Mngubhudle	D	29.5	19.9	26.9	0.041	0.063	0.122	0.205
RU K7	X11K-01165	Poponyane	C	13.7	14.7	22.7	0.01	0.012	0.047	0.071
	X11K-01199		D	2.4	15.1	22.3	0.002	0.004	0.004	0.006
IUA X1-5										
MRU Komati C	X12H-01258 EWR K2	Komati	C	545.6	9.3	18.3	0.599	0.82	1.156	1.649
IUA X1-6										
MRU Komati T	X12E-01287 EWR T1	Teespruit	C	56.4	22.6	35.3	0.206	0.272	0.294	0.349
RU K8	X12A-01305	Buffelspruit	B	32	31.2	39.9	0.085	0.168	0.195	0.261
	X12B-01246	Hlatjiwe	C	22.1	22.8	30.5	0.035	0.06	0.1	0.153
	X12C-01242	Phophenyane	B	6.3	28.7	37.5	0.016	0.024	0.032	0.041
	X12C-01271	Buffelspruit	B	71.1	31.7	40.5	0.261	0.367	0.495	0.789
	X12D-01235	Seekoeispruit	C	97	23.2	30.5	0.155	0.374	0.446	0.716
RU K9	X12H-01338	Sandspruit	B	4.4	27.9	36.7	0.035	0.056	0.069	0.12
	X12H-01340		B	4.8	30.6	39.5	0.022	0.031	0.031	0.043

RU	Biophysical node	River	TEC*	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)	October (m²/s) Mean of monthly flows at the indicated frequency[3]. 90%	October 60/70%	Feb (m²/s) 90%	Feb 60/70%
	X12H-01318	Sandspruit	C	13.9	24.1	31.7	0.025	0.043	0.043	0.076
	X12K-01333	Mlondozi	B/C	22.4	25	33.5	0.052	0.091	0.103	0.143
	X12K-01332	Mhlangampepa	B	3.4	30.7	40	0.015	0.022	0.021	0.029
RU K10	X12J-01202	Mtsoli	B	66.5	15.9	33.5	0.189	0.206	0.227	0.39
IUA X1-7										
RU K 12	X14A-01173	Lomati	B/C	84.38	22.9	31.2	0.220	0.285	0.390	0.603
	X14B-01166	Ugutugulo	C	20.87	23.4	31.7	0.051	0.072	0.117	0.131
IUA X1-8										
MRU Komati M	X14H-01066 EWR L1	Lomati	C	294.3	11.7	17.3	0.502	0.664	0.989	1.168
IUA X1-9										
RU K11	X13J-01141	Mzinti	D	6.3	10.5	19.1	0.003	0.011	0.006	0.016
	X13J-01205	Mbiteni	D	5.9	8.6	17.6	0.005	0.007	0.007	0.011
MRU Komati D	X13J-01130 EWR K3A	Komati	D	1021.7	9.9	17.2	0.672	1.547	1.552	2.802
IUA X1-10										
RU K13	X13K-01136	Mambane	D	1.8	13.1	22.4	0.001	0.003	0.001	0.004
	X13K-01068	Nkwakwa	C/D	5.4	11.2	22.7	0.003	0.009	0.006	0.012
	X13L-01000	Ngweti	D	4.6	7.5	14.5	0.002	0.008	0.003	0.009
MRU Komati E	X13K-01114	Komati	D	1341.4	12.9	18.1	3.75	3.942	5.529	6.121
	X13L-00995	Komati	D	1356.6	7.2	11.1	0.485	0.5	0.481	2.956

Target Ecological Category
1 nMAR is the natural Mean Annual Runoff in million cubic meters per annum.
2 %nMAR is flow required at the nodes expressed as a percentage of the natural Mean Annual Runoff, Low flows and Total flows.
3 Percentage points on the monthly low flow frequency distribution continuum at the nodes, expressed as the percentage of the months (90% and 60% for biophysical nodes and 90% and 70% for EWR sites) that the flow should equal or exceed the indicated minimum values.

Table 2 RIVERS: Summary of key hydrological RQOs of the CROCODILE RIVER System in the Inkomati catchment (X2)

RU	Biophysical node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[3]	October (m²/s) Mean of monthly flows at the indicated frequency[4] 90%	October 60/70%	Feb (m²/s) 90%	Feb 60/70%
IUA X2-1										
MRU Croc A	X21A-00930 EWR C1	Crocodile	A/B	15.6	24.36	30.13	0.033	0.059	0.121	0.205
	X21B-00962 EWR C2	Crocodile	B	76.1	30.88	35.48	0.246	0.373	0.673	1.162
RU C1	X21B-00929	Gemsbokspruit	C/D	3x.8	21.3	29.3	0.014	0.015	0.017	0.024
	X21B-00898	Lunsklip	C/D	9.6	19.8	27.7	0.031	0.034	0.026	0.058
	X21B-00925	Lunsklip	C	25.8	23.3	31.3	0.062	0.109	0.192	0.201

RU	Biophysical node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[3]	October (m^2/s) Mean of monthly flows at the indicated frequency[4] 90%	October 60/70%	Feb (m^2/s) 90%	Feb 60/70%
RU C2	*X21C-00859*	*Alexanderspruit*	*C*	*28.8*	*23.6*	*31.5*	*0.069*	*0.134*	*0.172*	*0.188*
IUA X2-2										
RU C3	*X21D-00957*	*Buffelskloofspruit*	*B/C*	*16.88*	*25*	*32.6*	*0.032*	*0.064*	*0.069*	*0.116*
RU C4	*X21E-00897*	*Buffelskloofspruit*	*B*	*8.39*	*25.5*	*35.3*	*0.03*	*0.043*	*0.047*	*0.067*
MRU Croc B	*X21E-00943 (EWR C3)*	*Crocodile*	*B/C*	*194*	*40.26*	*48.81*	*1.237*	*2.46*	*1.665*	*2.97*
IUA X2-3										
MRU Elan A	*X21G-01037 ER 1*	*Elands*	*B*	*60.00*	*10.39*	*47.12*	*0.100*	*0.177*	*0.293*	*0.613*
RU C7	*X21F-01100*	*Leeuspruit*	*C*	*11.88*	*30.8*	*39.5*	*0.065*	*0.069*	*0.065*	*0.098*
	X21F-01091	*Rietvleispruit*	*C*	*3.31*	*27.1*	*35.5*	*0.017*	*0.019*	*0.030*	*0.032*
	X21F-01092	*Leeuspruit*	*C/D*	*11.88*	*23.60*	*31.20*	*0.065*	*0.068*	*0.043*	*0.064*
IUA X2-4										
RU C8	*X21G-01090*	*Weltevredespruit*	*C*	*5.53*	*23.6*	*32.1*	*0.028*	*0.029*	*0.017*	*0.027*
	X21G-01016	*Swartkoppiespruit*	*C*	*11.36*	*24.4*	*32.6*	*0.06*	*0.065*	*0.035*	*0.061*
RU C10	*X21K-01007*	*Lupelule*	*B*	*29.4*	*25*	*35.3*	*0.051*	*0.07*	*0.143*	*0.257*
RU C9	*X21H-01060*	*Ngodwana*	*B*	*59.64*	*12.8*	*22.1*	*0.04*	*0.052*	*0.103*	*0.242*
X2-5										
MRU Elan B	*X21K-01035 ER 2*	*Elands*	*B*	*217.19*	*4.97*	*43.07*	*0.369*	*0.502*	*1.429*	*2.090*
X2-6										
MRU Croc C	*X22B-00987*	*Crocodile*	*Linked to EWR C4*							
	X22B-00888	*Crocodile*								
	X22C-00946	*Crocodile*								
	X22J-00993	*Crocodile*								
IUA X2-7										
RU C5	*X22A-00875*	*Houtbosloop*	*B*	*6.92*	*30.6*	*39*	*0.024*	*0.033*	*0.051*	*0.074*
	X22A-00887	*Beestekraalspruit*	*B/C*	*3.72*	*25.9*	*33.9*	*0.013*	*0.021*	*0.027*	*0.032*
	X22A-00824	*Blystaanspruit*	*B*	*21*	*32.2*	*40.6*	*0.072*	*0.095*	*0.142*	*0.219*
	X22A-00920		*B*	*1.69*	*30.8*	*39.4*	*0.007*	*0.011*	*0.015*	*0.017*
	X22A-00919	*Houtbosloop*	*B/C*	*10.64*	*30.3*	*38.7*	*0.037*	*0.064*	*0.078*	*0.109*
	X22A-00917	*Houtbosloop*	*C*	*14.8*	*31.4*	*39.8*	*0.054*	*0.076*	*0.111*	*0.149*
RU C6	*X22A-00913*	*Houtbosloop*	*B*	*75.26*	*33*	*41.3*	*0.336*	*0.376*	*0.566*	*0.821*
RU C11	*X22C-00990*	*Visspruit*	*B/C*	*3.36*	*20*	*31.1*	*0.005*	*0.012*	*0.007*	*0.016*
IUA X2-8										
RU C12	*X22C-01004*	*Gladdespruit*	*B/C*	*16.26*	*12.5*	*23.1*	*0.018*	*0.022*	*0.021*	*0.037*
RU C13	*X22D-00843*	*Nels*	*C*	*20.58*	*21.9*	*29.6*	*0.034*	*0.059*	*0.072*	*0.12*
	X22D-00846		*C*	*13.78*	*24.1*	*31.9*	*0.078*	*0.082*	*0.052*	*0.082*
	X22E-00849	*Sand*	*C*	*8.66*	*19.8*	*27.8*	*0.019*	*0.027*	*0.021*	*0.043*
	X22E-00833	*Kruisfonteinspruit*	*C*	*11.2*	*18.7*	*26.6*	*0.022*	*0.032*	*0.027*	*0.07*

RU	Biophysical node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[3]	October (m^2/s)		Feb (m^2/s)	
							Mean of monthly flows at the indicated frequency[4]			
							90%	60/70%	90%	60/70%
	X22F-00842	Nels	C	74.94	11.22	19	0.064	0.087	0.100	0.184
	X22F-00886	Sand	C	48.9	19.4	27.4	0.092	0.179	0.135	0.238
	X22F-00977	Nels	C/D	125.41	16.8	24.1	0.401	0.539	0.615	0.767
IUA X2-9										
RU C15	X22K-01042	Mbuzulwane	B	1.19	28.6	38.4	0.005	0.007	0.005	0.01
RU C15	X22K-01043	Blinkwater	B	5.93	24.2	34.9	0.025	0.027	0.025	0.037
RU C15	X22K-01029	Blinkwater	C	4.9	16.7	25.8	0.004	0.012	0.008	0.02
MRU Croc D	X22K-01018 EWR C4	Crocodile	C	824.8	9.07	31.93	0.772	1.426	2.44	4.137
IUA X2-10										
RU C16	X23B-01052	Noordkaap	C	50.91	26.9	34.4	0.212	0.246	0.253	0.396
RU C17	X23C-01098	Suidkaap	B/C	61.75	32.6	39.5	0.025	0.027	0.025	0.037
RU C17	X23E-01154	Queens	B/C	39.54	23.4	32.7	0.121	0.146	0.169	0.22
RU C17	X23F-01120	Suidkaap	C	109.79	24.1	31	0.321	0.482	0.698	0.979
MRU Kaap A	X23G-01057 EWR C7	Kaap	C	179.5	6.18	19.23	0.069	0.144	0.349	0.559
IUA X2-11										
MRU Croc E	X24H-00934 EWR C6	Crocodile	C	1165.6	9.65	19.55	0.76	0.898	3.083	4.276
MRU Croc E	X24D-00994 EWR C5	Crocodile	C	1117.4	10.93	23.96	1.616	2.047	2.7	4.408
IUA X2-12										
RU C18	X24A-00826	Nsikazi	C	1.97	24.1	33.9	0.004	0.009	0.004	0.011
RU C19	X24B-00903	Gutshwa	D	25.41	16.2	24.4	0.05	0.09	0.116	0.136
IUA X2-13										
RU C20	X24A-00881	Nsikazi	B	11.68	29.5	40.6	0.027	0.056	0.034	0.077
RU C20	X24B-00928	Nsikazi	A/B	42.39	31.8	44	0.236	0.351	0.261	0.319
RU C20	X24C-00978	Nsikazi	B	52.25	30.7	40.5	0.05	0.194	0.318	0.401

1 nMAR is the natural Mean Annual Runoff in million cubic meters per annum.

2 %nMAR is flow required at the nodes expressed as a percentage of the natural Mean Annual Runoff, Low flows and Total flows.

3 The monthly flow requirements for EWR 3 and 6 represent the total flow defined by the current operating rule where the revised Present Ecological State low flows and releases for water users defines the minimum requirements for the respective EWR sites.

4 Percentage points on the monthly low flow frequency distribution continuum at the nodes, expressed as the percentage of the months (90% and 60% for biophysical nodes and 90% and 70% for EWR sites) that the flow should equal or exceed the indicated minimum values.

Table 3 RIVERS: Summary of key hydrological RQOs of the SABIE AND SAND RIVER System in the Inkomati catchment (X3)

RU	Biophysical node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[3]	October (m^2/s)		Feb (m^2/s)	
							Mean of monthly flows at the indicated frequency[4]			
							90%	60/70%	90%	60/70%
IUA X3-1										
RU S2	*X31A-00741*	*Klein Sabie*	*B/C*	*14.62*	*16.9*	*25.8*	*0.046*	*0.05*	*0.046*	*0.083*
RU S1	*X31A-00783*		*C*	*12.12*	*26.1*	*33.8*	*0.034*	*0.049*	*0.065*	*0.098*
	X31A-00786		*B*	*4.65*	*39*	*47.7*	*0.026*	*0.029*	*0.039*	*0.051*
	X31A-00794		*B*	*Small SQ catchment areas (less than 3 km^2) and hence no hydrology modelled (small flows and inaccurate at this resolution).*						
	X31A-00796		*B*							
	X31A-00803		*B/C*							
IUA X3-2										
MRU Sabie A	*X31B-00757 EWR S1*	*Sabie*	*B*	*132*	*12.88*	*54*	*40.91*	*0.189*	*0.320*	*0.393*
	X31D-00755 EWR S2	*Sabie*	*B*	*261.7*	*11.14*	*63.35*	*24.21*	*0.360*	*0.535*	*0.638*
RU S4	*X31B-00792*	*Goudstroom*	*B/C*	*12.21*	*31*	*38.9*	*0.035*	*0.058*	*0.075*	*0.111*
	X31D-00773	*Sabani*	*C/D*	*19.23*	*16.3*	*19.5*	*0.03*	*0.063*	*0.068*	*0.105*
MRU Mac A	*X31C-00683 EWR S4*	*Mac-Mac*	*B*	*65.8*	*14.35*	*45.07*	*0.16*	*0.047*	*0.459*	*1.133*
RU S8	*X31E-00647a*	*Marite (US of dam)*	*B*	*79.88*	*29.2*	*38.7*	*0.231*	*0.336*	*0.493*	*0.71*
	X31F-00695	*Motitsi*	*B*	*43.91*	*25.6*	*35.2*	*0.101*	*0.159*	*0.172*	*0.206*
IUA X3-3										
Mar A	*X31G-00728 EWR S5*	*Marite*	*B/C*	*156.4*	*28.32*	*63.94*	*0.68*	*0.88*	*0.75*	*1*
MRU Sabie B	*X31K-00715 EWR S3*	*Sabie*	*A/B*	*493.7*	*9.71*	*37.94*	*0.581*	*0.955*	*1.489*	*2.848*
IUA X3-4										
RU S5	*X31H-00819*	*White Waters*	*C*	*28.94*	*25.9*	*31.4*	*0.063*	*0.173*	*0.098*	*0.202*
RU S6	*X31J-00774*	*Noord-Sand*	*D*	*45.08*	*9.3*	*16*	*0.053*	*0.066*	*0.086*	*0.123*
	X31J-00835	*Noord-Sand*	*D*	*12.01*	*24.2*	*31.3*	*0.081*	*0.086*	*0.025*	*0.057*
RU S9	*X31K-00713*	*Bejani*	*D*	*2.38*	*16.9*	*25.7*	*0.001*	*0.007*	*0.002*	*0.009*
RU S10	*X31L-00657*	*Matsavana*	*C*	*3.84*	*4.3*	*16.8*	*0*	*0*	*0.003*	*0.004*
	X31L-00664	*Saringwa*	*C*	*10.89*	*13.5*	*24.5*	*0.022*	*0.027*	*0.016*	*0.041*
	X31L-00678	*Saringwa*	*B/C*	*3.24*	*18.2*	*30.8*	*0.003*	*0.009*	*0.005*	*0.013*
RU S11	*X31M-00673*	*Musutlu*	*B/C*	*1.8*	*10.6*	*19*	*0.001*	*0.001*	*0.002*	*0.005*
IUA X3-7										
MRU Mut A	*X32F-00597 EWR S6*	*Mutlumuvi*	*C*	*45.0*	*22.21*	*28.46*	*0.0016*	*0.042*	*0.111*	*0.193*
RU S12	*X32F-00628*	*Nwarhele*	*C/D*	*14.77*	*23.3*	*31.3*	*0.02*	*0.041*	*0.027*	*0.07*
	X32E-00629	*Nwarhele*	*C*	*10.58*	*20.2*	*28.6*	*0.039*	*0.043*	*0.031*	*0.052*
IUA X3-8										
MRU Sand A	*X32A-00583 EWR S7*	*Tlulandziteka*	*B*	*28.9*	*11.14*	*39.66*	*0.025*	*0.047*	*0.086*	*0.138*
	X32C-00558	*Nwandlamuhari*	*C*							

RU	Biophysical node	River	TEC	nMAR[1] (MCM)	Low flows (%nMAR)[2]	Total flows (%nMAR)[3]	October (m^2/s)		Feb (m^2/s)	
							Mean of monthly flows at the indicated frequency[4]			
							90%	60/70%	90%	60/70%
	X32C-00606	*Nwandlamuhari*	*C*							
RU S14	*X32B-00551*	*Motlamogatsana*	*C*	*15.36*	*17.9*	*25.7*	*0.015*	*0.026*	*0.025*	*0.058*
	X32C-00564	*Mphyanyana*	*C*	*3.1*	*1.6*	*10.5*	*0*	*0*	*0*	*0*
RU S15	*X32G-00549*		*C*	*3.94*	*10.4*	*17*	*0.001*	*0.005*	*0.003*	*0.009*
IUA X3-9										
RU S16	*X32H-00560*	*Phungwe*	*A*	*7.59*	*15.7*	*26.1*	*0.01*	*0.021*	*0.016*	*0.027*
MRU Sand B	*X32J-00602 EWR S8*	*Sand*	*B*	*133.6*	*3.36*	*24.71*	*0.028*	*0.088*	*0.235*	*0.605*

1 nMAR is the natural Mean Annual Runoff in million cubic meters per annum.
2 %nMAR is flow required at the nodes expressed as a percentage of the natural Mean Annual Runoff, Low flows and Total flows.
3 The monthly flow requirements for EWR 5 represents the total flow defined by current operating rule where the Present Ecological State low flows and releases for water users defines the minimum requirements for the respective EWR site.
4 Percentage points on the monthly low flow frequency distribution continuum at the nodes, expressed as the percentage of the months (90% and 60% for biophysical nodes and 90% and 70% for EWR sites) that the flow should equal or exceed the indicated minimum values.

Table 4 - 6 provide the habitat, biota and water quality RQOs for each IUA of high priority RUs in the respective river systems. RQOs and the TECs are provided for each component and/or indicator.

Table 4 RIVERS: RQOs for water quality, geomorphology, riparian vegetation, macro-invertebrates and fish in HIGH priority RUs of the KOMATI RIVER System in the Inkomati catchment (X1)

Component/ Indicator	TEC	RQOs
		IUA X1-2; MRU KOMATI B (EWR K1) (Komati River)
Geomorphology	**C**	*Maintain the current EC and geomorphological structure.*
Fish	**C**	*Maintain TEC of C and fish species richness of eleven species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic Amphilius uranoscopus (AURA) and the large semi-rheophilic Labeobarbus marequensis (BMAR).*
Invertebrates	**B/C**	*Community is representative of a medium-sized foothill stream assemblage. Maintain the EC, good Stones-in-Current (SIC) and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**C**	*Maintain current Ecological Category (EC). Maintain vegetation cover (woody and non-woody) between 70 - 90%. Perennial invasive alien species kept in check. No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**B**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.02 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 42 mS/m (aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR[1] for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		IUA X1-4; MRU KOMATI G (EWR G1) (Gladdespruit River)
Geomorphology	**D**	*Maintain the current EC and geomorphological structure.*
Fish	**D**	*Maintain TEC of D and fish species richness of eleven species. Suitable habitats*

Component/ Indicator	TEC	RQOs
		should be adequate for especially the primary indicator fish species, namely the small rheophilic (AURA) and Chiloglanis pretoriae (CPRE).
Invertebrates	**D**	*Community is representative of a small mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, two moderate flow velocity species.*
Riparian vegetation	**D**	*Maintain D. Maintain vegetation cover (woody and non-woody) above 50%. Perennial invasive alien species kept in check. No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**C**	*Ensure that turbidity/clarity or Total Suspended Solids (TSS) levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
		Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.02 mg/L PO_4-P (aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		Ensure that As levels are within Ideal limits or A categories: 95th percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).
		Ensure that (free) Cn levels are within Ideal limits or A categories: 95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).
IUA X1-5; MRU KOMATI C (EWR K2) (Komati River)		
Geomorphology	**C**	*Maintain the current EC and geomorphological structure.*
Fish	**C**	*Maintain TEC of C and fish species richness of nineteen species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (AURA) and the large semi-rheophilic (BMAR).*
Invertebrates	**C**	*Community is representative of a medium mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain vegetation cover (woody and non-woody) between 50 - 80%. Perennial invasive alien species kept in check. No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**B/C**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.02 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 42 mS/m (aquatic ecosystems: driver).
		Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).
IUA X1-5; MRU KOMATI T (EWR T1) (Teewaterspruit River)		
Geomorphology	**C**	*Maintain the current EC and geomorphological structure.*
Fish	**C**	*Maintain TEC of C and fish species richness of nineteen species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (AURA) and the large semi-rheophilic (BMAR).*
Invertebrates	**C**	*Community is representative of a medium mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain vegetation cover (woody and non-woody) above 30%. Perennial invasive alien species kept in check (less than 20%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
		Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A small

Component/ Indicator	TEC	RQOs
		change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).
		IUA X1-8; MRU KOMATI M (EWR L1) (Lomati River)
Geomorphology	D	Maintain the current EC and geomorphological structure.
Fish	C	Maintain TEC of C and high fish species richness of thirty-six species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic Chiloglanis anoterus (CANO) and the large semi-rheophilic (BMAR).
Invertebrates	C	Community is representative of a medium-sized Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one high flow velocity species.
Riparian vegetation	B/C	Maintain current EC. Maintain vegetation cover (woody and non-woody) between 50 - 80%. Perennial invasive alien species kept in check (less than 10%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.
Water quality:	B/C	Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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 nutrient levels (phosphate) are within Tolerable limits: 50^{th} percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver).
		Ensure that nutrient levels (Total Inorganic Nitrogen - TIN) are within Acceptable limits: 50^{th} percentile of the data must be less than 1.0 mg/L TIN (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 or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		IUA X1-9; MRU KOMATI D (EWR K3) (Komati River)
Geomorphology	DE	Maintain the current EC and geomorphological structure.
Fish	C/D	Maintain TEC of C/D and high fish species richness of thirty-five species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic Barbus eutaenia (BEUT) and the large semi-rheophilic (BMAR).
Invertebrates	D	Community is representative of a larger-sized Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one high flow velocity species.
Riparian vegetation	D	Maintain a D EC. Maintain vegetation cover (woody and non-woody) between 50 - 75%. Perennial invasive alien species kept in check (less than 15%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.
Water quality	D	Ensure that electrical conductivity (salt) levels are within Tolerable limits: 95^{th} percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).
		Ensure that nutrient levels (phosphate) are within Tolerable limits: 50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).
		Ensure that nutrient levels (TIN) are within Acceptable limits: 50^{th} percentile of the data must be less than 1.0 mg/L TIN (aquatic ecosystems: driver).
		Ensure that periphyton levels are within Acceptable limits: 50^{th} percentile of the data must be less than 21 mg/m^2 (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).

Component/ Indicator	TEC	RQOs
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 5 RIVERS: RQOs for water quality, geomorphology, riparian vegetation, macro-invertebrates and fish in HIGH priority RUs of the CROCODILE RIVER System in the Inkomati catchment (X2)

Component/ Indicator	TEC	RQOs
		IUA X2-1; MRU CROC A (EWR C1) (Crocodile River)
Geomorphology	B	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the reach as an alluvial meandering channel type.* *PES score from the GAI level IV should equal or exceed 85%.*
Fish	A	*Maintain TEC of A and low fish species richness of one species. Suitable vegetated habitats should be available for small semi-rheophilic Barbus anoplus (BANO).*
Invertebrates	B	*Community is representative of a small mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, five high flow velocity species.*
Riparian vegetation	A	*Maintain current EC. Maintain woody vegetation cover below 10%. Maintain non-woody cover between 80% and 100%. Maintain reed cover below 5%. Perennial invasive alien species kept in check (less than 1%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	A	*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 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 (intermediate) use: Meet the TWQR[1] of 0 - 1000 counts per 100 ml (DWAF, 1996b).
		IUA X2-1; MRU CROC A (EWR C2) (Crocodile River)
Geomorphology	B	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the reach as an alluvial meandering channel type.* *PES score from the GAI level IV should equal or exceed 85%.*
Fish	B	*Maintain TEC of B and fish species richness of eleven species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (AURA) and (CPRE).*
Invertebrates	B	*Community is representative of a small mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, five high flow velocity species.*
Riparian vegetation	A/B	*Maintain current EC. Maintain woody vegetation cover below 5%. Maintain non-woody cover between 80% and 100%. Maintain reed cover below 5%. Perennial invasive alien species kept in check (less than 5%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	C	*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 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 (intermediate) use: Meet the TWQR of 0 - 1000 counts per 100 ml (DWAF, 1996b).
		IUA X2-2; MRU CROC B (EWR C3) (Crocodile River)

Component/ Indicator	TEC	RQOs
Geomorphology	C	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the reach as an alluvial meandering channel type.* *PES score from the GAI level IV should equal or exceed 64%.*
Fish	B	*Maintain TEC of C and fish species richness of six species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (AURA) and (CPRE).*
Invertebrates	C	*Community is representative of a medium-sized foothill stream assemblage. Maintain the EC, good SIC and marginal vegetation, five high flow velocity species.*
Riparian vegetation	C	*Maintain current EC. Maintain woody vegetation cover between 20 - 70%. Maintain non-woody cover between 30% and 90%. Maintain reed cover below 10%. Perennial invasive alien species kept in check (less than 15%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	C	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 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 (aquatic ecosystems: driver).
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X2-9; MRU CROC D (EWR C4) (Crocodile River)		
Geomorphology	B/C	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 81%.*
Fish	B	*Maintain TEC of B and fish species richness of twenty species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CPRE) and the large semi-rheophilic (BMAR).*
Invertebrates	C	*Community is representative of a larger-sized Lowveld river assemblage.* *Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one high flow velocity species.*
Riparian vegetation	C	*Maintain current EC. Maintain woody vegetation cover between 20 - 70%. Maintain non-woody cover above 30%. Maintain reed cover between 10 - 20%. Perennial invasive alien species kept in check (less than 20%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	C	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 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).
		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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X2-11; MRU CROC E (EWR C5) (Crocodile River)		
Geomorphology	C/D	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 60%.*
Fish	C	*Maintain TEC of C and high fish species richness of thirty five species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CPRE) and the large semi-rheophilic (BMAR).*

Component/ Indicator	TEC	RQOs
Invertebrates	**C**	*Community is representative of a large, wide Lowveld river assemblage. Maintain the Category C, good SIC, sand and gravel habitat, and marginal vegetation, one moderate flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain woody vegetation cover between 20 - 70%. Maintain non-woody cover above 40%. Maintain reed cover above 10% along the channel. Perennial invasive alien species kept in check (less than 10%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality:	**C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver, EWR C6.*
		Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 70 mS/m (aquatic ecosystems: driver).
		Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.
		Ensure that temperatures stay within Acceptable limits: A moderate change to instream temperatures should occur infrequently, i.e. vary by no more than 2◦C. Highly temperature sensitive species will occur in lower abundances (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 the CEV limits: 95th percentile of the data must be within the CEV for toxics or the B category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X2-11; MRU CROC E (EWR C6) (Crocodile River)		
Geomorphology	**C**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 66%.*
Fish	**C**	*Maintain TEC of C and high fish species richness of thirty-four species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic sawfin suckermouth (CPAR) and the large semi-rheophilic (BMAR).*
Invertebrates	**C**	*Community is representative of a large, wide Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one moderate flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain woody vegetation cover between 5 - 60%. Maintain non-woody cover above 30% in the marginal zone. Maintain reed cover between 10 - 90% along the channel. Maintain absence of perennial invasive alien species. No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver, EWR C6).*
		Ensure that electrical conductivity (salt) levels are within Acceptable limits: 95th percentile of the data must be less than or equal to 70 mS/m (aquatic ecosystems: driver).
		Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.
		Ensure that temperatures stay within Acceptable limits: A moderate change to instream temperatures should occur infrequently, i.e. vary by no more than 2ºC. Highly temperature sensitive species will occur in lower abundances (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 the CEV limits: 95th percentile of the data must be within the CEV for toxics or the B category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X2-10; MRU KAAP A (EWR C7) (Kaap River)		

Component/ Indicator	TEC	RQOs
Geomorphology	B	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 86%.*
Fish	C	*Maintain TEC of C and fish species richness of eleven species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CPRE) and (BEUT) and the large semi-rheophilic (BMAR).*
Invertebrates	B	*Community is representative of a medium-sized Lowveld river assemblage. Maintain the Category B, good SIC and marginal vegetation, three high flow velocity species.*
Riparian vegetation	C/D	*Maintain current EC. Maintain woody vegetation cover between 20 - 70%. Maintain non-woody cover above 30%. Maintain reed cover between 10 - 90% along the channel. Perennial invasive alien species kept in check (less than 30%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	B	*Ensure that nutrient levels are within Tolerable limits: The 50th percentile of the data may be at 0.125 mg/L PO_4-P (aquatic ecosystems: driver).* *The 50th percentile of the data must be ≤ 4.0 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 200 mS/m (Aquatic ecosystems: driver). Note this is a naturally salinised system.
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		Ensure that As levels are within Ideal limits or A categories: 95th percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).
		Ensure that (free) Cn levels are within Ideal limits or A categories: 95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 6 RIVERS: RQOs for water quality, geomorphology, riparian vegetation, macro-invertebrates and fish in HIGH priority RUs of the SABIE AND SAND RIVER System in the Inkomati catchment (X3)

Component/ Indicator	TEC	RQOs
IUA X3-2; MRU SABIE A (EWR S1) (Sabie River)		
Geomorphology	B	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 83%.*
Fish	B	*RQO will be immediately applicable if the non-flow related measures are addressed. This will result in an improvement in the fish assemblage (reduced sedimentation of rocky substrate, improved indigenous vegetative habitats). Fish species richness of eight species must be maintained. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic Varicorhinus nelspruitensis (VNEL).*
Invertebrates	B	*Community is representative of a small mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, one high flow velocity species. For an improvement in the PES additional key taxa for the improved situation: Oligoneuridae and Prosopistomatidae.*
Riparian vegetation	B	*RQO will be immediately applicable if the non-flow related measures are addressed. This will result in the woody cover improving and reed cover decreasing. Perennial invasive alien species should be less than 10%. No*

Component/ Indicator	TEC	RQOs
		increase of riparian zone fragmentation. Maintain riparian taxon richness.
Water quality	**A/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 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[1] of 0 - 130 counts per 100 ml (DWAF, 1996b).
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X3-2; MRU SABIE A (EWR S2) (Sabie River)		
Geomorphology	**B**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats. Maintain the channel/reach type. PES score from the GAI level IV should equal or exceed 85%.*
Fish	**B**	*RQO will be immediately applicable if the non-flow related measures are addressed. This will result in an improvement in the fish assemblage (reduced sedimentation of rocky substrate, improved indigenous vegetative habitats).Maintain fish species richness of eight species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (VNEL).*
Invertebrates	**B**	*Community is representative of a small mountain stream assemblage. RQO will be immediately applicable if the non-flow related measures are addressed. This will result in an improvement with increased SASS V and MIRAI scores as well as additional taxa that will occur (Trichorythidae and Libellulidae)*
Riparian vegetation	**B**	*RQO will be immediately applicable if the non-flow related measures are addressed. This will result in the woody cover improving and reed cover decreasing. Perennial invasive alien species should be less than 10%. No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**B**	*Ensure that nutrient levels are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver). For an improvement in the PES 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 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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X3-3; MRU SABIE B (EWR S3) (Sabie River)		
Geomorphology	**B**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats. Maintain the channel/reach type. PES score from the GAI level IV should equal or exceed 84%.*
Fish	**B**	*Maintain TEC of B and fish species richness of twenty six species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (BMAR).*
Invertebrates	**B**	*Community is representative of a medium-sized foothill stream assemblage. Maintain the EC, good SIC and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**A/B**	*Maintain current EC. Maintain woody vegetation cover between 20 - 40%. Maintain non-woody cover between 30 - 90%. Maintain reed cover between 20 -*

Component/ Indicator	TEC	RQOs
		40% along the channel. Perennial invasive alien species kept in check (less than 5%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.
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 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 turbidity/clarity or TSS levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X3-2; MRU MAC A (EWR S4) (MacMac River)		
Geomorphology	**A**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats. Maintain the channel/reach type. PES score from the GAI level IV should equal or exceed 93%.*
Fish	**B/C**	*Maintain TEC of B/C and fish species richness of twenty species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (VNEL).*
Invertebrates	**A/B**	*Community is representative of a small mountain stream assemblage. Maintain the EC, good SIC and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**A/B**	*Maintain current EC. Maintain woody vegetation cover between 20 - 80%. Maintain non-woody cover between 30 - 60% in the marginal zone. Maintain the absence of reed cover. Perennial invasive alien species kept in check (less than 5%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**A/B**	*Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
IUA X3-3; MRU MAR A (EWR S5) (Marite River)		
Geomorphology	**C**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats. Maintain the channel/reach type. PES score from the GAI level IV should equal or exceed 65%.*
Fish	**B/C**	*Maintain TEC of B/C and fish species richness of twenty six species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (BMAR).*
Invertebrates	**B/C**	*Community is representative of a medium-sized foothill stream assemblage. Maintain the EC, good SIC and marginal vegetation, two high flow velocity species.*
Riparian vegetation	**B/C**	*Maintain current EC. Maintain woody vegetation cover between 70 - 80%. Maintain non-woody cover between 40 - 50% in the marginal zone. Maintain reed cover between 20 - 30% along the channel. Perennial invasive alien species kept in check (less than 15%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
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 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

Component/ Indicator	TEC	RQOs
		TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).
		Ensure that toxics are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		IUA X3-7; MRU MUT A (EWR S6) (Mutlumuvi River)
Geomorphology	**C**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 71%.*
Fish	**C**	*Maintain TEC of C and fish species richness of twenty six species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (BMAR).*
Invertebrates	**B/C**	*Community is representative of a medium-sized Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, two moderate flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain woody vegetation cover between 20 - 70% along the banks. Maintain reed cover between 10 - 90% along the channel. Perennial invasive alien species kept in check (less than 20%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**B/C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 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/clarity or TSS levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (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 CEV limits or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
		IUA X3-8; MRU SAND A (EWR S7) (Thulandziteka River)
Geomorphology	**C/D**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats.* *Maintain the channel/reach type.* *PES score from the GAI level IV should equal or exceed 61%.*
Fish	**C**	*Maintain TEC of C and fish species richness of twenty nine species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (BMAR).*
Invertebrates	**B/C**	*Community is representative of a medium-sized Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one high flow velocity species.*
Riparian vegetation	**C**	*Maintain current EC. Maintain woody vegetation cover between 20 - 70% along the banks. Maintain reed cover between 10 - 90% along the channel. Perennial invasive alien species kept in check (less than 20%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**C**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 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 42 mS/m (aquatic ecosystems: driver).
		Ensure that turbidity/clarity or TSS levels stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).

Component/ Indicator	TEC	RQOs
		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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).
IUA X3-9; MRU SAND B (EWR S8) (Sand River)		
Geomorphology	**C**	*Maintain the bed material size distribution within the active channel in order to maintain the available physical habitats. Maintain the channel/reach type. PES score from the GAI level IV should equal or exceed 71%.*
Fish	**B**	*Maintain TEC of B and high fish species richness of thirty five species. Suitable habitats should be adequate for especially the primary indicator fish species, namely the small rheophilic (CANO) and the large semi-rheophilic (BMAR).*
Invertebrates	**B**	*Community is representative of a medium-sized Lowveld river assemblage. Maintain the EC, good SIC, sand and gravel habitat, and marginal vegetation, one moderate flow velocity species.*
Riparian vegetation	**B**	*Maintain current EC. Maintain the absence of terrestrial woody species in the channel. Maintain reed cover between 20 - 80% along the channel. Perennial invasive alien species kept in check (less than 10%). No increase of riparian zone fragmentation. Maintain riparian taxon richness.*
Water quality	**B**	*Ensure that nutrient levels are within Tolerable limits: 50th percentile of the data must be less than 0.125 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).

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 7 - 9 provide the water quality RQOs for each IUA of high priority RUs (other than EWR sites) in the respective river systems.

Table 7 RIVERS: Summary of key WATER QUALITY RQOs in HIGH WQ priority RUs of the KOMATI RIVER System in the Inkomati catchment (X1)

RUs	SQ number	Water Quality RQOs
IUA X1-1		
RU K1	*X11A-01358 X11A-01248 X11A-01295*	*Ensure that* **nutrient levels** *are within Acceptable limits: 50th percentile of the data must be less than 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 (aquatic ecosystems: driver). Ensure* **pH levels** *stay within Acceptable limits: A small change from the Ideal range is allowed, i.e. a 5th percentile of 5.9 - 6.5, and a 95th percentile of 8.0 - 8.8 (aquatic ecosystems: driver). Ensure that* **toxics** *are within Ideal limits or A categories or TWQR[1]: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008). Ensure that* **sulphate levels** *are within Acceptable limits: 95th percentile of the data must be less than 30 mg/L (industrial cat 3: drivers; DWA, 2012a). Meet* **faecal coliform and *E.coli* targets** *for recreational (full contact) use: Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
RU K2	*X11B-01370*	*Ensure that* **nutrient levels** *are within Acceptable limits: 50th percentile of the data must be less than 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 (aquatic ecosystems:*

RUs	SQ number	Water Quality RQOs
	X11B-01361 X11B-01272	*driver).* *Ensure* **pH levels** *stay within Acceptable limits: A small change from the Ideal range is allowed, i.e. a 5th percentile of 5.9 - 6.5, and a 95th percentile of 8.0 - 8.8 (aquatic ecosystems: driver).* *Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **sulphate levels** *are within Acceptable limits: 95th percentile of the data must be less than 30 mg/L (industrial cat 3: drivers; DWA, 2012a).* *Meet* **faecal coliform and *E.coli* targets** *for recreational (full contact) use: Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
IUA X1-3		
RU K3	X11C-01147 X11D-01129 X11D-01137	*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* **pH levels** *stay within Acceptable limits: A small change from the Ideal range is allowed, i.e. a 5th percentile of 5.9 - 6.5, and a 95th percentile of 8.0 - 8.8 (aquatic ecosystems: driver).* *Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **sulphate levels** *are within Acceptable limits: 95th percentile of the data must be less than 30 mg/L (industrial cat 3: drivers; DWA, 2012a).*
RU K4	X11E-01237	*Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
IUA X1-10		
RU K13	X13L-01000	*Ensure that* **electrical conductivity (salt) levels** *are within Tolerable limits: 95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).*
MRU Komati E	X13K-01114 X13K-01038 X13L-01027 X13L-00995	*Ensure that* **electrical conductivity (salt) levels** *are within Tolerable limits: 95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).* *Ensure that* **temperatures** *stay within Acceptable limits: A moderate change to instream temperatures should occur infrequently, i.e. vary by no more than 2ºC. Highly temperature sensitive species will occur in lower abundances (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.* *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 the CEV limits: 95th percentile of the data must be within the CEV for toxics or the B category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008) (aquatic ecosystems: driver).*

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 8 RIVERS: Summary of key WATER QUALITY RQOs in HIGH WQ priority RUs of the CROCODILE RIVER System in the Inkomati catchment (X2)

RUs	SQ number	Water Quality RQOs
IUA X2-3		
MRU Elan A	*X21F-01046*	*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 (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 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* **toxics** *are within Ideal limits or A categories or TWQR[1]: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **pH** *stays within Ideal limits: 5^{th} and 95^{th} percentiles of pH data must be between 6.5 and 8.0 (aquatic ecosystems: driver).* *Ensure that* **Cr-VI levels** *are within Ideal limits or A categories: 95^{th} percentile of the data must be less than 0.014 mg/L Cr-VI (aquatic ecosystems: driver).* *Ensure that* **Mn levels** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR of 0.180 mg/L Mn (aquatic ecosystems: driver).*
	X21F-01081	
	X21G-01037 ER 1	
RU C7	*X21F-01100*	*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 (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 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* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **pH** *stays within Ideal limits: 5^{th} and 95^{th} percentiles of pH data must be between 6.5 and 8.0 (aquatic ecosystems: driver).* *Ensure that* **Cr-VI levels** *are within Ideal limits or A categories: 95^{th} percentile of the data must be less than 0.014 mg/L Cr-VI (aquatic ecosystems: driver).* *Ensure that* **Mn levels** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR of 0.180 mg/L Mn (aquatic ecosystems: driver).*
IUA X2-4		
MRU Elan B	*X21G-1073*	*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* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
	X21J-01013	
IUA X2-5		
MRU Elan B	*X21K-01035 ER 2*	*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* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
	X21K-00997	
IUA X2-6 AND PART OF IUA X2-9		
MRU Croc C	*X22B-00987*	*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:*

RUs	SQ number	Water Quality RQOs
	X22B-00888 *X22C-00946* *X22J-00993* *X22J-00958* *X22K-00981*	*driver).* *Ensure that* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 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* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **Mn levels** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR of 0.180 mg/L Mn (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
	X22J-00958 *X22K-00981*	*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* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 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* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
IUA X2-8		
RU C12	*X22C-01004*	*Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **Mn levels** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR of 0.180 mg/L Mn (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
RU C14	*X22H-00836*	*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* **nutrient levels** *are within Tolerable limits: 50^{th} percentile of the data must be less than 0.125 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* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
IUA X2-10		
RU C16	*X23B-01052*	*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 (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Acceptable limits: 50^{th} percentile of the data must be less than 0.025 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
RU C17	*X23C-01098* *X23E-01154*	*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 (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Tolerable limits: 50^{th} percentile of the data must be less than 0.075 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* **toxics** *are within Ideal limits or A categories or TWQR: 95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in*

RUs	SQ number	Water Quality RQOs
	X23F-01120	*DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Ensure that* **As levels** *are within Ideal limits or A categories: 95th percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).* *Ensure that* **(free) Cn levels are** *within Ideal limits or A categories: 95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*
IUA X2-11		
MRU Croc D	*X24C-01033*	*Ensure that* **electrical conductivity (salt) levels** *are within Acceptable limits: 95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).* *Ensure that* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 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/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity.*
IUA X2-12 AND X2-13		
RU C19	*X24B-00903*	*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* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 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* **toxics** *are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 9 RIVERS: Summary of key WATER QUALITY RQOs in HIGH WQ priority RUs of the SABIE AND SAND RIVER System in the Inkomati catchment (X3)

RUs	SQ number	Water quality RQOs
IUA X3-4		
RU S6	*X31J-00774* *X31J-00835*	*Ensure that* **nutrient levels** *are within Acceptable limits: 50th percentile of the data must be less than 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 (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR[1]: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
RU S9	*X31K-00713*	*Ensure that* **nutrient levels** *are within Acceptable limits: 50th percentile of the data must be less than 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 (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*

RUs	SQ number	Water quality RQOs
IUA X3-5		
MRU Sabie C	X33A-00731 X33A-00737 X33B-00784 X33B-00804 X33B-00829 X33D-00811 X33D-00861	*Ensure that* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L PO_4-P.* *Ensure that* **electrical conductivity (salt) levels** *are within Ideal limits: 95th percentile of the data must be less than or equal to 42 mS/m (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).* *Ensure that* **toxics** *are within Ideal limits or A categories or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).* *Meet* **faecal coliform and *E.coli* targets** *for recreational (full contact) use: Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*
IUA X3-7		
RU S13	X32E-00639	*Ensure that* **nutrient levels** *are within Tolerable limits: 50th percentile of the data must be less than 0.125 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **periphyton chl-a levels** *are within Tolerable limits: 50th percentile of the data must be less than or equal to 84 mg/m^2 (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 42 mS/m (aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*
IUA X3-8		
RU S14	X32B-00551	*Ensure that* **nutrient levels** *are within Acceptable limits: 50th percentile of the data must be less than 0.025 mg/L* **PO_4-P** *(aquatic ecosystems: driver).* *Ensure that* **turbidity/clarity or TSS levels** *stay within Acceptable limits: A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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 or TWQR: 95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996a) and DWAF (2008).*

1 TWQR = Target Water Quality Range (DWAF, 1996a).
DWAF (1996a): South African Water Quality Guidelines: Volume 7: Aquatic Ecosystems.
DWAF (1996b): South African water quality guidelines. Volume 2: Recreational Use.

Table 10 - 12 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 TEC is provided for the relevant wetlands in the RU. All TECs are set to maintain the PES and are therefore immediately applicable. It must be noted, that although these wetlands can of high priority, the level of RQOs provided are at MODERATE level due to a lack of detailed information such as baseflow conditions and as none of the scenarios will impact on the wetlands.

Note that the following RQOs for the wetlands are standard and relevant for all RUs:
- *Maintain species composition and vegetative cover.*
- *No increase in the cover or abundance of woody alien invasive species.*
- *No increase in wetland fragmentation.*

Table 10 WETLANDS: Summary of key RQOs of HIGH PRIORITY wetlands situated in KOMATI RIVER System, Inkomati catchment (X1)

RUs	SQ number	TEC	Wetland RQO
IUA X1-1			
RU K1	*X11A-01354*	**C**	*Maintain C EC. Cessation of land use encroachment on pans, seeps and channeled valley bottom wetland.*
	X11A-01248	**C**	
RU K2	*X11B-01272*	**B/C**	*Improve to B/C by increasing buffer zones where wetlands are not artificial. Cessation of land use encroachment on non-artificial channeled valley bottom wetlands.*
IUA X1-3			
RU K3	*X11C-01147*	**C**	*Maintain C EC. Cessation of land use encroachment on pans, seeps and non-artificial channeled valley bottom wetlands.*
	X11D-01129	**C**	
RU K4	*X11E-01237*	**B**	*Maintain wetland EC of B/C. Cessation of land use encroachment on channeled valley bottom wetlands.*
RU K5	*X11G-01143*	**C**	*Maintain wetland EC of C. Cessation of land use encroachment on seeps.*
IUA X1-6			
RU K8	*X12A-01305*	**B**	*Cessation of land use, urban and forestry encroachment on seeps and channeled valley bottom wetlands.*
	X12C-01271	**B**	
	X12D-01235	**B/C**	
IUA X1-9			
RU K11	*X13J-01205*	**D**	*Maintain wetland EC of D. Cessation of land use and agricultural encroachment on floodplain and non-artificial channeled valley bottom wetlands.*

Table 11 WETLANDS: Summary of key RQOs of HIGH PRIORITY wetlands situated in the CROCODILE RIVER System, Inkomati catchment (X2)

RUs	SQ number	REC	Wetland RQO
IUA X2-1			
MRU Croc A	*X21A-00930*	**B/C**	*Off-channel wetlands generally in better condition, as well as those in Verloren Valei Nature Reserve. Other wetlands, improve to a B by improving wetland buffers, remove alien woody species in wetlands, no more dams and rehabilitate those not in use, reduce amount of dams if possible. Cessation of land use and forestry encroachment on wetlands*
RU C1	*X21B-00929*	**C**	*See above.*
	X21B-00898	**C**	
RU C2	*X21C-00859*	**C**	*Improve to a C by improving buffer zones for wetlands especially with reference to agriculture. Cessation of land use and forestry encroachment on natural wetlands.*
IUA X2-3			
MRU Elan A	*X21F-01046*	**B/C**	*Improve to a B/C by removing agriculture from wetland areas. Cessation of land use and agricultural encroachment on natural wetlands (seeps and channelled valley bottom).*
IUA X2-8			
RU C12	*X22C-01004*	**B/C**	*Improve to a B/C by removing agriculture from wetland areas. Cessation of land use and forestry encroachment on natural wetlands (seeps and channelled valley bottom).*
RU C14	*X22H-00836*	**D**	*Maintain EC of a D. Cessation of farm dam construction*
IUA X2-10			

RUs	SQ number	REC	Wetland RQO
RU C17	*X23E-01154*	**B/C**	*Maintain EC of a B/C. Cessation of forestry encroachment on seeps.*

Table 12 WETLANDS: Summary of key RQOs of HIGH PRIORITY wetlands situated in the SABIE AND SAND RIVER System, Inkomati catchment (X3)

RUs	SQ number	REC	Wetland RQO
IUA X3-7			
MRU Mut A	*X32D-00605 (EWR S6)*	**C**	*Improve to a C by improving wetland buffers and reduce overgrazing.*
IUA X3-8			
MRU Sand A	*X32A-00583 (EWR S7)*	**C**	*Improve to a C by improving wetland buffers and reduce overgrazing.*
RU S14	*X32B-00551*	**C**	*Maintain wetland EC of C.* *Cessation of land use encroachment on channelled valley bottom wetlands.*

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TERMINOLOGY AND ACRONYMS

AMD	*Acid Mine Drainage*
ASPT	*Average Score Per Taxon*
CD: WE	*Chief Directorate: Water Ecosystems*
CEV	*Chronic Effects Value*
DARDLA	*Department of Rural Development and Land Affairs*
DD	*Data Deficient*
DRM	*Desktop Reserve Model*
DS	*Downstream*
DSS	*Decision Support System*
DWA	*Department of Water Affairs (Change after 2008)*
DWAF	*Department of Water Affairs and Forestry*
DWS	*Department of Water Affairs and Sanitation (Change after May 2014)*
EC	*Ecological Category*
EcoSpecs	*Ecological Specifications*
EI	*Environmental Importance*
EIS	*Ecological Importance and Sensitivity*
ES	*Ecological Sensitivity*
EWR	*Ecological Water Requirement*
FRAI	*Fish Response Assessment Index*
FROC	*Frequency of Occurrence*
GDP	*Gross Domestic Product*
IIMA	*Interim IncoMaputo Agreement*
ind/min	*Individuals per minute*
IUA	*Integrated Unit of Analysis*
IUCN	*International Union for Conservation of Nature*
KNP	*Kruger National Park*
LC	*Least Concern*
MCM	*Million Cubic Metres*
MIRAI	*Macro Invertebrate Response Assessment index*
MPTA	*Mpumalanga Tourism and Parks Authority*
MRU	*Management Resource Unit*
NFEPA	*National Freshwater Ecosystem Priority Areas*
nMAR	*Natural Mean Annual Runoff*
NWRC	*National Water Resource Classification*
NWRS	*National Water Resource Strategy*
PAI	*Physico-chemical Driver Assessment Index*
PES	*Present Ecological State*
PESEIS	*Present Ecological State and Ecological Importance - Ecological Sensitivity*
pMAR	*Present Day Mean Annual Runoff*
PR	*Priority Rating*
PSP	*Professional Service Provider*
RDRM	*Revised Desktop Reserve Model*
REC	*Recommended Ecological State*
RHAM	*Rapid Habitat Assessment Method*
RQOs	*Resource Quality Objectives*
RU	*Resource Unit*
SASS 5	*South African Scoring System version 5*
Sc	*Scenario*
SIC	*Stones in Current*
SQ	*Sub Quaternary*

TEACHA	*Tool for Ecological Aquatic Chemical Habitat Assessment*
TEC	*Target EC*
TIN	*Total Inorganic Nitrogen*
TPCs	*Thresholds of Potential Concern*
TSS	*Total Suspended Solids*
TTG	*Technical Task Group*
TWQR	*Target Water Quality Range*
US	*Upstream*
VEGRAI	*Vegetation Response Assessment Index*
WMA	*Water Management Area*
WWTW	*Waste Water Treatment Works*
WReMP	*Water Resources Modelling Platform*

Fish species name abbreviations

AMAR	*Anguilla marmorata*
AMOS	*Anguilla mossambica*
ANAT	*Amphilius natalensis*
AURA	*Amphilius uranoscopus*
BANN	*Barbus annectens*
BANO	*Barbus anoplus*
BARG	*Barbus argenteus*
BBIF	*Barbus bifrenatus*
BBRI	*Barbus brevipinnis*
BEUT	*Barbus eutaenia*
BIMB	*Brycinus imberi*
BMAR	*Labeobarbus marequensis*
BNEE	*Barbus neefi*
BPAU	*Barbus paludinosus*
BPOL	*Labeobarbus polylepis*
BRAD	*Barbus radiatus*
BTRI	*Barbus trimaculatus*
BUNI	*Barbus unitaeniatus*
BVIV	*Barbus viviparus*
CANO	*Chiloglanis anoterus*
CBIF	*Chiloglanis bifurcus*
CBRE	*Chetia brevis*
CEMA	*Chiloglanis emarginatus*
CGAR	*Clarias gariepinus*
CPAR	*Chiloglanis paratus*
CPRE	*Chiloglanis pretoriae*
CSWI	*Chiloglanis swierstrai*
GGIU	*Glossogobius giuris*
HMOL	*Hypophthalmichthys molitrix*
HVIT	*Hydrocynus vittatus*
LCON	*Labeo congoro*
LCYL	*Labeo cylindricus*
LMOL	*Labeo molybdinus*
MACU	*Micralestes acutidens*
MMAC	*Marcusenius macrolepidotus*
OMOS	*Oreochromis mossambicus*
OMYK	*Oncorhynchus mykiss*
OPER	*Opsaridium peringueyi*
PCAT	*Petrocephalus wesselsi*

PPHI	*Pseudocrenilabrus philander*
SMER	*Serranochromis meridianus*
TREN	*Tilapia rendalli*
TSPA	*Tilapia sparrmanii*
VNEL	*Varicorhinus nelspruitensis*
XHEL	*Xiphophorus helleri*

Fish and Macro-invertebrate Habitats

FD	*Fast Deep*
FFCS	*Fast flow over coarse sediment*
FS	*Fast Shallow*
MV	*Marginal Vegetation*
SD	*Slow Deep*
SIC	*Stones in Current*
SS	*Slow Shallow*
VFCS	*Very fast flow over coarse sediment*

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Water Ecosystems (CD: WE) of the Department of Water and Sanitation (DWS) initiated a study during 2013 for the provision of professional services to undertake the determination of water resource classes and associated Resource Quality Objectives (RQOs) in the Inkomati Water Management Area (WMA). IWR Water Resources was appointed as the Professional Service Provider (PSP) to undertake this study which is managed by Rivers for Africa for IWR Water Resources.

1.2 STUDY AREA OVERVIEW

The study area comprises the Komati, Crocodile East and Sabie-Sand rivers. These three major tributaries of the international Incomati River Basin are operated largely independently of each other and are therefore described in this section as separate entities.

The Komati River rises in South Africa and flows into Swaziland, then re-enters South Africa where it is joined by the Crocodile River at the border with Mozambique, before flowing into Mozambique as the Incomati River. The Kruger National Park (KNP) is partially located in the Sabie and Crocodile catchments. The Crocodile River is located between the Komati and Sabie rivers. The Crocodile River joins the Komati River just before the border with Mozambique to form the Incomati River. The Sabie River catchment lies in the north of the Inkomati WMA, entering Mozambique after flowing through the Kruger National Park. Once in Mozambique, the Sabie joins the Komati River. The Sabie River catchment is considered the most pristine of the six river catchments that cross over from South Africa to Mozambique (DWA, 2013a).

1.3 INTEGRATED STEPS APPLIED IN THIS STUDY

The integrated steps for the National Water Classification System, the Reserve and RQOs (DWA, 2013b) 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.*
5	*Evaluate the scenarios with stakeholders and determine Water Resource 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 (2010a).

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 Integrated Units of Analysis (IUAs) and define RUs.*	*RUs are defined at a broad level on a sub-quaternary (SQ) 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 (EWRs) and changes in non-water quality ecosystem.*	*3. Prioritise and select RUs for RQO determination.*	*More detailed RUs defined for high priority rivers.*
		4 Prioritise 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 evaluation of scenarios within the Integrated Water Resource Management process.*		
5	*Evaluate the scenarios with stakeholders and determine Water Resource Classes.*	*6. Agree on RUs, RQOs and numerical limits with stakeholders.*	*Is undertaken during all preceding stakeholder meetings. RQOs (hydrological) are agreed on during the Water Resource Class decision making as the hydrological RQOs are the flows associated with the Water Resource Class.*
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, WATER RESOURCE CLASS AND RQOs

Operational scenarios, Water Resource Classes and RQOs are inherently linked as operational scenarios (Sc) to inform the Water Resource Class and RQOs define and/or describe the Water Resource Class (Figure 1.2).

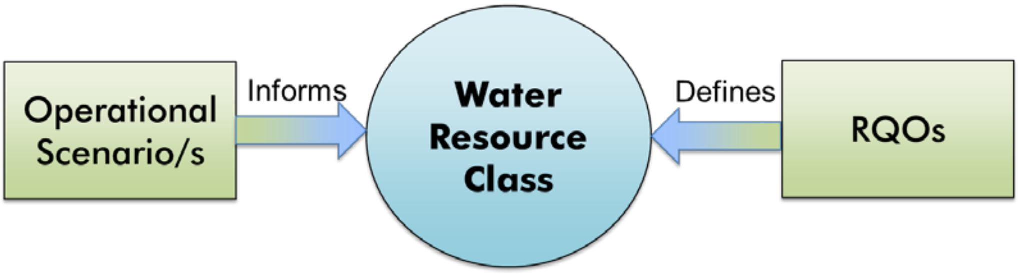


Figure 1.1 Links between RQOs and the Water Resource Class and operational scenarios

Various scenarios were tested and the selected Water Resource Class indicated for each scenario (DWS, 2014a). A summary of recommendations and implications are provided below:

1.6.1 Komati River System

- *The scenario immediately applicable:*
  - *Maintain the current ecological state and operation of the Komati and Lomati Rivers.*
  - *Institute measures (non flow-related) to achieve the Recommended Ecological Category (REC) in tributaries of the main rivers (relevant for future scenarios as well).*

Implications: No implications to users. The REC in the Lomati River is not achieved under the current situation and the ecological status quo is maintained.

- *Long-term scenario / the scenario that may be applicable in future (Sc K42)*
  - *Maintain the current ecological state,*
  - *Provision of Interim IncoMaputo water use Agreement (IIMA) flows,*
  - *Providing water for domestic growth up to the year 2030,*
  - *Reinstatement of fallow irrigation as suggested by the Department of Rural Development and Land Affairs (DARDLA).*

Implications: No negative economic implications as a whole but a reduction of the assurance of supply in irrigation downstream of Swaziland (other than the DARDLA irrigation).

The draft Water Resource Classes are provided in the table below. The catchment configuration are provided in the next table.

Table 1.3 Komati River system draft Water Resource Classes

Green - immediately applicable
Blue - applicable in the medium to long term.

IUA (EWR site)	PES[1]	REC	K42
X1-1	*II*	**II**	**II**
X1-2	*II*	**II**	**II**
X1-3 (K1)	*II*	**II**	**II**
X1-4 (G1)	*III*	**III**	**III**
X1-5 (K2)	*II*	**II**	**II**
X1-6 (T1)	*II*	**I**	**I**
X1-7	**II**	*I*	**II**
X1-8 (L1)	**III**	*II*	**III**

IUA (EWR site)	PES[1]	REC	K42
X1-9 (K3)	III	III	III
X1-10	XXX	III	III

1 Present Ecological State

Table 1.4 Komati River system draft Water Resource Classes and Catchment Configuration

Note: The red blocks indicate SQs which require non flow-related improvements to achieve the REC.

Note: The purple blocks indicate a change of the target Ecological Category - EC (REC) once Sc K42 or similar is applicable.

IUA	Water Resource Class	Nodes	River	KM	TEC for: Immediate[1]	TEC for: Sc K42[2]
X1-1	II	X11A-01300		12.3	B	B
		X11A-01354		25.6	C	C
		X11A-01358	Vaalwaterspruit	23.6	C	C
		X11A-01295	Vaalwaterspruit	12.0	C	C
		X11A-01248	Vaalwaterspruit	30.2	C	C
		X11B-01370	Boesmanspruit	15.7	B	B
		X11B-01361		17.5	B/C	B/C
		X11B-01272	Boesmanspruit	29.1	C	C
X1-2	II	EWRK1	Komati	93	C	C
X1-3	II	X11C-01147	Witkloofspruit	33.5	C	C
		X11D-01129	Klein-Komati	39.6	C	C
		X11D-01137	Waarkraalloop	21.1	C	C
		X11E-01237	Swartspruit	29.3	B	B
		X11F-01133	Bankspruit	17.6	B	B
		X11G-01188	Ndubazi	22.3	B	B
		X11G-01143	Gemakstroom	14.9	C	C
X1-4	III	EWRG1	Mngubhudle	49.6	D	D
		X11K-01165	Poponyane	13.8	C	C
		X11K-01199		8.5	D	D
X1-5	II	EWRK2	Komati	80.8	C	C
X1-6	I	X12A-01305	Buffelspruit	33.6	B	B
		EWRT1	Teespruit	66.1	C	C
		X12B-01246	Hlatjiwe	22.8	C	C
		X12C-01242	Phophenyane	10.7	B	B
		X12C-01271	Buffelspruit	12.5	B	B
		X12D-01235	Seekoeispruit	26.7	C	C
		X12H-01338	Sandspruit	12.6	B	B
		X12H-01340		10.4	B	B
		X12H-01318	Sandspruit	8.3	C	C
		X12J-01202	Mtsoli	54.4	B	B
		X12K-01333	Mlondozi	23.8	B/C	B/C

IUA	Water Resource Class	Nodes	River	KM	TEC for:	
					Immediate[1]	Sc K42[2]
		X12K-01332	Mhlangampepa	17.0	B	B
X1-7	II	X14A-01173	Lomati	47.7	B/C	B/C
		X14B-01166	Ugutugulo	24.8	C	C
		X14F-01085	Mhlambanyatsi	41.1	C	C
X1-8	III	EWRL1	Lomati	57.3	C	C/D
		X14G-01128	Lomati	23.5	D/E	D/E
X1-9	III	X13J-01214	Mgobode	24.2	C	C
		X13J-01205	Mbiteni	20.0	D	D
		X13J-01141	Mzinti	43.4	D	D
		EWRK3A	Komati	71.21	D	D
X1-10	III[3]	X13K-01114	Komati	5.2	D	D
		X13K-01136	Mambane	19.2	D	D
		X13K-01068	Nkwakwa	44.7	C/D	C/D
		X13K-01038	Komati	35.3	E	E
		X13L-01000	Ngweti	44.9	D	D
		X13L-01027	Komati	10.7	E	E
		X13L-00995	Komati	3.1	D	D

1 Immediately applicable until Sc K42 or a similar scenario is implemented.
2 Applicable in the medium to long term.
3 Due to the large sections of E EC river, this IUA does not comply with a Level III Water Resource Class. The Level III that has been allocated is applicable to the rest of the IUA which is in a D and C/D EC.

It is proposed to gazette the Water Resource Classes and catchment configuration as in the table above for the immediate TECs and RQOs will be set for the short term ECs.

1.6.2 Crocodile River system

- *The scenario immediately applicable:*
  - *The current situation which includes the release of a portion of the ecological flow requirements that were determined to maintain the PES.*
  - *Institute measures (non flow-related) to achieve the REC in tributaries of the main rivers (Elands, Crocodile and Kaap Rivers)(relevant for future scenarios as well),*

Implications: No implication to users as this scenario represents the current baseline. The REC in the downstream Crocodile River will not be met and the scenario will in the long term possibly degrade the PES.

- *The scenario that may be applicable in the near future (medium term) (Sc C3)*
  - *Allow for future domestic growth,*
  - *Give effect to the IIMA,*
  - *Supply the full flow requirements to maintain the PES.*

Implications: Some negative impact on Gross Domestic Product (GDP) and jobs. The REC in the downstream Crocodile River will not be met. The ecological state may improve from Sc C1 but will likely still not achieve the Present Ecological State.

- *The scenario that may be applicable in the far future (long term) (Sc C62)*
  - *Supply the full flow requirements to maintain the PES,*
  - *Allow for future domestic growth,*
  - *Give effect to the IIMA,*

- *Mountain view Dam development in the Kaap River.*

Implications: Job losses in the irrigation sector due to the provision of water for the domestic section (improvement from Sc C3). The ecological implications are the same as for Sc C3.

- *The scenario that may be applicable in the far future (next phase after Sc 62 has been implemented) (Sc C82)*
  - *Dam developments in both the Kaap River (Mountain View) and the Nels (Boschjeskop) River,*
  - *Supply the full flow requirements to maintain the PES,*
  - *Allow for future domestic growth,*
  - *Give effect to the IIMA.*

Implications: Jobs will increase from the baseline. The ecological implications are the same as for Sc C3.

Table 1.5 Crocodile River system draft Water Resource Classes

Green - immediately applicable
Blue - applicable in the short term
Pink - applicable in the long term
Orange - applicable in the far long term.

IUA	Scenarios and Water Resource Class				
	PES	REC	C3	C62	C82
X2-1	II	II	II	II	II
X2-2	II	II	II	II	II
X2-3	I	I	I	I	I
X2-4	I	I	I	I	I
X2-5	I	I	I	I	I
X2-6	II	I	II	II	II
X2-7	II	I	I	I	I
X2-8	XXX	II	II	II	II
X2-9	II	I	II	II	II
X2-10	II	II	II	II	II
X2-11	II	I	II	II	II
X2-12	II	II	II	II	II
X2-13	I	I	I	I	I

Table 1.6 Crocodile River system draft Water Resource Classes and Catchment Configuration

Note, the red blocks indicate SQs which require non flow-related improvements to achieve the REC and refers to Table 8.7.
Note: The purple blocks indicate SQs where the catchment configuration (in terms of the TEC) are different between the current state and future scenario.

IUA	Water Resource Class	Nodes	River	KM	TEC for:			
					Im-mediate	Sc C3	Sc C62	Sc C82
X2-1	II	X21B-00898	Lunsklip	11.0	C/D	C/D	C/D	C/D
		X21B-00929	Gemsbokspruit	8.8	C/D	C/D	C/D	C/D
		X21B-00925	Lunsklip	21.5	C	C	C	C
		EWRC1	Crocodile	30.8	A/B	A/B	A/B	A/B

IUA	Water Resource Class	Nodes	River	KM	TEC for: Im-mediate	Sc C3	Sc C62	Sc C82
		EWRC2	Crocodile	30.1	B	B	B	B
		X21C-00859	Alexanderspruit	36.9	C	C	C	C
X2-2	II	EWRC3	Crocodile	58.3	B/C	C	C	C
		X21D-00957	Buffelskloofspruit	27.1	B/C	B/C	B/C	B/C
		X21E-00897	Buffelskloofspruit	14.6	B	B	B	B
X2-3	I	X21F-01100	Leeuspruit	12.9	C	C	C	C
		X21F-01092	Leeuspruit	1.0	C/D	C/D	C/D	C/D
		X21F-01091	Rietvleispruit	13.2	C	C	C	C
		EWRE1	Elands	55.6	B	B	B	B
X2-4	I	X21G-01090	Weltevredespruit	13.8	C	C	C	C
		X21G-01016	Swartkoppiespruit	13.8	C	C	C	C
		X21H-01060	Ngodwana*	20	B	B	B	B
		X21K-01007	Lupelule	20.0	B	B	B	B
X2-5	I	EWRE2	Elands	59	B	B	B	B
X2-6	II	X22B-00987	Crocodile	Linked to EWR C4				
		X22B-00888	Crocodile					
		X22C-00946	Crocodile					
		X22J-00993	Crocodile					
X2-7	I	X22A-00824	Blystaanspruit	19.4	B	B	B	B
		X22A-00887	Beestekraalspruit	7.4	B/C	B/C	B/C	B/C
		X22A-00875	Houtbosloop	10.4	B	B	B	B
		X22A-00919	Houtbosloop	0.7	B/C	B/C	B/C	B/C
		X22A-00920		4.5	B	B	B	B
		X22A-00917	Houtbosloop	2.7	C	C	C	C
		X22A-00913	Houtbosloop	28.3	B	B	B	B
		X22C-00990	Visspruit	10.0	B/C	B/C	B/C	B/C
X2-8	II	X22D-00843	Nels	24.9	C	C	C	C
		X22D-00846		16.7	C	C	C	C
		X22F-00842	Nels	35.1	C	C	C	C
		X22E-00849	Sand	12.7	C	C	C	C
		X22E-00833	Kruisfonteinspruit	9.8	C	C	C	C
		X22F-00886	Sand	29.7	C	C	C	C
		X22F-00977	Nels	6.7	C/D	C/D	C/D	C/D
		X22C-01004	Gladdespruit	36.7	B/C	B/C	B/C	B/C
		X22H-00836	Wit	59.2	D	D	D	D
X2-9	II	X22K-01042	Mbuzulwane	10.0	B	B	B	B
		X22K-01043	Blinkwater	16.3	B	B	B	B
		X22K-01029	Blinkwater	3.4	C	C	C	C
		EWRC4	Crocodile	41.3	C	C	B/C	C

IUA	Water Resource Class	Nodes	River	KM	TEC for: Im-mediate	Sc C3	Sc C62	Sc C82
X2-10	II	X23B-01052	Noordkaap	7.2	C	C	C	C
		X23C-01098	Suidkaap	22.9	B/C	B/C	B/C	B/C
		EWRK7	Kaap	11.2	C	C	C	C
		X23E-01154	Queens	31.0	B/C	B/C	B/C	B/C
		X23F-01120	Suidkaap	28.6	C	C	C	C
X2-11	II	EWRC5	Crocodile	23	C	C	C	B/C
		EWRC6	Crocodile	99	C	C	C	C
X2-12	II	X24A-00826	Nsikazi	27.8	C	C	C	C
		X24A-00860	Sithungwane	12.4	A	A	A	A
		X24A-00881	Nsikazi	10.3	B	B	B	B
		X24B-00903	Gutshwa	19.1	D	D	D	D
		X24B-00928	Nsikazi	11.9	A/B	A/B	A/B	A/B
		X24C-00969	Mnyeleni	12.4	A	A	A	A
		X24C-00978	Nsikazi	21.2	B	B	B	B
X2-13	I	X24E-00973	Matjulu	17.3	B	B	B	B
		X24E-00922	Mlambeni	39.2	A/B	A/B	A/B	A/B
		X24G-00902	Mitomeni	21.9	A	A	A	A
		X24G-00876	Komapiti	16.0	A	A	A	A
		X24G-00844	Mbyamiti	19.8	A	A	A	A
		X24G-00823	Muhlambamadubo	21.0	A	A	A	A
		X24G-00820	Mbyamiti	28.9	A	A	A	A
		X24G-00904	Mbyamiti	5.2	A	A	A	A
		X24H-00882	Vurhami	36.6	A	A	A	A
		X24H-00892	Mbyamiti	28.8	A	A	A	A

**Note, the B is relevant upstream of Godwana Dam. The dam and the short river distance downstream of the dam is in an E Category, but the management of the rest of the river upstream of the dam (20 km) must be in a B.*

It is proposed to gazette the Water Resource Classes and catchment configuration ECs as in the Immediate column and RQOs will be set for these.

1.6.3 Sabie-Sand River systems

- *The scenario immediately applicable:*
  - *Maintain the current ecological state and operation of the system,*
  - *Institute measures (non flow-related) to achieve the REC in the Sabie River upstream of the KNP and various tributaries(relevant for future scenarios as well),*
  - *May include the reinstatement of forestry in the Sand catchment.*

Implications: No implications to users as this scenario represent the current baseline. This scenario will not however cater for an increase in domestic use in the Sabie River in the future. The REC in the Mutlumuvi River is not achieved under the current situation and the ecological status quo is maintained in this river.

- *Long-term scenario / the scenario that may be applicable in future (Sc S71)*
  - *New dam development in the Mutlumuvi River,*

- *Supply of the environmental flows supporting the REC in the Mutlumuvi River and downstream Sand River,*
- *Assumed increase in return flows of 25% resulting from improved water supply to the Sand catchment,*
- *Decreased transfer from the Sabie River.*

Implications: Significant economic improvement in GDP and jobs in the Sand River. Water for increased domestic growth in the Sabie River will be available. The REC will be maintained in all rivers except for the Mutlumuvi River.

Table 1.7 Sabie-Sand River systems draft Water Resource Classes

Green - immediately applicable
Blue - applicable in the medium to long-term

IUA	Catchment	Scenarios and Water Resource Class		
		PES	REC	S 71
X3-1	Sabie	II	I	I
X3-2	Sabie	II	I	I
X3-3	Sabie	I	I	I
X3-4	Sabie	III	III	III
X3-5	Sabie	I	I	I
X3-6	Sabie	I	I	I
X3-7	Sand	III	II	II
X3-8	Sand	II	II	II
X3-9	Sand	I	I	I

Table 1.8 Sabie-Sand River systems draft Water Resource Classes and Catchment Configuration

Note, the red blocks indicate SQs which require non flow-related improvements to achieve the REC and refers to Table 8.7.
Note: The purple blocks indicate SQs where the catchment configuration (in terms of the TEC) are different between the current state and future scenario.

IUA	Water Resource Class	Nodes	River	KM	Immediate	Sc S71
X3-1	I	X31A-00741	Klein Sabie	14.6	B/C	B/C
		X31A-00783		5.4	C	C
		X31A-00786		5.2	B	B
		X31A-00794		1.1	B	B
		X31A-00796		1.0	B	B
		X31A-00803		0.6	B/C	B/C
X3-2	I	EWR S1	Sabie	57	B	B
		X31B-00792	Goudstroom	8.8	B/C	B/C
		EWR S4	Mac-Mac	46.8	B	B
		EWR S2	Sabie		B	B
		X31E-00647a	Marite (US of dam)	19.9	B	B

IUA	Water Resource Class	Nodes	River	KM	Immediate	Sc S71
		X31F-00695	Motitsi	42.8	B	B
X3-3	I	EWR S5	Marite	8.0	B/C	B/C
		EWR S3	Sabie		A/B	A/B
X3-4	III	X31D-00773	Sabani	19.8	C/D	C/D
		X31H-00819	White Waters	32.6	C	C
		X31J-00774	Noord-Sand	16.9	D	D
		X31J-00835	Noord-Sand	13.4	D	D
		X31K-00713	Bejani	17.7	D	D
		X31L-00657	Matsavana	12.8	C	C
		X31M-00673	Musutlu	40.3	B/C	B/C
		X31L-00664	Saringwa	28.9	C	C
		X31L-00678	Saringwa	16.6	B/C	B/C
X3-5	I	X33A-00731	Sabie		A/B	A/B
		X33A-00737	Sabie		A/B	A/B
		X33B-00784	Sabie		A/B	A/B
		X33B-00804	Sabie		A/B	A/B
		X33B-00829	Sabie		A/B	A/B
		X33D-00811	Sabie		A/B	A/B
		X33D-00861	Sabie		A/B	A/B
X3-6	I	X31K-00771	Phabeni	19.2	B	B
		X31M-00763	Nwaswitshaka	56.0	A	A
		X33A-00661	Nwatindlopfu	25.9	A	A
		X33A-00806	Nwatimhiri	35.5	A	A
		X33B-00694	Salitje	35.4	A	A
		X33B-00834	Lubyelubye	20.7	A	A
		X33C-00701	Mnondozi	46.9	A	A
		X33D-00864	Mosehla	19.9	A	A
		X33D-00894	Nhlowa	9.9	A	A
		X33D-00908	Shimangwana	8.3	A	A
		X33D-00911	Nhlowa	5.7	A	A
X3-7	II	X32E-00629	Nwarhele	18.0	C	C
		X32E-00639	Ndlobesuthu	6.8	D/E	D/E
		EWR S6	Mutlumuvi		C	C
		X32F-00628	Nwarhele	6.5	C/D	C/D
X3-8	II	X32B-00551	Motlamogatsana	27.1	C	C
		EWR S7	Tlulandziteka		C	C
		X32C-00558	Nwandlamuhari	15.1	C	C
		X32C-00564	Mphyanyana	11.9	C	C
		X32C-00606	Nwandlamuhari	1.2	C	C
		X32G-00549	Khokhovela	28.0	C	C
X3-9	I	X32H-00560	Phungwe	**30.9**	A	A
		EWR S8	Sand		B	B
		X32J-00651	Mutlumuvi	**24.8**	A	A

It is proposed to gazette the Water Resource Classes and catchment configuration as in the Immediate column above and RQOs will be set for the short term ECs these.

1.6.4 X4 Secondary Catchment

None of the scenarios impact on the X4 rivers which are mostly situated in the KNP. The TEC is therefore the same as the PES and REC.

Table 1.9 TECs and Water Resource Classes in the X4 Secondary Catchment

IUA	Class	Nodes	River	TEC
U4	I	X40A-00437	Shinkelengane	A
		X40A-00454	Mmondzo	A
		X40A-00479	Nwanedzi	A
		X40A-00492	Rihlazeni	A
		X40A-00433	Mtomeni	A
		X40A-00420	Gudzani	A
		X40A-00426	Mavumbye	A
		X40A-00475	Mavumbye	A/B
		X40A-00459	Nwanedzi	A
		X40A-00486	Nwanedzi	A/B
		X40A-00469	Nwanedzi	B
		X40B-00534	Nungwini	A
		X40B-00537	Gwini	A
		X40B-00532	Mrunzuluku	A
		X40B-00497	Sweni	A
		X40B-00531	Mrunzuluku	A
		X40B-00530	Mrunzuluku	A
		X40B-00511	Sweni	A
		X40C-00592	Ripape	A
		X40C-00513	Nwaswitsontso	B
		X40D-00663	Shilolweni	A
		X40D-00594	Metsimetsi	A
		X40D-00598	Nwaswitsontso	A/B

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 Inkomati Catchment.

The report outline is as follows:

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

Chapter 2: Prioritising RUs and Indicator Components
This Chapter provides an overview of the important Resource Units in the study area, the approach and format of selected RQO components.

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

Chapter 4 – 33: Resource Quality Objectives
These chapters outline the RQOs of the various components per IUA.

Chapter 34: References

2 PRIORITISING RUs AND INDICATOR COMPONENTS

2.1 RIVER RESOURCE UNITS

As part of the Classification process, once the IUAs have been defined, Resource Units (RUs) and biophysical nodes must be identified for different levels of EWR assessment and the setting of RQOs. Resource Units (RUs) are sections of a river that frequently have different natural flow patterns, react differently to stress according to their sensitivity, and therefore require individual specifications of the Reserve appropriate for that reach. The guiding principle is that if the hydrology, geomorphic characteristics (i.e. geomorphic zone), physico-chemical attributes and river size remains relatively similar, a RU can be demarcated (DWAF, 2008a).

Management requirements (DWAF, 1999, volume 3) also play a role in the delineation. An example could be where large dams and/or transfer schemes occur. Furthermore, the type of disturbance/impact on the river plays a role to select homogenous river reaches from a biophysical basis under present circumstances. These are called Management Resource Units (MRUs) and the purpose of distinguishing MRUs is to identify a management unit within which the EWR can be implemented and managed based on one set of identified flow requirements. MRUs are homogenous units which are sufficiently different from adjacent areas to warrant a separate EWR assessment being undertaken (Louw and Hughes, 2002). This means that an EWR site in the MRU, according to the EWR site selection criteria in context of the MRU, will provide for the whole MRU. Hydrological changes due to incremental runoff must obviously be taken into account (DWAF, 2008a).

Therefore an IUA can consist of RUs, MRUs or both.

Resource Units are delineated as follows:

- *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).*
- *For the purposes of RQOs, the SQs were combined to form RUs which represent a homogenous area of similar state and landuse. This process is followed in tributaries and rivers with no EWR sites which are usually lower priority areas and therefore do not include hotpots (DWA, 2013a)*
- *In key rivers which include hotspots (DWA, 2013a), a detailed RU assessment was undertaken to determine MRU. These also consist of a range of SQs, but the process and criteria used are more detailed than for the lower priority rivers. These MRUs were undertaken during Reserve studies (AfriDev, 2005a; DWAF, 2008a). Most MRUs are represented by key biophysical nodes (EWR sites) (DWA, 2013a).*

RU priority is based on the outcome of the hotspot assessment (DWA, 2013a) (Step 1 of the integrated steps for the National Water Resource Classification (NWRC) and RQO determination; DWA (2007)) as well as available information and confidence in the information.

There are three main 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 PES and REC (EcoStatus).*
	1b	*Habitat RQO in terms of PES and REC (EcoStatus) (total river length 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 EWR site.*
	3b	*EWR site. Flow RQO related to preferred scenario. Detailed habitat and biota RQO (EcoSpecs).*
	3WQ	*User water quality RQOs required. Habitat and biota RQO will be at a priority level 2.*

2.1.1 Priority of Resource Units

The allocated priority level of each RU consisting of SQ reaches, each represented by biophysical node is provided in Table 2.1 to 2.4 and Figure 2.1 to 2.3 according to River System.

Table 2.2 Komati River System: Priority level of RQO RUs

RUs	SQ number	River	RU priority rating	RU priority breakdown
IUA X1-1				
RU K1	*X11A-01300*		**2**	
	X11A-01354			
	X11A-01358	*Vaalwaterspruit*	**3WQ**	*2 for biota and habitat*
	X11A-01248	*Vaalwaterspruit*	**3WQ**	*2 for biota and habitat*
	X11A-01295	*Vaalwaterspruit*		*2 for biota and habitat*
RU K2	*X11B-01370*	*Boesmanspruit*	**3WQ**	*2 for biota and habitat*
	X11B-01361			
	X11B-01272	*Boesmanspruit*		
IUA X1-2				
MRU Komati B	*X11D-01219*	*Komati*	**3**	*3b, EWR K1*
	X11D-01196	*Komati*		*3b, EWR K1*
	X11E-01157	*Komati*		*3b, EWR K1*
	X11F-01163	*Komati*		*3b, EWR K1*
	X11G-01142 EWR K1	*Komati*		*3a*
	X11G-01177	*Komati*		*3b, EWR K1*
	X11H-01140a	*Komati, X11H-01140a*		*3b, EWR K1*
IUA X1-3				
RU K3	*X11C-01147*	*Witkloofspruit*	**3WQ**	*2 for biota and habitat*
	X11D-01129	*Klein-Komati*		
	X11D-01137	*Waarkraalloop*		
RU K4	*X11E-01237*	*Swartspruit*	**3WQ**	*2 for biota and habitat*
RU K5	*X11F-01133*	*Bankspruit*	**2**	
	X11G-01143	*Gemakstroom*		
RU K6	*X11G-01188*	*Ndubazi*	**2**	
IUA X1-4				
MRU Komati G	*X11J-01106 EWR G1*	*Mngubhudle*	**3**	*3a*
	X11K-01179	*Gladdespruit*		*3b, EWR G1*
	X11K-01194	*Gladdespruit*		*3b, EWR G1*
RU K7	*X11K-01165*	*Poponyane*	**2**	

RUs	SQ number	River	RU priority rating	RU priority breakdown
	X11K-01199			
IUA X1-5				
MRU Komati C	X11H-01140b	X11H-01140b	**3**	3b, EWR K2
	X11K-01227	Komati		3b, EWR K2
	X12G-01200	Komati		3b, EWR K2
	X12H-01296	Komati		3b, EWR K2
	X12H-01258 EWR K2	Komati		3a
	X12K-01316	Komati		3b, EWR K2
IUA X1-6				
MRU Komati T	X12E-01287 EWR T1	Teespruit	**3**	3a
RU K8	X12A-01305	Buffelspruit	**2**	
	X12B-01246	Hlatjiwe		
	X12C-01242	Phophenyane		
	X12C-01271	Buffelspruit		
	X12D-01235	Seekoeispruit		
RU K9	X12H-01338	Sandspruit	**2**	
	X12H-01340			
	X12H-01318	Sandspruit		
	X12K-01333	Mlondozi		
	X12K-01332	Mhlangampepa		
RU K10	X12J-01202	Mtsoli	**1**	1a
IUA X1-7				
RU K 12	X14A-01173	Lomati	**1**	1a
	X14B-01166	Ugutugulo		1a
	X14F-01085	Mhlambanyatsi	**2**	
IUA X1-8				
MRU Komati M	X14G-01128	Lomati	**3**	3b, EWR L1
	X14H-01066 EWR L1	Lomati		3a
IUA X1-9				
RU K11	X13J-01214	Mgobode	**2**	
	X13J-01141	Mzinti		
	X13J-01205	Mbiteni		
MRU Komati D	X13J-01221	Komati	**3**	3b, EWR K3A
	X13J-01210	Komati		3b, EWR K3A
	X13J-01149	Komati		3b, EWR K3A
	X13J-01130 (EWR K3A)	Komati		3a
IUA X1-10				
RUK13	X13K-01136	Mambane	**2**	
	X13K-01068	Nkwakwa		
	X13L-01000	Ngweti	**3WQ**	2
MRU Komati E	X13K-01114	Komati	**3WQ**	3b, EWR K3A
	X13K-01038	Komati		3b, EWR K3A
	X13L-01027	Komati		3b, EWR K3A
	X13L-00995	Komati		3b, EWR K3A

Table 2.3 Crocodile River System: Priority level of RQO RUs

RUs	SQ number	River	RU priority rating	RU priority breakdown

RUs	SQ number	River	RU priority rating	RU priority breakdown
IUA X2-1				
MRU Croc A	X21A-00930 (EWR C1)	Crocodile		3a
	X21B-00962 (EWR C2)	Crocodile		3a
RU C1	X21B-00929	Gemsbokspruit	**2**	
	X21B-00898	Lunsklip		
	X21B-00925	Lunsklip		
RU C2	X21C-00859	Alexanderspruit	**2**	
IUA X2-2				
RU C3	X21D-00957	Buffelskloofspruit	**2**	
RU C4	X21E-00897	Buffelskloofspruit	**2**	
MRU Croc B	X21D-00938	Crocodile	**3**	3b, EWR C3
	X21E-00947	Crocodile		3b, EWR C3
	X21E-00943 (EWR C3)	Crocodile		3a
IUA X2-3				
MRU Elan A	X21F-01046	Elands	**3WQ and 3**	3b, EWR ER1
	X21F-01081	Elands		3b, EWR ER1
	X21G-01037 (EWR ER 1)	Elands		3a
RU C7	X21F-01100	Leeuspruit	**3WQ**	2 for biota and habitat
	X21F-01091	Rietvleispruit	**2**	
	X21F-01092	Leeuspruit		
IUA 4 AND 5				
RU C8	X21G-01090	Weltevredespruit	**2**	
	X21G-01016	Swartkoppiespruit		
RU C10	X21K-01007	Lupelule	**2**	
RU C9	X21H-01060	Ngodwana	**2**	
MRU Elan B	X21G-01073	Elands	**3WQ and 3**	3b, EWR ER 2
	X21J-01013	Elands		3b, EWR ER 2
	X21K-01035 (EWR ER 2)	Elands		3a
	X21K-00997	Elands		3b, EWR ER 2
IUA X2-6 AND PART OF IUA X2-9				
MRU Croc C	X22B-00987	Crocodile	**3WQ and 3b**	3b, EWR C4
	X22B-00888	Crocodile		3b, EWR C4
	X22C-00946	Crocodile		3b, EWR C4
	X22J-00993	Crocodile		3b, EWR C4
	X22J-00958	Crocodile	**3WQ and 3b**	3b, EWR C4
	X22K-00981	Crocodile		
IUA X2-7				
MRU RU C5	X22A-00875	Houtbosloop	**2**	
	X22A-00887	Beestekraalspruit		
	X22A-00824	Blystaanspruit		
	X22A-00920			
	X22A-00919	Houtbosloop		
	X22A-00917	Houtbosloop		
RU C6	X22A-00913	Houtbosloop	**2**	
RU C11	X22C-00990	Visspruit	**2**	
IUA X2-8				
RU C12	X22C-01004	Gladdespruit	**3WQ**	2 for biota and habitat

RUs	SQ number	River	RU priority rating	RU priority breakdown
RU C13	*X22D-00843*	*Nels*	**2**	
	X22D-00846			
	X22E-00849	*Sand*		
	X22E-00833	*Kruisfonteinspruit*		
	X22F-00842	*Nels*		
	X22F-00886	*Sand*		
	X22F-00977	*Nels*	**2**	
RU C14	*X22H-00836*	*Wit*	**3WQ**	*2 for biota and habitat*
IUA X2-9				
RU C15	*X22K-01042*	*Mbuzulwane*	**2**	
	X22K-01043	*Blinkwater*		
	X22K-01029	*Blinkwater*		
MRU Croc D	*X22K-01018 (EWR C4)*	*Crocodile*	**3WQ and 3**	*3a*
IUA X2-10				
RU C16	*X23B-01052*	*Noordkaap*	**3WQ**	*2 for biota and habitat*
RU C17	*X23C-01098*	*Suidkaap*	**3WQ**	*2 for biota and habitat*
	X23E-01154	*Queens*		
	X23F-01120	*Suidkaap*		
MRU Kaap A	*X23G-01057 (EWR C7)*	*Kaap*	**3WQ and 3**	*3a*
IUA X2-11				
MRU Croc D	*X24C-01033*	*Crocodile*	**3WQ and 3b**	*3b, EWR C6*
MRU Croc E	*X24H-00880*	*Crocodile*	**3WQ and 3**	*3b, EWR C6*
	X24H-00934 (EWR C6)	*Crocodile*		*3a*
	X24D-00994 (EWR C5)	*Crocodile*		*3a*
	X24E-00982	*Crocodile*		*3b, EWR C6*
	X24F-00953	*Crocodile*		*3b, EWR C6*
IUA X2-12 AND X2-13				
RU C18	*X24A-00826*	*Nsikazi*	**2**	
RU C19	*X24B-00903*	*Gutshwa*	**3WQ**	*2 for biota and habitat*
RU C20	*X24A-00860*	*Sithungwane*	**1**	*1b*
	X24A-00881	*Nsikazi*		
	X24B-00928	*Nsikazi*		
	X24C-00969	*Mnyeleni*		
	X24C-00978	*Nsikazi*		
	X24E-00973	*Matjulu*		
	X24E-00922	*Mlambeni*		
	X24G-00902	*Mitomeni*		
	X24G-00876	*Komapiti*		
	X24G-00844	*Mbyamiti*		
	X24G-00823	*Muhlambamadubo*		
	X24G-00820	*Mbyamiti*		
	X24G-00904	*Mbyamiti*		
	X24H-00882	*Vurhami*		
	X24H-00892	*Mbyamiti*		

Table 2.4 Sabie and Sand River System: Priority level of RQO RUs

RUs	SQ number	River	RU priority rating	RU priority breakdown
IUA X3-1 AND X3-2				
RU S2	X31A-00741	Klein Sabie	2	
MRU Sabie A	X31A-00778	Sabie	3	3b, EWR S1
	X31A-00799	Sabie		3b, EWR S1
	X31B-00756	Sabie		3b, EWR S1
	X31B-00757 EWR S1	Sabie		3a
	X31D-00755 EWR S2	Sabie		3a
	X31D-00772	Sabie		3b, EWR S2
RU S1	X31A-00783		2	
	X31A-00786			
	X31A-00794			
	X31A-00796			
	X31A-00803			
IUA X3-2 AND PART OF IUA X3-4				
RU S4	X31B-00792	Goudstroom	2	
	X31D-00773	Sabani		
MRU Mac A	X31C-00683 EWR S4	Mac-Mac	3	3a
RU S8	X31E-00647a	Marite (US[1] of dam)	2	
	X31F-00695	Motitsi		
IUA X3-3				
Mar A	X31G-00728 EWR S5	Marite	3	3a
	X31E-00647b	Marite (DS[2] of Dam)		3b, EWR S5
MRU Sabie B	X31K-00715 EWR S3	Sabie	3	3a
	X31K-00750	Sabie		3b, EWR S3
	X31K-00752	Sabie		3b, EWR S3
	X31K-00758	Sabie		3b, EWR S3
	X31M-00681	Sabie		3b, EWR S3
	X31M-00747	Sabie		3b, EWR S3
	X31M-00739	Sabie		3b, EWR S3
IUA X3-4				
RU S5	X31H-00819	White Waters	2	
RU S6	X31J-00774	Noord-Sand	3WQ	2 for biota and habitat
	X31J-00835	Noord-Sand		
RU S9	X31K-00713	Bejani	3WQ	2 for biota and habitat
RU S10	X31L-00657	Matsavana	2	
	X31L-00664	Saringwa		
	X31L-00678	Saringwa		
RU S11	X31M-00673	Musutlu	2	
IUA X3-5				
MRU Sabie C	X33A-00731	Sabie	3	3b, EWR S3
	X33A-00737	Sabie		3b, EWR S3
	X33B-00784	Sabie		3b, EWR S3
	X33B-00804	Sabie		3b, EWR S3
	X33B-00829	Sabie		3b, EWR S3
	X33D-00811	Sabie		3b, EWR S3
	X33D-00861	Sabie		3b, EWR S3
IUA X3-6				

RUs	SQ number	River	RU priority rating	RU priority breakdown
RU S7	*X33D-00864*	*Mosehla*	**1**	*1b*
	X33D-00894	*Nhlowa*		*1b*
	X33D-00908	*Shimangwana*		*1b*
	X33A-00806	*Nwatimhiri*		*1b*
	X33B-00694	*Salitje*		*1b*
	X31M-00763	*Nwaswitshaka*		*1b*
	X33A-00661	*Nwatindlopfu*		*1b*
	X33B-00834	*Lubyelubye*		*1b*
	X33C-00701	*Mnondozi*		*1b*
	X33D-00911	*Nhlowa*		*1b*
	X31K-00771	*Phabeni*		*1b*
	X32H-00560	*Phungwe*		*1a*
	X32J-00651	*Mutlumuvi*		*1b*
IUA X3-7				
MRU Mut A	*X32D-00605*	*Mutlumuvi*	**3**	*3b, EWR S6*
	X32F-00597 EWR S6	*Mutlumuvi*		*3a*
RU S13	*X32E-00639*	*Ndlobesuthu*	**3WQ**	
RU S12	*X32F-00628*	*Nwarhele*	**2**	
	X32E-00629	*Nwarhele*		
IUA X3-8				
MRU Sand A	*X32A-00583 EWR S7*	*Tlulandziteka*	**3**	*3a*
	X32C-00558	*Nwandlamuhari*		*3b, EWR S7*
	X32C-00606	*Nwandlamuhari*		*3b, EWR S7*
RU S14	*X32B-00551*	*Motlamogatsana*	**3WQ**	*2 for biota and habitat*
	X32C-00564	*Mphyanyana*	**2**	
RU S15	*X32G-00549*		**2**	
IUA X3-9				
MRU Sand B	*X32H-00578*	*Sand*	**3**	*3b, EWR S8*
	X32J-00602 EWR S8	*Sand*		*3a*
	X32J-00730	*Sand*		*3b, EWR S8*
	X32G-00565	*Sand*		*3b, EWR S8*

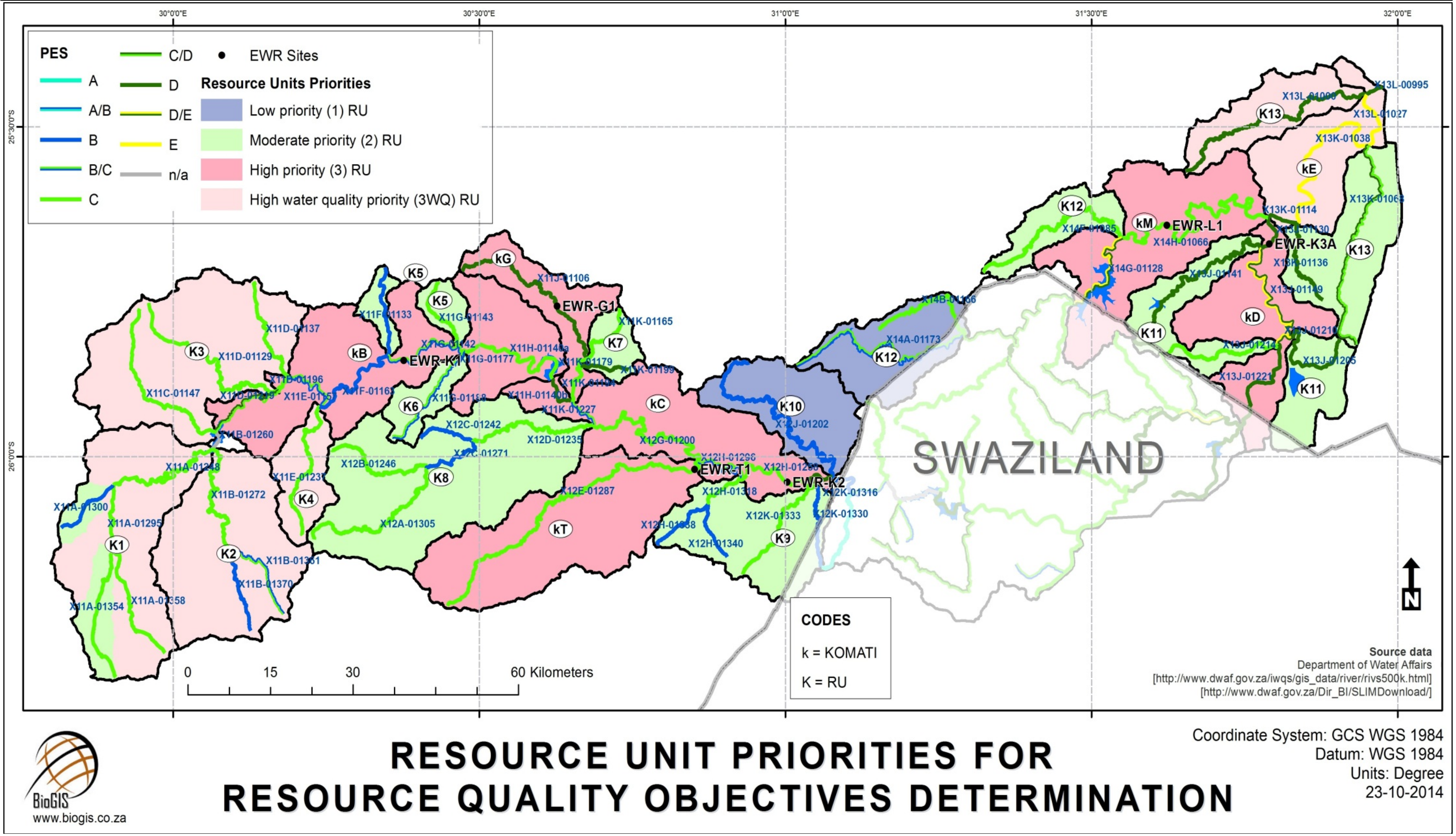


Figure 2.1 Komati River System: Low, Moderate and High RUs for RQO determination

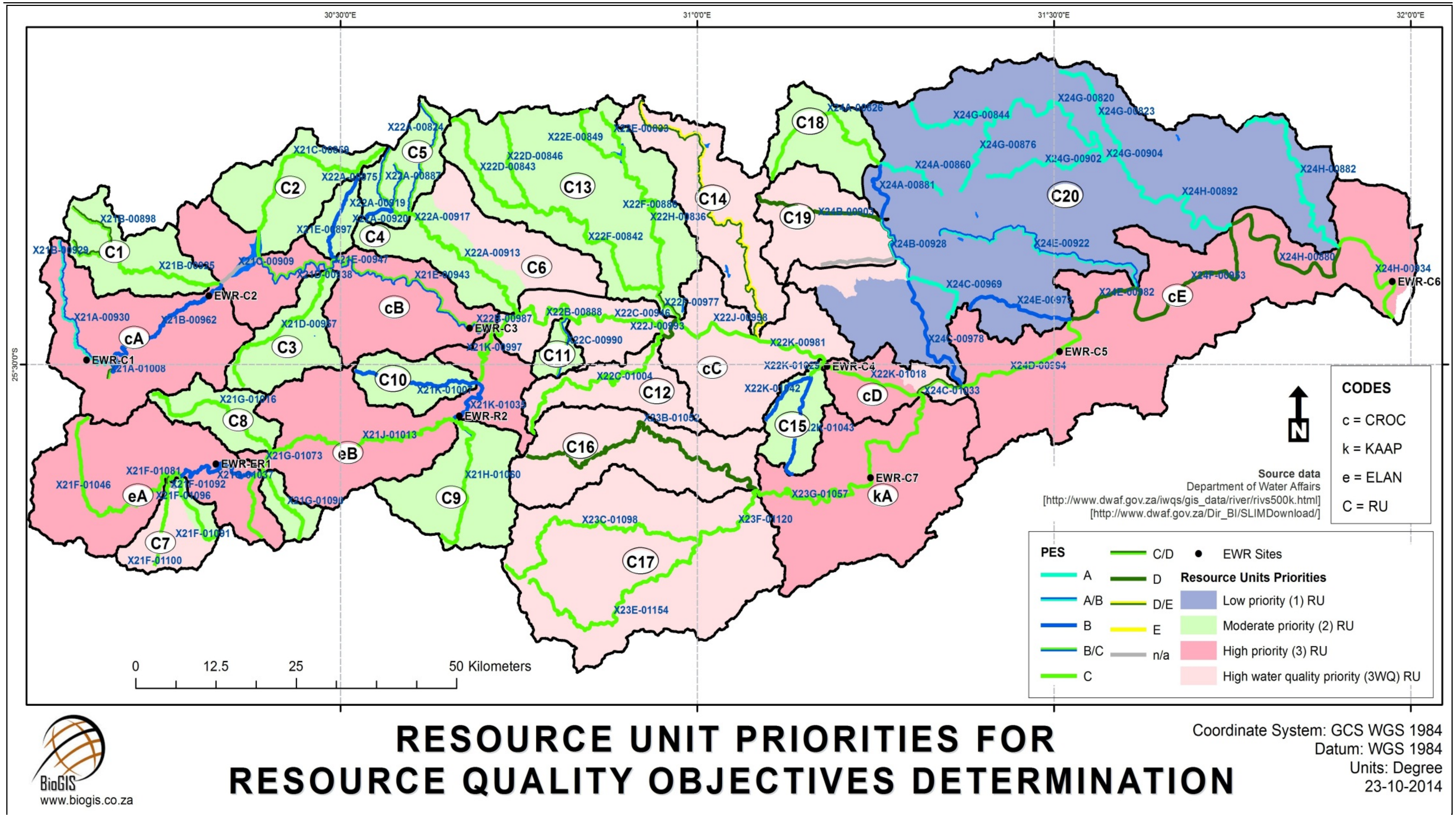


Figure 2.2 Crocodile River System: Low, Moderate and High RUs for RQO determination

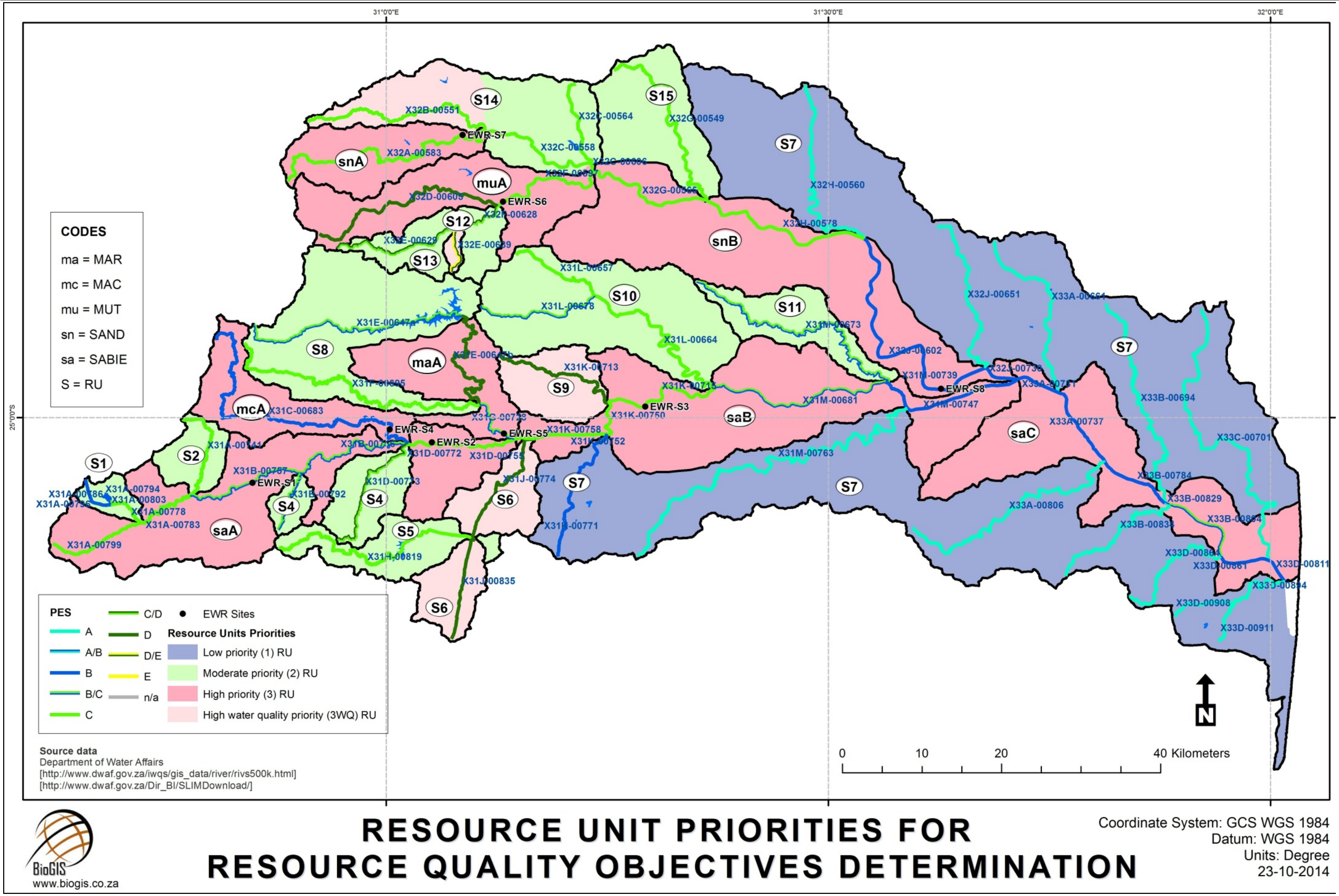


Figure 2.3 Sabie and Sand River System: Low, Moderate and High RUs for RQO determination

2.1.2 Format of RQO components

RQOs are set for the following components:

- *Quantity, pattern and timing of instream flow (hydrology).*
- *Water quality.*
- *Characteristics and condition of riparian habitat and biota.*
- *Characteristics and condition of instream habitat and biota.*

Hydrological RQOs are provided as a flow regime (described by means of a time series) associated with the Water Resource Classes (i.e. relating to a recommended scenario) or the flows required for the REC. The output is for;

- *Flow duration table based on a hydrological time series.*
- *Summary using various statistics.*
- *Defined quantity and frequency.*

Water quality RQOs were set for Moderate (Level 2) priority RUs where identified as an indicator, and all High (Level 3) Priority RUs. Note that Level 3 WQ RUs were also identified and are areas where water quality only is considered a high priority. The water quality component of developing Level 2 and 3 RQOs is discussed in Section 2.1.3.

Habitat and biota is described as the habitat and biota associated with an EC. The EC can be the target resulting from the Water Resource Class that will be implemented or the REC. The format of the RQOs depends on the priority level of the RU and the indicator selected. The format can range as follows:

- *Overall TEC – usually the REC.*
- *EC for each component.*
- *EcoSpecs (Ecological specifications) for components.*
- *Ecological objectives for components.*

2.1.3 Rivers: Selection of RQO components and indicators

RQO components and RQO indicators are selected for RQO determination. Only relevant indicators (or high priority ones) are selected and the range selected links directly to the priority level of the RU. The indicators can be for different components, subcomponents and specific species or taxa.

High Priority RUs (3a or 3b): *These require RQOs to be provided in as much detail as available information allows for all components. As such, no selection of RQO component indicators are required as EcoSpecs are provided for all relevant components which are:*

- *Hydrology.*
- *Physico-chemical variables (water quality).*
- *Geomorphology.*
- *Riparian vegetation.*
- *Fish.*
- *Macro-invertebrates.*

To provide this level of detail, the RU should include an EWR site as the most detailed level of investigations are undertaken at these sites in terms of EWR assessment. This is why the hotspot *selection is undertaken during the beginning of the study as the key rivers (i.e. high priority RUs) in which EWR sites should be selected must be identified up front.*

Detailed RQOs for High (Level 3 WQ) Priority RUs were produced for water quality using any existing information as these are high priority water quality sites. Note that a water quality assessment was normally not available for these sites, unless also an EWR site.

Detailed water quality assessments for High (Level 3) Priority RUs have been conducted for Reserve studies using tools such as Tool for Ecological Aquatic Chemical Habitat Assessment (TEACHA) and Physico-chemical Driver Assessment Index (PAI models) (DWAF, 2008). Historical Reserve assessments were used (DWAF, 2000; DWA, 2010).

Moderate Priority RUs (2): *RQOs will not be identified for all components as done for High Priority RUs. A process of prioritisation for the components to be addressed is followed. Hydrology RQOs are provided as a standard for each SQ as for the High Priority RQOs. The component prioritisation process is therefore relevant for instream and riparian habitat and biota as well as water quality. As a first filter, the specific sources and causes that have caused changes in the state of the ecosystem are used to guide the selection of relevant components. The following guidelines are used to aid the identification of component indicators for which RQOs must be provided for each moderate priority RU:*

- *If the causes and sources are non-flow related, then riparian vegetation is likely to be the key indicator component.*
- *If the system is seasonal, then riparian vegetation is likely to be the key indicator component.*
- *If causes and sources are flow related, then instream biota and habitat are likely to be the key indicator components.*
- *If water quality causes and sources are identified as an issue, broad EcoSpecs and/or user water quality RQOs are provided.*

No detailed water quality assessment was conducted for Moderate (Level 2) Priority RUs. PES 2011 data (DWA, 2013b) and literature sources (e.g. O'Brien, 2003; Beukes et al., 2012; DWA, 2012b; DWA, 2013a; McCarthy and Humphries, 2013) were used for the assessment.

Table 2.5 to 2.7 provides the key causes and sources in Column e per River System. This column provides the most significant causes and sources, i.e. the highest two ratings (None, Small, Moderate, Large, Serious, Critical). I.e., if all impacts have been rated and the evaluation provided are for Small, Moderate and Large, then the descriptions associated with the Moderate and Large ratings will be provided.

Column f provides the derived indicator components for which RQOs will be determined.

Column g identifies the water quality role players (or users), while Column h lists the primary water quality variables for which water quality RQOs are provided.

Low Priority RUs (1a and 1b): *For level 1a hydrology RQOs will be provided and a habitat and biota EcoSpec in terms of the EcoStatus Ecological Category for the REC. For level 1b, hydrology RQOs will not be provided. These usually represent rivers which are protected for the total length of river, and as there is no threat of development, and therefore a flow RQO is unnecessary.*

Table 2.5 Komati River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
				IUA X1-1			
RU K1	*X11A-01300*		**2**	*LARGE: Agricultural fields, small (farm) dams, inundation, grazing (land-use). MODERATE: Abstraction, algal growth, low water crossings, alien vegetation, overgrazing/trampling, vegetation removal.*	*1. Instream biota 1. Riparian veg*		*Salts, sulphates, pH, nutrients, E coli, toxics*
	X11A-01354						
	X11A-01358	*Vaalwaterspruit*	**3WQ**			*AMD[1], Breyten WWTW[2]*	
	X11A-01248	*Vaalwaterspruit*	**3WQ**			*AMD*	
	X11A-01295	*Vaalwaterspruit*					
RU K2	*X11B-01370*	*Boesmanspruit*	**3WQ**	*SERIOUS/ABUNDANT: Grazing (land-use). LARGE: Bed and channel disturbance. MODERATE: Agricultural fields, alien vegetation, overgrazing/trampling, sedimentation, vegetation removal.*	*1. Rip veg (2) 2. Instream Biota (2)*	*AMD*	*Salts, sulphates, pH, nutrients, E coli, toxics.*
	X11B-01361						
	X11B-01272	*Boesmanspruit*				*AMD, Carolina*	
				IUA X-2			
MRU Komati B	*X11D-01219*	*Komati*	**3**	*SERIOUS/ABUNDANT: Agricultural fields, large dams, grazing (land-use), nature reserves. MODERATE: Forestry, bed and channel disturbance, alien vegetation, overgrazing/trampling, inundation, sedimentation, vegetation removal.*	*All*	*Primary user and or EcoSpecs (no water quality hotspot identified)*	*All EcoSpec variables and driving variables.*
	X11D-01196	*Komati*					
	X11E-01157	*Komati*					
	X11F-01163	*Komati*					
	X11G-01142 EWR K1	*Komati*					
	X11G-01177	*Komati*					
	X11H-01140a	*Komati, X11H-01140a*					
				IUA X1-3			
RU K3	*X11C-01147*	*Witkloofspruit*	**3WQ**	*SERIOUS/ABUNDANT: Small (farm) dams. LARGE: Agricultural fields, inundation, grazing (land-use).*	*1. Riparian veg 2. Instream Biota*	*AMD*	*Salts, sulphates, pH, toxics.*
	X11D-01129	*Klein-Komati*					
	X11D-01137	*Waarkraalloop*					
RU K4	*X11E-01237*	*Swartspruit*	**3WQ**	*LARGE: Algal growth, natural areas/nature reserves. MODERATE: Agricultural fields, bed and channel disturbance, recreation, runoff/effluent: Industries, grazing (land-use). SMALL: Abstraction, small (farm) dams, alien vegetation, overgrazing/trampling, inundation, roads,*	*1. Riparian veg 2. Instream Biota*	*Mining*	*Toxics, turbidity.*

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
				sedimentation, vegetation removal.			
RU K5	*X11F-01133*	*Bankspruit*	**2**	*MODERATE: Agricultural fields, alien vegetation, forestry, recreation, grazing (land-use).*	*1. Riparian veg 2. Instream Biota*		
	X11G-01143	*Gemakstroom*					
RU K6	*X11G-01188*	*Ndubazi*	**2**	*SERIOUS/ABUNDANT: Forestry. LARGE: Roads. MODERATE: Vegetation removal.*	*1. Riparian veg 2. Instream biota*		
IUA X1-4							
MRU Komati G	*X11J-01106 EWR G1*	*Mngubhudle*	**3**	*SERIOUS/ABUNDANT: Forestry, agricultural fields. LARGE: Abstraction, runoff/effluent: Mining.*	*All*	*Mining, trout farms*	*Turbidity nutrients, toxics.*
	X11K-01179	*Gladdespruit*					
	X11K-01194	*Gladdespruit*					
RU K7	*X11K-01165*	*Poponyane*	**2**	*SERIOUS/ABUNDANT: Small (farm) dams, inundation. LARGE: Abstraction, forestry. MODERATE: Agricultural fields, bed and channel disturbance, alien vegetation, vegetation removal.*	*1. Riparian veg*		
	X11K-01199						
IUA X1-5							
MRU Komati C	*X11H-01140b*	*X11H-01140b*	**3**	*LARGE: Abstraction, large dams, agricultural fields, algal growth, sedimentation, grazing (land-use). MODERATE: Bed and channel disturbance, overgrazing/trampling, inundation, irrigation, sedimentation, grazing (land-use), vegetation removal.*	*All*	*Settlements (extensive grazing), WWTW*	*Nutrients, salts, E coli, turbidity.*
	X11K-01227	*Komati*					
	X12G-01200	*Komati*					
	X12H-01296	*Komati*					
	X12H-01258 EWR K2	*Komati*					
	X12K-01316	*Komati*					
IUA X1-6							
MRU Komati T	*X12E-01287 (EWR T1)*	*Teespruit*	**3**	*MODERATE: Agricultural fields, algal growth, forestry, overgrazing/trampling, runoff/effluent: Urban areas, sedimentation, grazing (land-use), vegetation removal. SMALL: Abstraction, bed and channel disturbance, low water crossings, small (farm) dams, alien vegetation, inundation, natural areas/nature reserves, roads, urbanization.*	*All*	*WWTW in lower reaches*	*Turbidity, nutrients, E coli.*
RU K8	*X12A-01305*	*Buffelspruit*	**2**	*LARGE: Agricultural fields, forestry, grazing. MODERATE: Algal growth, low water crossings, small (farm) dams, roads, vegetation removal.*	*1. Riparian veg 2. Instream Biota 3. Water quality (linked to last SQ)*	*Settlements*	*Nutrients, E coli, turbidity.*
	X12B-01246	*Hlatjiwe*					
	X12C-01242	*Phophenyane*					
	X12C-01271	*Buffelspruit*					

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
	X12D-01235	*Seekoeispruit*					
RU K9	*X12H-01338*	*Sandspruit*	**2**	*LARGE: Agricultural fields, overgrazing/trampling, grazing (land-use). MODERATE: Bed and channel disturbance, natural areas/nature reserves, vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Settlements (over-grazing), old coal mine*	*Nutrients, E coli, turbidity, salts, toxics.*
	X12H-01340						
	X12H-01318	*Sandspruit*					
	X12K-01333	*Mlondozi*					
	X12K-01332	*Mhlangampepa*					
RU K10	*X12J-01202*	*Mtsoli*	**1b**	*LARGE: Forestry, natural areas/nature reserves.*	*REC, Flow*		
IUA X1-7							
RU K 12	*X14A-01173*	*Lomati*	**1b**	*LARGE: Forestry. MODERATE: Abstraction, alien vegetation, natural areas/nature reserves.*	*REC, Flow*		
	X14B-01166	*Ugutugulo*					
	X14F-01085	*Mhlambanyatsi*	**2**		*1. Riparian veg 2. Instream Biota*		
IUA X1-8							
MRU Komati M	*X14G-01128*	*Lomati*	**3**	*CRITICAL/EXTENSIVE: Large dams. SERIOUS/ABUNDANT: Abstraction, irrigation, bed and channel disturbance, irrigation, sedimentation. LARGE: Agricultural fields, algal growth, inundation, increased flows, vegetation removal.*	*All*	*Settlements, WWTW, sand mining, extensive crop farming*	*Nutrients, salts, turbidity, toxics.*
	X14H-01066 EWR L1	*Lomati*					
IUA X1-9							
RU K11	*X13J-01214*	*Mgobode*	**2**	*LARGE: Agricultural fields, overgrazing/trampling, grazing (land-use), urbanization, vegetation removal. MODERATE: Abstraction, algal growth, bed and channel disturbance, low water crossings, erosion, alien vegetation, sedimentation.*	*1. Riparian veg 2. Instream Biota 3. Water quality (sedimentation largely)*	*Settlements (over-grazing), some agriculture*	*Nutrients, turbidity.*
	X13J-01141	*Mzinti*					
	X13J-01205	*Mbiteni*					
MRU Komati D	*X13J-01221*	*Komati*	**3**	*CRITICAL/EXTENSIVE: Inundation. SERIOUS/ABUNDANT: Abstraction, irrigation, vegetation removal. LARGE: Algal growth, bed and channel disturbance, sedimentation. MODERATE: Alien vegetation, overgrazing/trampling. SMALL: Agricultural fields, small (farm) dams, grazing (land-use).*	*All*	*Irrigation return flows, Tongo WWTW*	*Nutrients, E coli, salts, toxics.*
	X13J-01210	*Komati*					
	X13J-01149	*Komati*					
	X13J-01130 (EWR K3)	*Komati*					
IUA X1-10							
RU K13	*X13K-01136*	*Mambane*	**2**	*SERIOUS/ABUNDANT: Small (farm) dams. LARGE: Abstraction, bed and channel disturbance,*	*1. Riparian veg 2. Instream biota*	*Livestock, agriculture, trout*	*Turbidity, salt, nutrients.*
	X13K-01068	*Nkwakwa*					

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
	X13L-01000	*Ngweti*	**3WQ**	*agricultural fields, irrigation, grazing (land-use), vegetation removal.*		*farming, approved coal mine*	
MRU Komati E	*X13K-01114*	*Komati*	**3WQ**	*CRITICAL/EXTENSIVE: Bed and channel disturbance, inundation, irrigation. SERIOUS/ABUNDANT: Abstraction, agricultural fields, algal growth, small (farm) dams, runoff/effluent: Irrigation, vegetation removal. LARGE: Alien vegetation.*	*n/a (section largely inundated)*	*Urban impacts, Komati Mill, irrigation return flows*	*Salts, nutrients, toxics, international agreements.*
	X13K-01038	*Komati*					
	X13L-01027	*Komati*					
	X13L-00995	*Komati*					

1 Acid Mine Drainage

2 Waste Water Treatment Works

Table 2.6 Crocodile River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
				IUA X2-1			
MRU Croc A	*X21A-00930 EWR C1*	*Crocodile*	**3**				
	X21B-00962 EWR C2	*Crocodile*					
RU C1	*X21B-00929*	*Gemsbokspruit*	**2**	*SERIOUS/ABUNDANT: Inundation.* *LARGE: Algal growth, small (farm) dams, recreation.*	*1 Instream biota* *2 Riparian veg* *3 Water quality*	*Trout farming*	*E. coli (recreational contact), nutrients.*
	X21B-00898	*Lunsklip*					
	X21B-00925	*Lunsklip*					
RU C2	*X21C-00859*	*Alexanderspruit*	**2**	*SERIOUS/ABUNDANT: Small (farm) dams, inundation.* *LARGE: Agricultural fields.*	*1. Riparian veg*		
				IUA X2-2			
RU C3	*X21D-00957*	*Buffelskloofspruit*	**2**	*Non-flow: Agriculture, livestock, limited forestry.*	*1. Riparian veg*		
RU C4	*X21E-00897*	*Buffelskloofspruit*	**2**	*LARGE: Forestry, natural areas/nature reserves.* *MODERATE: None.* *SMALL: Roads, vegetation removal.*	*1. Riparian veg*		
MRU Croc B	*X21D-00938*	*Crocodile*	**3**	*LARGE: Increased flows, abstraction, agricultural fields, algal growth, roads, runoff/effluent: Irrigation.* *MODERATE: Bed and channel disturbance, alien vegetation, vegetation removal, natural areas/nature reserves.*	*All*	*Irrigation return flows (citrus)*	*Toxics, nutrients, salts.*
	X21E-00947	*Crocodile*					
	X21E-00943 EWR C3	*Crocodile*					
				IUA X2-3			
MRU Elan A	*X21F-01046*	*Elands*	**3WQ** **3**	*LARGE: Large dams, recreation, grazing (land-use).* *MODERATE: Agricultural fields, algal growth, small (farm) dams, alien vegetation, inundation, runoff/effluent: Industries, vegetation removal.*	*All*	*Urban impacts, WWTW and ferrochrome processing (Machadodorp)*	*Nutrients, E. coli, toxics (Cr-VI, Mn), salts.*
	X21F-01081	*Elands*					
	X21G-01037 ER 1	*Elands*					
RU C7	*X21F-01100*	*Leeuspruit*	**3WQ**	*LARGE: Small (farm) dams, Inundation, Grazing (land-use),* *MODERATE: Algal growth, Bed and Channel disturbance, Alien vegetation, Overgrazing/trampling, Vegetation removal,*	*1. Riparian veg* *2. Instream biota*	*Assmang chrome, WWTW, urban impacts*	*Nutrients, E. coli, toxics (Cr-VI, Mn).*
	X21F-01091	*Rietvleispruit*	**2**				
	X21F-01092	*Leeuspruit*					
				IUA X2-4 AND X2-5			

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
RU C8	*X21G-01090*	*Weltevredespruit*	**2**	*LARGE: Algal growth, small (farm) dams, recreation. MODERATE: Low water crossings, alien vegetation, forestry, inundation, runoff/effluent: Industries.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Trout farming*	*E. coli (recreational contact), nutrients.*
	X21G-01016	*Swartkoppiespruit*					
RU C10	*X21K-01007*	*Lupelule*	**2**	*SERIOUS/ABUNDANT: Forestry. MODERATE: Low water crossings, vegetation removal.*	*1. Riparian veg 2. Instream biota*		
RU C9	*X21H-01060*	*Ngodwana*	**2**	*LARGE: Large dams. MODERATE: Alien vegetation, forestry, inundation, runoff/effluent: Industries, sedimentation, grazing (land-use), vegetation removal.*	*1. Riparian veg*		
MRU Elan B	*X21G-01073*	*Elands*	**3WQ 3**	*SERIOUS/ABUNDANT: Roads. LARGE: Agricultural fields, bed and channel disturbance, vegetation removal, forestry. MODERATE: Abstraction, algal growth, alien vegetation, forestry, inundation, sedimentation. SMALL: Agricultural fields, chicken farms, small (farm) dams, erosion.*	*All*	*SAPPI (Ngodwana Mill), Elandshoek settlement*	*Salts, toxics, nutrients, turbidity.*
	X21J-01013	*Elands*					
	X21K-01035 ER 2	*Elands*					
	X21K-00997	*Elands*					
IUA X2-6 AND PART OF IUA X2-9							
MRU Croc C	*X22B-00987*	*Crocodile*	**3WQ 3b**	*SERIOUS/ABUNDANT: Irrigation. LARGE: Abstraction, Runoff/effluent: Irrigation, urbanisation.*	*All*	*Irrigation upstream Nelspruit, Nelspruit (upper area - urban impacts), Papas quarry*	*Toxics (Mn), nutrients, salts, E. coli.*
	X22B-00888	*Crocodile*					
	X22C-00946	*Crocodile*					
	X22J-00993	*Crocodile*					
	X22J-00958	*Crocodile*	**3WQ 3b**	*SERIOUS/ABUNDANT: Roads. LARGE: Abstraction, irrigation, vegetation removal, algal growth, farm dams.*		*Nelspruit urban and industrial area.*	*Toxics, nutrients, salts, E coli.*
	X22K-00981	*Crocodile*					
IUA X2-7							
RU C5	*X22A-00875*	*Houtbosloop*	**2**	*CRITICAL/EXTENSIVE: Forestry. LARGE: Roads. SMALL: Low water crossings, vegetation removal.*	*1. Riparian veg 2. Instream biota*		
	X22A-00887	*Beestekraalspruit*					
	X22A-00824	*Blystaanspruit*					
	X22A-00920						
	X22A-00919	*Houtbosloop*					
	X22A-00917	*Houtbosloop*					
RU C6	*X22A-00913*	*Houtbosloop*	**2**	*LARGE: Low water crossings. MODERATE: Abstraction, agricultural fields, algal growth, bed and channel disturbance, small (farm) dams, alien vegetation, forestry, irrigation, runoff/effluent: Irrigation, vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Old gold mine decant*	*Suspended solids, toxics (Cn and As).*

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
RU C11	*X22C-00990*	*Visspruit*	**2**	*MODERATE: Alien vegetation, forestry, irrigation, vegetation removal. SMALL: Abstraction, agricultural fields, bed and channel disturbance, low water crossings, roads, runoff/effluent: Irrigation, sedimentation.*	*1. Riparian veg*		
IUA X2-8							
RU C12	*X22C-01004*	*Gladdespruit*	**3WQ**	*SERIOUS/ABUNDANT: Roads. LARGE: Forestry. MODERATE: Abstraction, algal growth, bed and channel disturbance, low water crossings, alien vegetation, irrigation, runoff/effluent: Irrigation, runoff/effluent: Urban areas, sedimentation, vegetation removal.*	*1. Riparian veg*	*Mining, landfills*	*Toxics (Mn), turbidity.*
RU C13	*X22D-00843*	*Nels*	**2**	*CRITICAL/EXTENSIVE: Forestry. LARGE: Vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Irrigation return flows, chicken farms (Sand)*	*Nutrients, salts.*
	X22D-00846						
	X22E-00849	*Sand*					
	X22E-00833	*Kruisfonteinspruit*					
	X22F-00842	*Nels*					
	X22F-00886	*Sand*					
	X22F-00977	*Nels*	**2**	*LARGE: Irrigation. MODERATE: Abstraction, agricultural fields, algal growth, small (farm) dams, alien vegetation, inundation, runoff/effluent: Urban areas, urbanization.*	*1. Riparian veg 2. Instream biota 3. Water quality*		
RU C14	*X22H-00836*	*Wit*	**3WQ**	*SERIOUS/ABUNDANT: Abstraction. LARGE: Algal growth, bed and channel disturbance, large dams, small (farm) dams, forestry, inundation, irrigation, grazing (land-use), Vegetation removal.*		*White River and Kabokweni (urban impacts), agriculture*	*Toxics, nutrients, salts, E coli.*
IUA X2-9							
RU C15	*X22K-01042*	*Mbuzulwane*	**2**	*LARGE: Natural areas/nature reserves. MODERATE: Small (farm) dams, agricultural fields, alien vegetation (lower section).*	*1. Riparian veg 2. Instream biota*		
	X22K-01043	*Blinkwater*					
	X22K-01029	*Blinkwater*					
MRU Croc D	*X22K-01018 EWR C4*	*Crocodile*	**3WQ 3**	*CRITICAL/EXTENSIVE: Roads. LARGE: Abstraction, natural areas/nature reserves.*	*All*	*Kanyamazane urban and industrial area*	*Toxics, nutrients, salts, E coli.*
IUA X2-10							
RU C16	*X23B-01052*	*Noordkaap*	**3WQ 2**	*LARGE: Agricultural fields, bed and channel disturbance, vegetation removal. MODERATE: Algal growth, low water crossings, erosion, alien*	*Water quality (3) Riparian veg (2)*	*Irrigation return flows*	*Salts, nutrients, turbidity.*

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
				vegetation, forestry, overgrazing/trampling, sedimentation, grazing (land-use).			
RU C17	*X23C-01098*	*Suidkaap*	**3WQ**	*LARGE: Forestry, irrigation lower section. MODERATE: Abstraction, algal growth, bed and channel disturbance, alien vegetation, overgrazing/trampling, irrigation, sedimentation, grazing (land-use), vegetation removal.*	*1. Riparian veg 2. Instream Biota*	*Agriculture, gold mines, Barberton WWTW, timber processing*	*Toxics (Cn, As), nutrients, salts, E coli.*
	X23E-01154	*Queens*					
	X23F-01120	*Suidkaap*					
MRU Kaap A	*X23G-01057 EWR C7*	*Kaap*	**3WQ 3**	*SERIOUS/ABUNDANT: Irrigation. LARGE: Abstraction, algal growth, small (farm) dams, alien vegetation, inundation, runoff/effluent: Irrigation.*	*All*	*Lily & Barbrooke Goldmines*	*Toxics (Cn, As),*
IUA X2-11							
Croc D	*X24C-01033*	*Crocodile*	**3WQ 3b**	*LARGE: Algal growth, irrigation, roads, urbanization. MODERATE: Abstraction, bed and channel disturbance, alien vegetation, inundation, runoff/effluent: Irrigation, runoff/effluent: Urban areas, vegetation removal.*		*Settlements (left bank), irrigation return flows (right bank)*	*Nutrients, salts, E coli, turbidity.*
MRU Croc E	*X24H-00880*	*Crocodile*	**3WQ 3**	*Natural areas/nature reserves. SERIOUS/ABUNDANT: Abstraction. LARGE: Agricultural fields, irrigation, roads, runoff/effluent: Irrigation, vegetation removal.*	*All*	*Urban impacts (Malelane, Marloth Park, Komatipoort; sugar mill and fruit processing), numerous WWTWs, irrigation return flows.*	*Toxics, nutrients, salts, temperature, E coli.*
	X24H-00934 EWR C6	*Crocodile*					
	X24D-00994 EWR C5	*Crocodile*					
	X24E-00982	*Crocodile*					
	X24F-00953	*Crocodile*					
IUA X2-12 AND X2-13							
RU C18	*X24A-00826*	*Nsikazi*	**2**	*LARGE: Agricultural fields, overgrazing/trampling, vegetation removal. MODERATE: Abstraction, algal growth, bed and channel disturbance, alien vegetation, natural areas/nature reserves, roads, runoff/effluent: Urban areas, sedimentation, grazing (land-use), urbanization.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*WWTW*	*Nutrients, salts, E coli.*
RU C19	*X24B-00903*	*Gutshwa*	**3WQ**	*SERIOUS/ABUNDANT: Vegetation removal. LARGE: Agricultural fields, sedimentation, grazing (land-use), urbanization.*		*Urban and rural impacts from Kabokweni and Malekutu towns*	*Toxics, nutrients, salts, E coli, turbidity.*
RU C20	*X24A-00860*	*Sithungwane*	**1b**		*1. Habitat REC 2. Flow RQO at*		
	X24A-00881	*Nsikazi*					

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
	X24B-00928	*Nsikazi*		*Comment: NB - Problems in trib not on the 1:500 000 river scale. It has to have RQOs specifically for the trib for water quality. WWTW.*	*border SQs only*		
	X24C-00969	*Mnyeleni*					
	X24C-00978	*Nsikazi*					
	X24E-00973	*Matjulu*					
	X24E-00922	*Mlambeni*					
	X24G-00902	*Mitomeni*					
	X24G-00876	*Komapiti*					
	X24G-00844	*Mbyamiti*					
	X24G-00823	*Muhlambamadubo*					
	X24G-00820	*Mbyamiti*					
	X24G-00904	*Mbyamiti*					
	X24H-00882	*Vurhami*					
	X24H-00892	*Mbyamiti*					

Table 2.7 Sabie and Sand River System: Key causes and sources and derived components for which RQOs will be set, the water quality users, and water quality variables

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
IUA X3-1 AND X3-2							
RU S2	*X31A-00741*	*Klein Sabie*	**2**	*SERIOUS/ABUNDANT: Forestry. LARGE: Alien vegetation.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Sabie Town*	*Nutrients.*
MRU Sabie A	*X31A-00778*	*Sabie*	**3**	*CRITICAL: Forestry, Roads, irrigation. LARGE: Urbanization, bed and channel disturbance, alien vegetation.*	*All*	*Sabie town, irrigation return flows, upper parts of Hazyiew including WWTW.*	*Nutrients, salts, E coli, toxics.*
	X31A-00799	*Sabie*					
	X31B-00756	*Sabie*					
	X31B-00757 EWR S1	*Sabie*					
	X31D-00755 EWR S2	*Sabie*					
	X31D-00772	*Sabie*					
RU S1	*X31A-00783*		**2**	*SERIOUS/ABUNDANT: Forestry. MODERATE: Bed and channel disturbance, natural areas/nature reserves, roads.*	*1. Riparian veg 2. Instream biota*		
	X31A-00786						
	X31A-00794						
	X31A-00796						
	X31A-00803						
IUA X3-2 AND PART OF IUA X3-4							
RU S4	*X31B-00792*	*Goudstroom*	**2**	*CRITICAL/EXTENSIVE: Forestry. MODERATE: Alien vegetation, vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Old gold mine leachate and decant, irrigation return flows*	*Nutrients, salts, turbidity, toxics (As and Cn).*
	X31D-00773	*Sabani*		*SERIOUS/ABUNDANT: Abstraction, inundation. LARGE: Agricultural fields, small (farm) dams, irrigation.*	*1. Riparian veg 2. Instream biota 3. Water quality*		
MRU Mac A	*X31C-00683 EWR S4*	*Mac-Mac*	**3**	*SERIOUS/ABUNDANT: Forestry. LARGE: Natural areas/nature reserves. MODERATE: Algal growth, low water crossings, alien vegetation, recreation.*	*All*	*Forestry and related activities, e.g. Venus Sawmill*	*? Suspended solids.*
RU S8	*X31E-00647a*	*Marite (US[1] of dam)*	**3**	*SERIOUS/ABUNDANT: Forestry. LARGE: Vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Graskop (urban impacts), mining*	*Nutrients, E coli, turbidity, toxics, salts.*
	X31F-00695	*Motitsi*	**2**				
IUA X3-3							

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
Mar A	*X31G-00728 EWR S5*	*Marite*	**3**	*SERIOUS/ABUNDANT: Irrigation. LARGE: Agricultural fields, algal growth, increased flows.*	*All*	*Settlements, irrigation return flows*	*Nutrients, E coli, turbidity, salts, toxics.*
	X31E-00647b	*Marite (DS[2] of Dam)*					
MRU Sabie B	*X31K-00715 EWR S3*	*Sabie*	**3**	*LARGE: Agricultural fields, Beda nd Channel disturbance, overgrazing, Natural areas/nature reserves, Recreation, Roads, Vegetation removal, MODERATE: Abstraction, Algal growth, Sedimentation*	*All*	*Rural and urban settlements (e.g. Hazyview), Manghwazi WWTW, irrigation return flows, Pabeni quarry*	*Salts, nutrients, E coli, turbidity, suspended solids.*
	X31K-00750	*Sabie*					
	X31K-00752	*Sabie*					
	X31K-00758	*Sabie*					
	X31M-00681	*Sabie*					
	X31M-00747	*Sabie*					
	X31M-00739	*Sabie*					
IUA X3-4							
RU S5	*X31H-00819*	*White Waters*	**2**	*CRITICAL/EXTENSIVE: Forestry. LARGE: Algal growth, small (farms) dams, inundation, roads, runoff.*			
RU S6	*X31J-00774*	*Noord-Sand*	**3WQ**	*LARGE: Algal growth, small (farm) dams, inundation, roads, runoff/effluent: Urban areas, urbanization, vegetation removal. MODERATE: Abstraction, bed and channel disturbance, low water crossings, erosion, alien vegetation, overgrazing/trampling, irrigation, runoff/effluent: Irrigation, sedimentation, grazing (land-use).*	*No instream as system is seasonal 1. Rip veg (2 priority)*	*Rural settlements, urban areas, irrigation return flows*	*Nutrients, E coli, toxics, salts, turbidity.*
	X31J-00835	*Noord-Sand*					
RU S9	*X31K-00713*	*Bejani*	**3WQ**	*SERIOUS/ABUNDANT: Urbanization, vegetation removal. LARGE: Algal growth, bed and channel disturbance, overgrazing/trampling, runoff/effluent: Urban areas, sedimentation, grazing (land-use).*	*No instream as system is seasonal 1. Rip veg (2 priority)*	*Urban areas including Mkhuhlu WWTW, irrigation return flows*	*Nutrients, E coli, toxics, salts, turbidity.*
RU S10	*X31L-00657*	*Matsavana*	**2**	*SERIOUS/ABUNDANT: Grazing (land-use). LARGE: Algal growth, bed and channel disturbance, low water crossings, overgrazing/trampling, sedimentation, urbanization, vegetation removal.*	*1. Riparian veg 2. Instream biota (only Saringa) 3. Water quality*	*Extensive settlements*	*Nutrients, E coli, turbidity.*
	X31L-00664	*Saringwa*					
	X31L-00678	*Saringwa*					
RU S11	*X31M-00673*	*Musutlu*	**2**	*SERIOUS/ABUNDANT: Low water crossings. LARGE: Roads, grazing (land-use).*	*1. Riparian veg 2. Instream biota*		
IUA X3-5							
MRU Sabie	*X33A-00731*	*Sabie*	**3**	*CRITICAL/EXTENSIVE: Natural areas/nature reserves, recreation.*	*WQ only*	*Skukuza camp, international*	*Nutrients, E coli, salts, turbidity, toxics.*
	X33A-00737	*Sabie*					

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
C	*X33B-00784*	*Sabie*		*SERIOUS/ABUNDANT: Roads.*		*agreements*	
	X33B-00804	*Sabie*					
	X33B-00829	*Sabie*					
	X33D-00811	*Sabie*					
	X33D-00861	*Sabie*					
IUA X3-6							
RU S7	*X33D-00864*	*Mosehla*	**1**	*Nature Reserve.*	*1. Habitat RQO (REC)*		
	X33D-00894	*Nhlowa*					
	X33D-00908	*Shimangwana*					
	X33A-00806	*Nwatimhiri*					
	X33B-00694	*Salitje*					
	X31M-00763	*Nwaswitshaka*					
	X33A-00661	*Nwatindlopfu*					
	X33B-00834	*Lubyelubye*					
	X33C-00701	*Mnondozi*					
	X33D-00911	*Nhlowa*					
	X31K-00771	*Phabeni*			*1. Habitat RQO (REC)* *2. Flow RQO*		
	X32H-00560	*Phungwe*			*1. Habitat RQO (REC)* *2. Flow RQO*		
	X32J-00651	*Mutlumuvi*			*1. Habitat RQO (REC)*		
IUA X3-7							
MRU Mut A	*X32D-00605*	*Mutlumuvi*	**3**	*CRITICAL/EXTENSIVE: Large dams.* *SERIOUS/ABUNDANT: Sedimentation, bed and channel disturbance, vegetation removal.* *LARGE: Agricultural fields, algal growth, bed and channel disturbance, low water crossings, overgrazing/trampling, runoff/effluent: Urban areas, grazing (land-use), urbanization, vegetation removal.*	*All*	*Settlements, irrigation return flows*	*Nutrients, E coli, turbidity, salts, toxics.*
	X32F-00597 EWR S6	*Mutlumuvi*					
RU S13	*X32E-00639*	*Ndlobesuthu*	**3WQ**	*CRITICAL/EXTENSIVE: Runoff/effluent: Urban areas, Urbanization, Vegetation removal, SERIOUS/ABUNDANT: Bed and Channel disturbance, Sedimentation, Grazing (land-use)*	*WQ only*	*Extensive settlements, urban runoff and effluent*	*Nutrients, E coli, turbidity, salts, toxics.*

a	b	c	d	e	f	g	h
RUs	**SQ number**	**River**	**RU priority rating**	**Comments**	**Biota and habitat component indicators**	**WQ Users**	**WQ Variables**
						discharge (Bushbuckridge)	
RU S12	*X32F-00628*	*Nwarhele*	**2**	*SERIOUS/ABUNDANT: Grazing (land-use). LARGE: Agricultural fields, algal growth, bed and channel disturbance, overgrazing/trampling, sedimentation, urbanization, vegetation removal.*	*1. Riparian veg 2. Instream biota 3. Water quality*	*Extensive settlements*	*Nutrients, E coli, turbidity.*
	X32E-00629	*Nwarhele*					
IUA X3-8							
MRU Sand A	*X32A-00583 EWR S7*	*Tlulandziteka*	**3**	*SERIOUS/ABUNDANT: Agricultural fields. LARGE: Algal growth, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal.*	*All*	*Settlements, irrigation return flows*	*Nutrients, E coli, turbidity, salts, toxics.*
	X32C-00558	*Nwandlamuhari*					
	X32C-00606	*Nwandlamuhari*					
RU S14	*X32B-00551*	*Motlamogatsana*	**3WQ**	*LARGE: Agricultural fields, bed and channel disturbance, overgrazing/trampling, sedimentation, grazing (land-use), vegetation removal. MODERATE: Abstraction, algal growth, low water crossings, erosion, alien vegetation, urbanization.*	*1. Riparian veg 2. WQ*	*Hospital WWTW (Acornhoek area)*	*Nutrients, E coli, toxics, suspended solids.*
	X32C-00564	*Mphyanyana*	**2**				
RU S15	*X32G-00549*		**2**	*SERIOUS/ABUNDANT: Grazing (land-use). LARGE: Agricultural fields, overgrazing/trampling, sedimentation.*	*1. Riparian veg 2. WQ*	*Extensive settlements*	*Nutrients, turbidity.*
IUA X3-9							
MRU Sand B	*X32H-00578*	*Sand*	**3**	*CRITICAL/EXTENSIVE: Natural areas/nature reserves, recreation. SMALL: Alien vegetation, inundation, roads, vegetation removal.*	*All*	*Thulamahashe WWTW (outside reserve)*	*Nutrients, E coli.*
	X32J-00602 EWR S8	*Sand*					
	X32J-00730	*Sand*					
	X32G-00565	*Sand*					

1 Upstream *2 Downstream*

2.2 WETLANDS

During the Status quo assessment (DWA, 2013a) an evaluation was done 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 Inkomati Wetland Scoping report (reference), previous Reserve studies (AfriDev, 2005b; DWA, 2010b), 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 entire system (DWS, 2014b).

Ecologically Important wetlands occurring in the Inkomati basin are listed in Table 2.8. These wetlands form the basis for a selection of wetlands (a sub-set of those listed in Table 2.8) that were important for defining Hotspots. "Hotspot" wetlands are a combination of the ecologically important wetlands (Table 2.8), those with a high PES, and those that are threatened by landuse pressures or other impacts. RAMSAR sites were automatically included in the hotspot evaluation. These "hotspot" wetlands directly translate to wetlands with a high priority for defining RQOs.

Table 2.8 Ecologically important wetlands in the Inkomati system and key drivers resulting in modification from natural

RUs	SQ	River	PES	Primary PES Driver	Integrated EIS[1]
RU K1	X11A-01248	Vaalwaterspruit	C	Flow modification and landuse activities.	Moderate
	X11A-01354		C	Flow reduction and landuse activities.	Moderate
RU K2	X11B-01272	Boesmanspruit	C	Landuse activities.	High
RU K3	X11C-01147	Witkloofspruit	C	Flow modification	High
	X11D-01129	Klein-Komati	C	Flow reduction activities.	Moderate
RU K4	X11E-01237	Swartspruit	B/C	Landuse activities, water quality.	High
RU K5	X11G-01143	Gemakstroom	B/C	Flow. on-flow and water quality aspects.	Moderate
MRU KOMATI C	X11H-01140	Komati	C	Flow modification and overgrazing.	High
	X11K-01194	Gladdespruit	B/C	Landuse activities.	Moderate
RU K8	X12A-01305	Buffelspruit	B/C	Forestry and Invasive vegetation.	High
	X12C-01271	Buffelspruit	B	Landuse activities, overgrazing.	Moderate
	X12D-01235	Seekoeispruit	C	Urbanisation and landuse activities.	Moderate
MRU KOMATI T	X12E-01287	Teespruit	B/C	Flow and non-flow related impacts.	High
RU K11	X13J-01149	Komati	D/E	Flow modification and agriculture.	Moderate
	X13J-01205	Mbiteni	D	Flow, non-flow and water quality impacts.	Moderate
	X13J-01221	Komati	D	Flow modification, agricultural encroachment.	Moderate
RU K13	X13K-01068	Nkwakwa	D	Flow modification and reduction.	Low
	X13L-01000	Ngweti	D/E	Flow modification and reduction, dams.	Low
MRU KOMATI M	X14G-01128	Lomati	E	Dams, flow modification and reduction.	Moderate
MRU CROC A	X21A-00930	Crocodile	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.	Very High
	X21A-01008		C/D	Flow reduction and small dams.	Low

RUs	SQ	River	PES	Primary PES Driver	Integrated EIS[1]
RU C1	X21B-00898	Lunsklip	C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species.	Very High
	X21B-00929	Gemsbokspruit	C	Small dams and pockets of forestry.	Very High
RU C2	X21C-00859	Alexanderspruit	C/D	Dams, irrigation, forestry.	High
MRU ELAN A	X21F-01046	Elands	C	Many small dams and agricultural encroachment.	High
RU C12	X22C-01004	Gladdespruit	C	Afforestation/Invasive plants, landuse encroachment.	High
RU C14	X22H-00836	Wit	E	Flow modification, dams.	High
RU C17	X23E-01154	Queens	C	Afforestation/Invasive plants.	Low
RU S8	X31F-00695	Motitsi	C	Forestry.	Moderate
MRU SAND A	X32A-00583	Tlulandziteka	D	Vegetation removal and overgrazing.	High
RU S14	X32B-00551	Motlamogatsana	D	Vegetation removal and overgrazing.	High
MRU MUT A	X32D-00605	Mutlumuvi	D	Vegetation removal and overgrazing.	High
RU S7	X33A-00806	Nwatimhiri	A/B	In KNP.	High
	X40A-00469	Nwanedzi	C	Weirs.	Low

1 Ecological Importance and Sensitivity.

Two broad areas of priority wetlands were identified in the status quo study (DWA, 2013a) and these wetlands are prioritised for the determination of RQOs:

- *The wetlands around Dullstroom (quaternary catchments X21A, X21B, X21C and X21F) all have High EIS scores and relatively high PES scores. These catchments are part of the Escarpment WRU and are located close to the RAMSAR Verloeren Vallei wetland complex.*
- *Wetlands of the Highveld WRU (X11A, X11B, X11C, X12A, X12B and X12E) generally have High EIS and Moderate PES scores. Of particular importance are the wetlands near the Chrissiesmeer Lake system – a dense grouping of pans in the headwaters of the Inkomati, Vaal and Usutu Rivers provides unique wetland habitats for birds and other fauna, and has a strong recreational and conservation value.*

Tables 2.9 to Table 2.11 list the prioritised wetlands that were used to define habitat and biota RQOs. For the sake of ease, wetlands are sorted within existing river RUs as well as SQs. The TEC is provided for each RU. It must be noted, that although these wetlands can be high priority, the level of RQOs provided are at moderate level due to a lack of detailed available information and none of the scenarios impact on the wetlands. Also, where the TEC is the same as the PES, no improvement was possible or required. In most cases (unless otherwise stated) scenarios did not influence wetland status.

Table 2.9 Important wetlands in the Komati River System in the Inkomati catchment (X1) and key drivers resulting in modification from natural

RUs	SQ number	EIS	PES[1]	REC	TEC	Key drivers causing PES
IUA X1-1						
RU K1	X11A-01354	Moderate	C	C	C	Flow modification and landuse activities.
	X11A-01248	Moderate	C	C	C	
RU K2	X11B-01272	High	C	B/C	B/C	Landuse activities.
IUA X1-3						

RUs	SQ number	EIS	PES[1]	REC	TEC	Key drivers causing PES
RU K3	X11C-01147	High	C	C	C	Flow modification for those wetlands that are associated with farm dams, otherwise landuse around pans.
	X11D-01129	Moderate	C	C	C	Flow reduction activities.
RU K4	X11E-01237	High	B/C	B/C	B/C	Landuse activities, water quality.
RU K5	X11G-01143	Moderate	B/C	B/C	B/C	Flow and non flow-related impacts as well as water quality impacts.
IUA X1-4						
MRU KOMATI G	X11K- 01194	Moderate	B/C	B/C	B/C	Landuse activities.
IUA X1-5						
MRU KOMATI C	X11H-01140	High	C	B/C	B/C	Flow modification and overgrazing: need to improve wetland buffers and reduce overgrazing.
MRU KOMATI T	X12E-01287	High	B/C	B/C	B/C	Mostly associated with urban impact, unlikely to improve.
IUA X1-6						
RU K8	X12A-01305	High	B/C	B/C	B/C	Forestry and invasive vegetation.
	X12C-01271	Moderate	B	B	B	Landuse activities, overgrazing.
	X12D-01235	Moderate	C	C	C	Urbanization and landuse activities.
IUA X1-9						
RU K11	X13J-01205	Moderate	D	D	D	Flow and non flow-related impacts as well as water quality impacts.

1 The PES score represents an average score for wetlands associated with the SQ.

Table 2.10 Important wetlands in the Crocodile River System in the Inkomati catchment (X2) and key drivers resulting in modification from natural

RUs	SQ number	EIS	PES	REC	TEC	Wetland RQO
IUA X2-1						
RU C1	X21B-00929	Very high	C	B/C	B/C	Small dams and pockets of forestry. Small portion of wetlands associated with small dams, but several wetlands in good condition, improvement will require removal of dams.
	X21B-00898	Very high	C	B/C	B/C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species. Off-channel wetlands generally in better condition, as well as those in Verloren Valei Nature Reserve, improve wetland buffers, remove alien woody species in wetlands, do not allow any more dams and rehabilitate those not in use, reduce amount of dams if possible.
RU C2	X21C-00859	High	C/D	C	C	Dams, irrigation, forestry. Improve buffer zones for wetlands especially with respect to agriculture.
MRU CROC A	X21A-00930	Very high	C	B/C	B/C	Many small dams, landuse activities, some urbanisation and small pockets of alien woody species. Off-channel wetlands generally in better condition, as well as those in Verloren Valei Nature Reserve, improve wetland buffers, remove alien woody species in wetlands, do not allow any more dams and rehabilitate those not in use, reduce amount of dams if possible.
IUA X2-3						
MRU ELAN A	X21F-01046	High	C	B/C	B/C	Many small dams and agricultural encroachment. Remove agriculture from wetland areas.
IUA X2-8						

RUs	SQ number	EIS	PES	REC	TEC	Wetland RQO
RU C12	*X22C-01004*	*High*	**C**	**B/C**	**B/C**	*Afforestation/invasive plants, landuse encroachment. Improve wetland buffers.*
RU C14	*X22H-00836*	*High*	**D/E**	**D/E**	**D/E**	*Flow modification, dams. Unlikely to improve, mostly dams or urban impacts.*

Table 2.11 Important wetlands in the Sabie and Sand River System in the Inkomati catchment (X3) and key drivers resulting in modification from natural

RUs	SQ number	EIS	PES	REC	TEC	Wetland RQO
IUA X3-2 AND PART OF IUA X3-4						
RU S8	*X31F-00695*	*Moderate*	**C**	**C**	**C**	*Forestry.*
IUA X3-7						
MRU MUT A	*X32D-00605*	*High*	**D**	**C**	**C**	*Vegetation removal and overgrazing. Improve wetland buffers and reduce overgrazing.*
IUA X3-8						
RU S14	*X32B-00551*	*High*	**D**	**C**	**C**	*Vegetation removal and overgrazing. Improve wetland buffers and reduce overgrazing.*
MRU SAND A	*X32A-00583*	*High*	**D**	**C**	**C**	*Vegetation removal and overgrazing. Improve wetland buffers and reduce overgrazing.*

3 APPROACH

3.1 RIVERS

3.1.1 Biota and habitat EcoSpecs, TPCs and RQOs

For the purpose of RQO determination, the following differentiation is made between biota and habitat EcoSpecs and RQOs.

EcoSpecs are associated with the Ecological Reserve process and are usually provided at EWR sites. As explained in Chapter 2, EWR sites are situated in hotspots and high priority RUs and detailed RQOs must be provided. EcoSpecs are seen as detailed RQOs as they are quantifiable, measurable, verifiable and enforceable to ensure protection of all components of the resource, which make up ecological integrity (DWA, 2009a). Therefore, EcoSpecs are numerical and can be used for monitoring. TPCs are upper and lower levels along a continuum of change in selected environmental indicators and are used and interpreted according to the following guidelines (Rogers and Bestbier, 1997) and are linked to EcoSpecs. When setting EcoSpecs, the work is usually based on field work that has been undertaken, a monitoring baseline is therefore available and monitoring to determine whether the specifications are being achieved (or Ecological Category) can be undertaken.

Biota and habitat RQOs are usually determined for the Moderate Priority RUs (Level 2) rather than EcoSpecs. The requirements for Moderate Priority RUs are that the RQOs should be broader or less detailed than High Priority RUs and this is inherently the case as fieldwork has not been undertaken. A monitoring baseline is therefore also not available and EcoSpecs cannot be determined. Monitoring at Moderate Priority RUs will be of lower priority than at EWR sites in High Priority RUs. As sufficient data is not available to set specifications, broad objectives for the EC are provided only. RQOs in this format cannot be used in monitoring as is. It therefore follows that if monitoring must be undertaken for some or other reason at some stage, then the objectives must be translated into EcoSpecs based on field surveys and the establishment of a monitoring baseline.

3.1.2 Water quality

General approach

The water quality RQOs were generated following the approach shown in Figure 3.1. Note that water quality RQOs were generated as EcoSpecs for the EWR sites as part of the Reserve process (i.e. objectives for aquatic ecosystems), and UserSpecs for the following users:

- *Domestic use - assumes primary treatment.*
- *Agriculture - Stock watering and Irrigation.*
- *Aquaculture.*
- *Industrial - Category 3.*
- *Recreation - Intermediate or full-contact (DWAF, 1996a).*

Data from DWAF (1996b) were used for aquaculture quality requirements. Where objectives for aquatic ecosystems were not available from a Reserve study, water quality guidelines were used (DWAF, 1996c).

The approach followed can be seen as Steps 1 - 5 in Figure 3.1. Steps 1 to 3, particularly data collected regarding users and driving variables for which RQOs should be set, were tested at a

Technical Task Group (TTG) meeting held in Nelspruit on 28 August 2014. Invaluable data were collected and RQOs set according to the agreed set of variables.

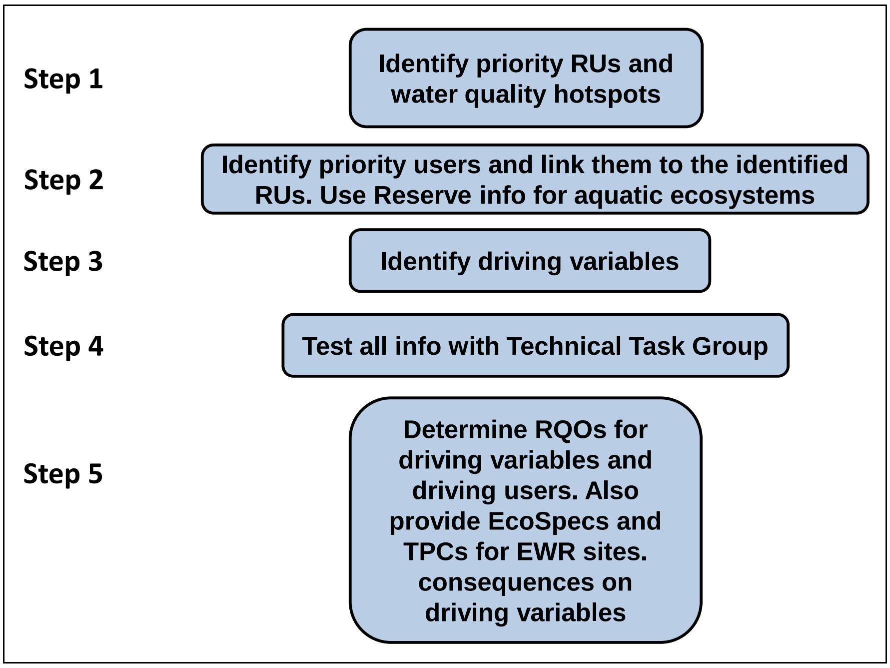


Figure 3.1 Approach followed to generate water quality RQOs

Setting numerical and narrative RQOs

Numerical and narrative RQOs were therefore produced using all existing data sources, including the preliminary water quality objectives produced by DWS Water Quality Planning (DWA, 2012a-c). Objectives were produced 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 or full-contact.*

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. This approach was followed for setting water quality RQOs for identified reaches. Note that Reserve data available as A - F Categories were converted to Ideal to Tolerable categories, following standard methodology.

To summarize, user water quality state per relevant RU and IUA was evaluated by determining the <u>driving</u> water quality variables linked to the <u>primary</u> water quality user(s). Note that although the aquatic ecosystem is the **resource base** *rather than a "user", it was grouped and evaluated with other users for purposes of this step of the Classification process. The driving user and set of variables were identified and the water quality RQOs set accordingly.*

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 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Trout farming and some irrigation.*
Water quality issue: *Water is abstracted for irrigation and trout farming. Nutrient elevations are therefore the main water quality issue.*
Narrative and Numerical: *Details for MRU Croc A are provided in tables below. The latter two tables refer to the EWR sites, i.e. EWR C1 and EWR C2 respectively. Data used for water quality assessments should be collected from X2H074Q01.*

Assumptions when setting RQOs

The following set of assumptions and rules were developed and followed when setting RQOs. Rules were tested and developed further with stakeholders at the TTG meeting in August 2014.

- *Although microbial compliance targets for Waste Water Treatment Works (WWTW) should be specified in the water use license for the discharge, an objective for Escherichia coli and faecal coliforms must be set below each WWTW, town and large settlement, together with an objective for nutrients (specifically ortho-phosphate).*
- *Run-of-river objectives (Escherichia coli and faecal coliforms) are focused on intermediate, e.g. angling, or 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.*
- *Broad numerical guidelines for toxics are not suitable for areas where specific information on toxics are available, or where the identity of contaminants are known, e.g. areas prone to contamination by gold mining leachate should specify RQOs for arsenic (As) and cyanide (Cn).*
- *Areas prone to contamination from AMD should be protected by setting RQOs for salts, sulphate and pH.*
- *International agreements (e.g. the Tripartite Interim Agreement between the Republic of Mozambique, the Republic of South Africa and the Kingdom of Swaziland; May 2002) must be assessed for water quality requirements. A full set of water quality RQOs have been specified at downstream points where international boundaries exist.*
- *Detailed EcoSpecs and TPCs are provided for the EWR sites, as available from the Reserve studies of 2000 and 2010. Note the following points:*
    - *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 official using TEACHA to produce aggregated salts will be a DWS 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.

- *Note that TEACHA is not operational at present (i.e. as at December 2014), but as it is the only tool to generate aggregated salts and was used during the Reserve studies, it is included in this document.*

3.1.3 Fish

High priority rating (3) RUs: *The RQOs and EcoSpecs as developed during the Reserve Determination studies (Afridev, 2006a; DWA, 2010a) was primarily used during this process. The information was adapted and simplified where possible and all other available and relevant information (e.g. PES 2011[1]) was used to update and expand the descriptions to be relevant for the EWR reach as well as the entire management unit. RQOs and EcoSpecs were described for different metrics, such as Ecological Status (PES), species richness, migratory requirements, alien species and for specific habitat features (such as fast shallow habitats, rocky substrates). Indicator species were identified for all these various metrics and primary indicator species (that would best provide indication of potential concern, especially in terms of flow and flow related water quality) was then highlighted.*

Moderate priority rating (2) RUs: *The available information, as provided in the PES 2011 assessment (DWS, 2014b) was used as the primary fish information source for RUs with a level 2 priority rating. This information, together with other relevant available information were used to determine the expected species that may occur in the reach/es under present ecological condition. Based on this information, species richness, primary and secondary indicator species were identified and used to describe the narrative and numerical RQOs for each of this sub component indicators for the reach.*

3.1.4 Macro-invertebrates

High priority rating (3) RUs: *For the macro-invertebrate component of the study, EcoSpecs and TPCs were provided only for the EWR sites, and the detail of the approach and methodology is available from the Reserve study of 2009 (DWAF, 2010a).*

By using the taxa preference data in the Macro Invertebrate Response Assessment Index (MIRAI) sheets (Thirion, 2007), the indicator taxa for different criteria were selected. These sheets indicate the habitat value and preference (1 - 5) for each taxa related to the different variables (flow, water quality and habitat). The physical and hydraulic-habitat criteria are considered to be those relevant to the indicator taxa per reach or site:

- *Preference for fast-flowing water.*
- *Optimal substrate types.*
- *Integrity of marginal vegetation habitats.*
- *Moderate to good water quality.*

The actual setting of EcoSpecs and TPCs was guided by the data described above. South African Scoring System version 5 (SASS5) and MIRAI scores also integrate these habitat parameters, thus these scores are also translated into EcoSpecs. Macro-invertebrate EcoSpecs are described for each criterion, and once the EcoSpecs are described, TPCs are then derived for each of the selected criteria for the EWR site, supplying measurable biotic TPCs.

[1] *Desktop Present Ecological State (PES) and Ecological Importance (EI) - Ecological Sensitivity (ES) (DWS, 2014b) assessment (referred to as PES 2011).*

Measurable reaction (presence/absence or population trends) of the sensitive or key taxa to changes in the system, will indicate the integrity of the river reach, and should be quantifiable with the specific TPC.

The following data was used for determining EcoSpecs and TPCs:

- *Data collected during the EWR site visits;*
- *Relevant historic data and observations from surveys in the catchment.*

Moderate priority rating (2) RUs: *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 PES 2011 data (DWS, 2014b)) 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 are used 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.*
- *Suitable marginal vegetation or sand/gravel habitat.*
- *Acceptable water quality (Moderate - Good).*

3.1.5 Riparian vegetation

High priority RUs

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. 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	*1-5*
B	*5-10*
B/C	*10-15*
C	*15-20*
C/D	*20-30*
D	*30-50*
D/E	*50-60*
E	*60-70*
E/F	*70-80*
F	*>80*

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. Table 3.2 outlines the hypothesis used to relate the degree of terrestrialisation to the EC.

Table 3.2 Hypothesised relationship between degree of terrestrialisation and EC for different sub-zones within the riparian zone.

Class	Marginal Zone	Lower Zone	Upper Zone	Note
A	*0*	*0*	*0 - 5*	*This hypothesis is based on the phenomenon that terrestrial species occur naturally in the riparian zone, but are reduced in cover and abundance by increased flooding disturbance. Data of terrestrial:riparian plant ratios (on the Sabie River) showed a distinct reduction in terrestrial individuals with increasing exposure to flooding disturbance.*
A/B	*0*	*0*	*5 - 10*	
B	*0*	*0*	*10 - 15*	
B/C	*0*	*1 - 5*	*15 - 20*	
C	*0*	*5 - 10*	*20 - 30*	
C/D	*0*	*10 - 15*	*30 - 40*	
D	*1 - 5*	*15 - 20*	*40 - 50*	
D/E	*5 - 10*	*20 - 30*	*50 - 60*	
E	*10 - 15*	*30 - 40*	*60 - 70*	
E/F	*15 - 20*	*40 - 50*	*70 - 80*	
F	*> 20*	*> 50*	*> 80*	

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 3.3). 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 3.3 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 3.4.

Table 3.4 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, 2009b), 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 3.5. 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 reed 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 3.5 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	30 - 40; >80	30 - 40; 70 - 80	<20; 30 - 40
B/C	20-30	20-30	
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

Moderate priority RUs

Data from the PES 2011 (DWS, 2014b) assessment were used to develop narrative and numerical RQOs for moderate priority RUs. Where more than a single SQ was included in the RU, data from an SQ with a better EC and farther downstream was used to represent the RU. The following indicators are described below and were used to describe narrative (and where data lend themselves numerical) RQOs.

Dominant vegetation cover

Different types of riparian ecosystems are characterised by different dominant riparian vegetation e.g. grass-dominated Highveld/mountainous streams, tree and shrub-dominated Lowveld/lowland rivers flowing through Bushveld, tall tree-dominated (forest) streams through forested /kloof areas, or mixed vegetation e.g. reed and tree/shrub dominated rivers which are common in the Inkomati catchment. The dominant vegetation type (riparian) is a key component of the structure and function of the riparian zone as a whole.

Presence of alien plant species

Invasion of riparian zones by alien plant species is a major concern and determinant of EC deterioration along almost all South African rivers. As such its consideration and measurement are imperative for effective management. The consideration here makes no distinction of species but does focus on perennial aliens rather than including annuals as well. Alien invasion is expressed as the percentage aerial cover (% of total riparian zone area) of all perennial aliens within the riparian zone area.

Longitudinal riparian zone continuity

Longitudinal riparian zone continuity was an integral factor in the PES 2011 assessment (DWS, 2014b) 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.*

Riparian zone fragmentation

The ability of the riparian zone to function as such depends largely on the level of longitudinal and lateral fragmentation. Where fragmentation is high functionality is lost. As such RQOs were developed that relate to fragmentation, but make specific reference to agricultural and forestry activities as these are the most common and dominant reasons for an increase in fragmentation. Since both agricultural and forestry activities were rated in the PES 2011 (DWS, 2014b) fact sheets, it is possible to monitor changes over time.

Riparian plant endemism

Based on the observed distribution of riparian species, the PES 2011 project (DWS, 2014b) measured the presence of endemic riparian species. These data were used to develop RQOs that highlight the presence of these species within respective RUs.

Threatened riparian species

Based on the observed distribution of riparian species, the PES 2011 project (DWS, 2014b) measured the presence of threatened riparian species (those with International Union for Conservation of Nature (IUCN) status other than Least Concern (LC) or Data Deficient (DD). These data were used to develop RQOs that highlight the presence and protection of these species within respective RUs.

Riparian taxon richness

Based on the observed distribution of riparian species, the PES 2011 project (DWS, 2014b) measured the presence of riparian species (referred to as taxa). These data were used to develop RQOs that highlight the maintenance of baseline species (riparian) richness within respective RUs.

3.2 WETLANDS

RQOs were only defined for those wetlands highlighted in Tables 2.9 to 2.11 in Section 2.2. When determining RQOs, data from previous Reserve studies (AfriDev, 2005b; DWA, 2010b) and the PES 2011 work that was done for the entire system (DWS, 2014b) were used to define RQO specifications. Although some wetlands can have a High priority, the level of RQOs provided are at moderate level due to a lack of more detailed available information, time constraints and because in most cases the scenarios did not impact wetlands.

Throughout, the most common cause for wetland PES deterioration was agricultural and forestry activities. Restriction of such activities within and directly surrounding wetlands has thus been a major focus for defining RQOs. In addition the following high priority components were incorporated when defining RQOs:

- *Wetland fragmentation.*
- *Species composition and indigenous vegetation cover.*
- *Cover or abundance of invasive alien species, particularly perennial or woody species.*

As such wetland RQOs focussed mainly on:

- *Maintaining TEC and EIS.*
- *Maintaining species composition and vegetative cover.*

- *Halting an increase in the cover or abundance of woody alien invasive species, or reducing their abundance.*
- *Halting an increase in wetland fragmentation.*
- *The cessation of land use encroachment on and within wetlands, particularly forestry and agriculture.*

Acknowledging that these RQOs are defined based on desktop information, there are some generic RQOs that will not be repeated for every high priority wetland in the RQO sections in the rest of the report. These are:

- *There should be no increase in wetland fragmentation.*
- *Maintain species composition and indigenous vegetative cover*
- *There should be no increase in the cover or abundance of woody invasive alien species.*

4 KOMATI: IUA X1-1 - RESOURCE QUALITY OBJECTIVES

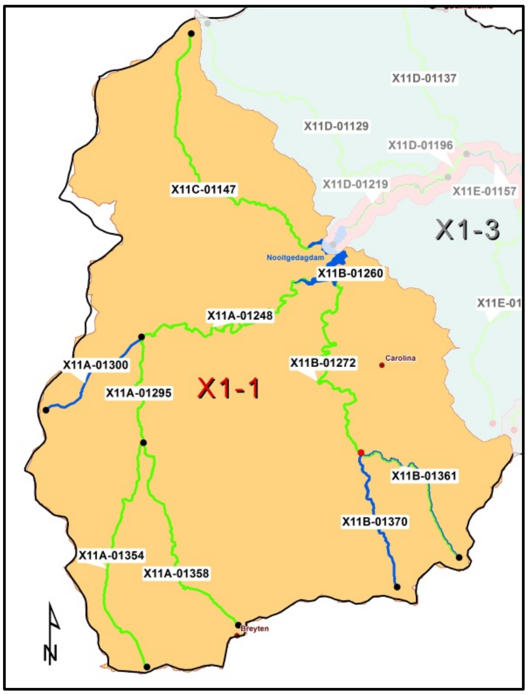
4.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the headwater catchments of the Komati River up to the Nooitgedacht Dam. In addition to the Nooitgedacht Dam, the only other significant dam is the Boesmanspruit Dam which supplies the town of Carolina. Water from the Nooitgedacht Dam is transferred to the Olifants River catchment for cooling of the coal-fired power stations located there. There are limited farm dams in the catchment but several waste water containment dams which are supposed to contain the highly acidic runoff from coal mines in the area.

This area is relatively flat and a large proportion of this IUA is endorheic, as is evidenced by the large number of natural plans. Land use in the catchment is mostly grazing and dry land crops. There is limited irrigation of maize. The IUA is dominated with C PES with two SQs in a B PES and one in a B/C PES. Impacts are largely non flow-related due to agriculture (grazing and dry-land), barrier effects and inundation due to numerous farm dams and some alien vegetation. Flow also plays a role due to the mostly run of river abstractions for irrigation and the farm dams

IUA X1-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-1 KOMATI TO NOOITGEDACHT DAM



PRIORITY RATINGS

RU	SQ	River	PES	TEC	PR[1]
RU K1	*X11A-01300*		B	B	2
	X11A-01354		C	C	
	X11A-01358	*Vaalwaterspruit*	C	C	3WQ
	X11A-01248	*Vaalwaterspruit*	C	C	3WQ
	X11A-01295	*Vaalwaterspruit*	C	C	
RU K2	*X11B-01370*	*Boesmanspruit*	B	B	3WQ
	X11B-01361		B/C	B/C	
	X11B-01272	*Boesmanspruit*	C	C	

1 Priority rating.

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

4.2 RQOs FOR RU K1: MODERATE PRIORITY - 2 (X11A-01300, 01354, 01358, 01248, 01295)

4.2.1 Flow RQOs

***Source:** DWA (2014).*
***Model:** Desktop Reserve Model (DRM) (Hughes and Hunnart, 2003) for X11A-01300; Revised Desktop Reserve Model (RDRM) (Hughes et al., 2013) for the rest of the SQs in IUA X1-1.*

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

Table 4.1 RU K1: Flow RQOs

TEC	nMAR[1] (MCM)[2]	pMAR[3] (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X11A-01300										
B	*1.7*	*1.4*	*0.31*	*18.1*	*0.48*	*28.1*	*0.001*	*0.002*	*0.003*	*0.007*
X11A-01354										
C	*3.9*	*3.1*	*0.59*	*15.1*	*0.962*	*24.5*	*0.003*	*0.01*	*0.005*	*0.016*
X11A-01358										
C	*6.6*	*5.7*	*1.13*	*17.3*	*1.76*	*26.8*	*0.011*	*0.014*	*0.018*	*0.026*
X11A-01248										
C	*26.3*	*22.4*	*3.73*	*14.2*	*6.19*	*23.5*	*0.022*	*0.05*	*0.048*	*0.081*
X11A-01295										
C	*15.4*	*12.9*	*2.81*	*18.2*	*4.2*	*27.2*	*0.012*	*0.035*	*0.023*	*0.058*

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

4.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012a; 2012d; 2013a; DWS, 2014b; McCarthy and Humphries, 2013) were used.*
Model: *N/A.*
Users: *Potential AMD impact; Breyten WWTW (X11A-01358).*
Water quality issue: *Salts (sulphates), nutrients, toxics, and pH.*

Narrative and numerical details for RU K1 are provided in Table 4.2.

Table 4.2 RU K1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure pH levels stay within Acceptable limits.	*A small change from the Ideal range is allowed, i.e. a 5th percentile of 5.9 - 6.5, and a 95th percentile of 8.0 - 8.8 (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 (aquatic ecosystems: driver).*
Ensure that sulphate levels are within acceptable limits.	*95th percentile of the data must be less than or equal to 30 mg/L (industrial cat 3: drivers; DWA, 2012a).*
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or Target Water Quality Range (TWQR).	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Meet faecal coliform and E.coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996a).*

4.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 4.3.

Table 4.3 RU K1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (Crinum bulbispermum and C. macowanii)*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 45 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is generally low (four species) in most of the reaches in this RU, reaching seven species in the lowest reach under the PES. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/BPOL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish or spread of alien fish species.*	*Maintain indigenous species (AURA, BPOL, BANO, CGAR, CPRE, PPHI and TSPA) richness ranging between four to seven fish species in various reaches of unit. Maintain current habitat diversity to meet the requirements of these species.*
Primary indicator species: AURA/BPOL (flow and flow related water quality, substrate, migration)		*Maintain suitable flows and velocities (>0.3 m/s) (all seasons) to sustain the rheophilic species, adequate velocities (>0.3 m/s) and depth (>0.3 m) during wet season for large semi-rheophilic species in the reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicator species: *Flow: CPRE* *Water quality: BANO*[1] *Vegetation: BANO, PPHI, TSPA* *Migration: CGAR*		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Psephenidae	*Flows should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for both these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be*	*Maintain suitable conditions in the*

Indicators	Narrative RQO	Numerical RQO
	adequate to ensure suitable habitats for this sensitive taxon.	*SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*Marginal vegetation habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the marginal vegetation (MV) in moderate velocity (0.3 - 0.6 m/s) for these key taxon.*

1 According to the Mpumalanga Tourism and Parks Authority (MPTA), this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

4.2.4 Wetland RQOs

Wetland RQOs are provided in Table 4.4.

Table 4.4 RU K1: Wetland RQOs

SQ	TEC	Wetland RQO
X11A-01354	C	*Maintain TEC (C) and moderate EIS at least. Cessation of land use encroachment on pans, seeps and channelled valley bottom wetlands.*
X11A-01248	C	

4.3 RQOs FOR RU K2: MODERATE PRIORITY - 2 (X11B-01370, 01361, 01272)

X11B-01272 situated in RU K2 requires improvement to achieve the TEC of a B/C. The actions required are mostly flow-related which entails changes in the flow regime through releases from Boesmansspruit Dam although it is acknowledged that this may be very difficult (DWS, 2014a). With an improvement in the flow regime, the fish habitats, and therefore fish assemblage as a whole, may improve. It is however not possible to quantify the extent of improvement.

4.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 4.5 RU K2: 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%
X11B-01370										
B	*4.8*	*3.5*	*0.91*	*19*	*1.39*	*28.8*	*0.009*	*0.014*	*0.017*	*0.023*
X11B-01361										
B/C	*4.2*	*3.6*	*0.68*	*16*	*1.14*	*27*	*0.004*	*0.009*	*0.007*	*0.016*
X11B-01272										
C	*51.4*	*41.9*	*8.87*	*17.3*	*13.75*	*26.8*	*0.051*	*0.133*	*0.083*	*0.191*

4.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012a; 2012b; 2013a; DWS, 2014b; McCarthy and Humphries, 2013) were used.*
Model: *N/A.*
Users: *Irrigation activities.*
Users: *Potential AMD impact; urban impacts of Carolina (X11B-01272).*
Water quality issue: *Salts (sulphates), nutrients, toxics, and pH.*

Narrative and numerical details for RU K2 are provided in Table 4.6.

Table 4.6 RU K2: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure pH levels stay within Acceptable limits.	*A small change from the Ideal range is allowed, i.e. a 5^{th} percentile of 5.9 - 6.5, and a 95^{th} percentile of 8.0 - 8.8 (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 (aquatic ecosystems: driver).*
Ensure that sulphate levels are within acceptable limits.	*95^{th} percentile of the data must be less than or equal to 30 mg/L (industrial cat 3: drivers; DWA, 2012a).*
Ensure that nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Meet faecal coliform and E.coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996b).*

4.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 4.7.

Table 4.7 RU K2: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain large or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should*	*Two listed riparian species should remain within the RU (C. bulbispermum*

Indicators	Narrative RQO	Numerical RQO
	remain within the RU.	*and C. macowanii).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 40 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is generally low (six species) in this RU under the PES. It is important to maintain adequate water quality and vegetation and substrate as cover for the small semi-rheophilic guild. Flows should be adequate to ensure suitable habitats for large semi-rheophilic indicator species (BPOL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers to fish or spread of alien fish species.*	*Maintain indigenous species (BANO, BPAU, BPOL, CGAR, PPHI and TSPA) richness of six species in unit. Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: BANO[2] /BPOL (flow and flow related water quality, substrate, vegetation, migration)		*Maintain suitable vegetated habitats and substrate of good quality to sustain the small semi-rheophilic guild. Maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BPOL) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Vegetation: BPAU, PPHI, TSPA Migration: CGAR		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Psephenidae Philopotamidae (Leptophlebidae Hydropsychidae 2spp for improved conditions)	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent species (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*MV habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

4.3.4 Wetland RQOs

Wetland RQOs are provided in Table 4.8.

Table 4.8 RU K2: Wetland RQOs

SQ	TEC	Wetland RQO
X11B-01272	**B/C**	*Maintain TEC (B) and High EIS.* *Cessation of land use encroachment on non-artificial channelled valley bottom wetlands.* *Improve to B/C by increasing buffer zones where wetlands are not artificial.*

5 KOMATI: IUA X1-2 - RESOURCE QUALITY OBJECTIVES

5.1 IUA OVERVIEW AND DESCRIPTION

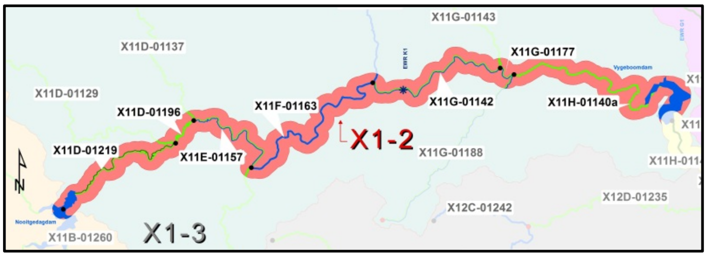
This IUA consists of the main stem of the Komati River commencing immediately downstream of the Nooitgedacht dam and ending with the Vygeboom Dam. Other than the Vygeboom Dam, there is no significant storage. There is however a weir located on the river between the two dams from which water is pumped by Eskom for transfer to the Olifants system. The other significant abstraction is from the Vygeboom Dam, also for transfer to the Olifants.

This IUA is relatively flat in the upper reaches but becomes increasingly incised progressing downstream, although the catchment flattens out again in the vicinity of the Vygeboom Dam. Land use is grazing, dry land crops and limited irrigation.

The Komati River is dominated by changes in flow largely due to the operation of Nooitgedacht Dam. The six SQs consist of two C ECs and one C/D immediately below the dam. The PES is mostly a result of the changes in flow regime from Nooitgedacht Dam. Further downstream the river is more protected (game reserves) and the flow impact improves slightly as tributaries bring in some flow and variability. Of these three SQs one is in a B EC and two are in a B/C EC.

IUA X1-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-2 - KOMATI RIVER FROM NOOITGEDACHT TO VYGEBOOM



PRIORITY RATINGS

RU	SQ	River	PES	TEC	PR
MRU Komati B	*X11D-01219*	*Komati*	C/D	C/D	3
	X11D-01196	*Komati*	C	C	
	X11E-01157	*Komati*	B/C	B/C	
	X11F-01163	*Komati*	B	B	
	X11G-01142 EWR K1	*Komati*	C	C	
	X11G-01177	*Komati*	B/C	B/C	
	X11H-01140a	*Komati*	C	C	

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

5.2 RQOs FOR MRU KOMATI B: HIGH PRIORITY – 3 (EWR K1 - X11G-01142; INCLUDING X11D-01219, 01196, X11E-01157, X11F-01163, X11G-01177, X11H-0140A)

The TECs is provided for EWR K1 below. Note that EWR K1 represents the Komati River from the Nooitgedacht to Vygeboom Dam and is not impacted by the scenarios. Scenario K42 was the preferred scenario for the Komati River System (refer to section 1.6.1).

Table 5.1 TECs for EWR K1

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	B	B	B	B
Geomorphology	C	C	C	C
Fish	C	C	C	C
Invertebrates	B/C	B/C	B/C	B/C
Riparian vegetation	C	C	C	C
EcoStatus	C	C	C	C

5.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *Water Resources Modelling Platform (WReMP) (Mallory et al., 2010).*

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

Table 5.2 MRU KOMATI B: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X11G-01142 (EWR K1)										
C	*158.6*	*108.5*	*25.57*	*16.1*	*41*	*27.5*	*0.254*	*0.374*	*0.618*	*0.779*

5.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *Tool for Ecological Aquatic Chemical Habitat Assessment (TEACHA) and Physico-chemical Driver Assessment Index (PAI) model (Kleynhans et al., 2005) version available at the time.*
Users: *Irrigation activities.*
Water quality issue: *Elevated nutrients, salts and toxics.*
Narrative and Numerical: *Details for MRU KOMATI B are provided in Tables 5.3 and 5.4. Data used for water quality assessments should be collected from X1H033Q01.*

Table 5.3 MRU KOMATI B: 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 0.02 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 42 mS/m (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements*

Table 5.4 EWR K1: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Komati Monitoring site: X1H033Q01	PES: B Category	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*0.129 mg/L.*
PO_4-P		*0.017 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*5 µg/L.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) Current monitoring does not include any toxics other than Fluoride.
(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.

5.2.3 Habitat and biota RQOs (EcoSpecs)

5.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES, based on fish assemblage is estimated to fall in a Category C (DWA, 2014) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates EWR K1 is estimated to be eleven species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this RU and provides valuable indicators of potential change. The primary indicator fish species for this unit include the small rheophilic mountain catfish (AURA) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary* *indicators species are also present to monitor other aspects of the ecosystem. Fish in this RU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the presence of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 5.5 and were derived from AfriDev (2006a).*

Table 5.5 EWR K1: Fish EcoSpecs and TPCs (PES and TEC: C) (derived from AfriDev, 2006a)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) indicated that this reach falls in a Category B/C while the EWR revision done as part of this study (DWA, 2014) indicated the PES to be in a Category C (FRAI = 75.7%).*	*Any decreased FROC[2] in reach of indicator species (mentioned in this table) OR FRAI[3] EC decreasing below a C.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated eleven species present in SQ reach under PES (PES 2011; DWS, 2014b).*	*Any decrease in the species richness of this unit (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/ introduced spp.*	*Present status of alien species uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD Habitats, FS habitats, substrate	**AURA**	*AfriDev (2006a): FROC[2] of 4 under PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every three surveys.*	*Reduced suitability (abundance and quality) of Fast Deep and Fast Shallow (FD and FS) habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified with RHAM; DWA, 2009b). Decreased water quality.*
	CPRE	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	*N/A.*
FD Habitats, FS habitats	*CEMA*	*AfriDev (2006): FROC of 2 under PES.*	*This species should be present in some surveys. Habitat can be limited for this species and is expected to occur at least in one in five surveys*	
	BARG	*AfriDev (2006a): FROC of 2 under PES.*	*This species should be present in some surveys. Habitat can be limited for this species and is expected to occur at least in one in five surveys*	
	BMAR	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys.*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			The absence of this species from any survey is considered an indication of change	
Overhanging vegetation	*BANO*	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present in most surveys. Habitat can be limited for this species and is expected to occur at least in one in two surveys*	*Significant change in overhanging vegetation habitats (bank erosion, overgrazing and trampling, alien vegetation encroachment) (to be quantified with RHAM; DWA, 2009b).*
Substrate	*BPOL*	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	*Reduced suitability (abundance and quality) of substrates, increased sedimentation, and excessive algal growth on (to be quantified with RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR BPOL*	*AMOS is a catadromous species[4] while the rest of the indicator species can be described as potamodromous[4] species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

The following notes are applicable to all tables in this document relating to fish EcoSpecs and TPCs at EWR sites:
1 Primary indicator species (flow and flow related aspects) are indicated in **bold**.
2: Frequency of Occurrence (FROC):
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%)*
3 Fish Response Assessment Index (Kleynhans, 2007).
4 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.*

5.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The Ecological Category for the macro-invertebrates at EWR K1 is a Category B/C for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: medium-sized foothill river associated with perennial flows; U-shaped channel incised in a bed-rock dominated substrate. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa are provided in Table 5.6 and Table 5.7 provides EcoSpecs and TPCs for a B/C Category at EWR K1.*

Table 5.6 EWR K1: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Psephenidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 5.7 EWR K1: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B/C)

EcoSpecs	TPCs
Ensure that the SASS5[1] scores and ASPT[1] values occur in the following range: SASS5 score 160 to 200; ASPT 6.3 to 7.2	*SASS5 score <170 and ASPT < 6.5.*
Ensure that the MIRAI score is within the range for Category B (i.e. 80 to 89).	*The MIRAI score <82.*
Ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	*Any taxon abundance D (>1000) in two consecutive surveys.*
Maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ Perlidae: Abundance A. ▪ Hydropsychidae - 2 species: Abundance B. ▪ Psephenidae: Abundance A.	*▪ Perlidae absent from two or more consecutive surveys. ▪ Psephenidae absent from two or more consecutive surveys. ▪ Hydropsychidae less than three species in two or more consecutive surveys.*
Maintain suitable conditions for the following species in the Cobble biotope: ▪ Heptageniidae: Abundance B. ▪ Ancylidae: Abundance A.	*▪ Heptageniidae absent from two or more consecutive surveys. ▪ Ancylidae absent from two or more consecutive surveys.*
Maintain suitable conditions for the following species in the vegetation: ▪ Leptoceridae: Abundance A.	*Leptoceridae absent from two or more consecutive surveys.*
Maintain suitable conditions for the following seven key taxa: ▪ Hydroptilidae. ▪ Psephenidae. ▪ Ancylidae.	*Less than three key taxa listed.*

1 South African Scoring System version 5. *2 Average Score Per Taxon*

5.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR K1 (as at March 2014) for riparian vegetation was a Category C (71.3%) (DWA, 2014). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

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

Table 5.8 EWR K1: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain Phragmites cover between 5 - 25%.*	*More than 25% Phragmites cover.*
Vegetation cover	*Maintain 70 - 90% vegetation cover*	*Less than 70% vegetation cover.*

Assessed Metric	EcoSpec	TPC
Species richness	*Maintain indigenous riparian species diversity at 15 or more species.*	*Less than 15 indigenous riparian species.*
Species composition	*Maintain less than 5% Paspalum dilatatum cover.*	*More than 5% P. dilatatum cover.*
	Maintain 26 - 50% Ischaemum fasciculatum cover.	*Less than 25% I. fasciculatum cover.*
	Maintain 5 - 25% Cyperus marginatus cover.	*Less than 5% C. marginatus cover.*
Lower zone		
Vegetation cover	*Maintain 75 - 90% vegetation cover.*	*Less than 75% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 18 or more species.*	*Less than 18 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 10%.*	*An increase in perennial alien cover above 10%.*
Upper zone		
Vegetation cover	*Maintain 70 - 80% vegetation cover.*	*Less than 70% vegetation cover.*
	Maintain presence of mesophytic species such as Bothriochloa insculpta.	*Absence of mesophytic species such as B. insculpta.*
Species richness	*Maintain indigenous species diversity at 23 species or more.*	*Less than 23 indigenous riparian species.*

Note: EcoSpecs and TPCs to be assessed in summer.

5.2.1 Wetland RQOs

Wetland RQOs are provided in Table 5.9.

Table 5.9 MRU KOMATI B: Wetland RQOs

SQ	TEC	Wetland RQO
X11H-01140	**B/C**	*Maintain TEC (B/C) and High EIS.* *Cessation of land use encroachment on pans, seeps and channelled valley bottom wetlands.* *Improve to B/C by increasing wetland buffers and reducing overgrazing.*

6 KOMATI: IUA X1-3 - RESOURCE QUALITY OBJECTIVES

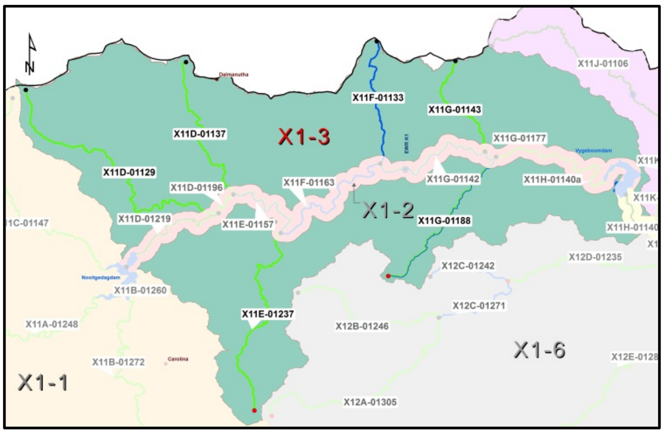
6.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the tributaries which feed into the main stem of the Komati River. Storage in this catchment is limited to a few small farm dams. These tributaries become increasingly steep and mountainous as one proceeds down the Komati River. Land use consists of grazing, limited dry land crops and irrigation, and forestry in the high lying areas.

The six SQs mostly have non-flow related impacts which are dominated by the effect of barriers (farm and trout dams) and inundation. Other impacts link to agriculture (grazing, some limited irrigation and dryland agriculture. Of the six SQs, four are in a C EC, one in a B EC and one in a B/C EC. The B and B/C SQs are in a good state as the river is within a gorge (i.e. inaccessible) for large sections of the SQ.

IUA X1-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-3 - TRIBUTARIES TO THE KOMATI



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU K3	*X11C-01147*	*Witkloofspruit*	C	C	3WQ
	X11D-01129	*Klein-Komati*	C	C	
	X11D-01137	*Waarkraalloop*	C	C	
RU K4	*X11E-01237*	*Swartspruit*	C	B	3WQ
RU K5	*X11F-01133*	*Bankspruit*	B	B	2
	X11G-01143	*Gemakstroom*	C	C	
RU K6	*X11G-01188*	*Ndubazi*	B/C	B	2

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

6.2 RQOs FOR RU K3: MODERATE PRIORITY - 2 (X11C-01147, X11D-01129, 01137)

6.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 6.1 RU K3: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X11C-01147										
C	*11.4*	*9.9*	*1.54*	*13.5*	*2.51*	*22.1*	*0.015*	*0.022*	*0.025*	*0.041*
X11D-01129										

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	21	17.8	4.04	19.2	5.76	27.4	0.027	0.056	0.107	0.122
X11D-01137										
C	11.7	10.9	2.18	18.6	3.19	27.3	0.035	0.037	0.029	0.061

6.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012a; 2012b; 2013a; DWS, 2014b; McCarthy and Humphries, 2013) were used.*
Model: *N/A.*
Users: *Potential AMD impact.*
Water quality issue: *Salts (sulphates), toxics, and pH.*

Narrative and numerical details for RU K3 are provided in Table 6.2.

Table 6.2 RU K3: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure pH levels stay within Acceptable limits.	*A small change from the Ideal range is allowed, i.e. a 5th percentile of 5.9 - 6.5, and a 95th percentile of 8.0 - 8.8 (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 (aquatic ecosystems: driver).*
Ensure that sulphate levels are within acceptable limits.	*95th percentile of the data must be less than or equal to 30 mg/L (industrial cat 3: drivers; DWA, 2012a).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

6.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 6.3.

Table 6.3 RU K3: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation shall not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011*	*One endemic riparian plant species should remain present within the RU*

Indicators	Narrative RQO	Numerical RQO
	project (DWS, 2014b) should be maintained.	*(refer to DWS, 2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 15 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be ten species in this unit under PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BPOL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of ten species in the various reaches of this RU (AMOS, ANAT, AURA, BANO, BPOL, CGAR, CPRE, CEMA, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BPOL (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BPOL) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Flow: ANAT, CPRE, CEMA Water quality: ANAT, CPRE, CEMA Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, CGAR		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Psephenidae Trichorythidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for both these flow dependent taxa (high velocity: >0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent species (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*Marginal vegetation habitat should be adequate to accommodate these key taxa.*	*To maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

6.2.4 Wetland RQOs

Wetland RQOs are provided in Table 6.4.

Table 6.4 RU K3: Wetland RQOs

SQ	TEC	Wetland RQO
X11C-01147	C	*Maintain TEC.* *Cessation of land use encroachment on pans, seeps and non-artificial channelled valley bottom wetlands.*
X11D-01129	C	

6.3 RQOs FOR RU K4: MODERATE PRIORITY - 2 (X11E-01237)

6.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 6.5 RU K4: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B*	*14.8*	*13.8*	*3.78*	*25.6*	*5.25*	*35.5*	*0.049*	*0.057*	*0.067*	*0.111*

** Flows provided for the PES of a C as improvement is related to non-flow related actions.*

6.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Mining.*
Water quality issue: *Toxics, turbidity.*

Narrative and numerical details for RU K4 are provided in Table 6.6.

Table 6.6 RU K4: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or total suspended solids (TSS) levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

6.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 6.7.

Table 6.7 RU K4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain grassland.*	*N/A.*
Presence of alien plant species in the	*The extent of perennial alien plant species within the riparian zone*	

Indicators	Narrative RQO	Numerical RQO
riparian zone	*should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There shall be no expansion of agricultural activities into the riparian zone and existing agriculture shall not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (C. bulbispermum; and C. macowanii)*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 45 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be nine species in this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BPOL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of nine species in the various reaches of this RU (AMOS, ANAT, AURA, BANO, BPOL, CGAR, CPRE, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BPOL (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BPOL) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: *Flow: ANAT, CPRE* *Water quality: ANAT, CPRE,* *Vegetation: BANO*[1]*, PPHI, TSPA* *Migration: AMOS, CGAR*		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Libellulidae *Hydropsychidae*	*Flows should be adequate to ensure suitable habitats for these moderate flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (moderate velocity: 0.3 - 0.6 m/s) in the SIC biotope (15 cm depth).*
Coenagrionidae	*Marginal vegetation habitat should be*	*Maintain suitable conditions in the*

Indicators	Narrative RQO	Numerical RQO
Hydraenidae	*adequate to accommodate these key taxa.*	*marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

6.3.4 Wetland RQOs

Wetland RQOs are provided in Table 6.8.

Table 6.8 RU K4: Wetland RQOs

SQ	TEC	Wetland RQO
X11E-01237	**B/C**	*Maintain TEC and High EIS.* *Cessation of land use encroachment on channelled valley bottom wetlands.*

6.4 RQOs FOR RU K5: MODERATE PRIORITY – 2 (X11F-01133, X11G-01143)

6.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 6.9 RU K5: 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%
X11F-01133										
B	6.5	5.8	1.32	20.3	2	30.8	0.019	0.022	0.026	0.064
X11G-01143										
C	10.4	7.9	1.82	17.5	2.72	26.1	0.028	0.031	0.032	0.051

6.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 6.10.

Table 6.10 RU K5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not*	

Indicators	Narrative RQO	Numerical RQO
	expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (C. macowanii; and Gunnera perpensa).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 60 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be eleven species in this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of eleven species in the various reaches of this RU (AMOS, ANAT, AURA, BANO, BPOL, BMAR, CGAR, CPRE, CEMA, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: *Flow and substrate: ANAT, CPRE, CEMA* *Water quality: ANAT, CPRE, CEMA* *Vegetation: BANO[1], PPHI, TSPA* *Migration: AMOS, CGAR*		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Psephenidae, Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for both these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Pyralidae	*Marginal vegetation habitat and water quality should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and good water*

Indicators	Narrative RQO	Numerical RQO
		quality for this taxon.
Coenagrionidae Hydraenidae	*Marginal vegetation habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

6.4.3 Wetland RQOs

Wetland RQOs are provided in Table 6.11.

Table 6.11 RU K5: Wetland RQOs

SQ	TEC	Wetland RQO
X11G-01143	**B/C**	*Maintain TEC and Moderate EIS.* *Cessation of land use encroachment on seeps.*

6.5 RQOS FOR RU K6: MODERATE PRIORITY - 2 (X11G-01188)

X11G-01188 situated in RU K6 requires improvement to achieve the TEC of a B. The actions required are mostly non flow-related which includes improved forestry management and an improved riparian zone (DWS, 2014a).

6.5.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 6.12 RU K6: 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%
X11G-01188										
B	*17.4*	*14.2*	*4.33*	*24.9*	*6.07*	*34.9*	*0.055*	*0.063*	*0.067*	*0.145*

** Flows provided for the PES of a C as improvement is related to non-flow related actions.*

6.5.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 6.13.

Table 6.13 RU K6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone	*Riparian zone fragmentation should*	*To improve to a B EC the presence of*

Indicators	Narrative RQO	Numerical RQO
fragmentation	*not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture and forestry shall not expand or intensify towards or within the riparian zone.*	*forestry within the riparian zone or directly adjacent to it should be reduced by 10% (aerial cover).*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 12 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be ten species in this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of ten species in the various reaches of this RU (AMOS, ANAT, AURA, BANO, BPOL, BMAR, CGAR, CPRE, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Flow and substrate: ANAT, CPRE, BPOL Water quality: ANAT, CPRE Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, CGAR		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae, Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for this flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm deep).*

Indicators	Narrative RQO	Numerical RQO
Pyralidae	*Marginal vegetation habitat and water quality should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae *Hydraenidae*	*Marginal vegetation habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

7 KOMATI: IUA X1-4 - RESOURCE QUALITY OBJECTIVES

7.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Gladdespruit tributary, which is undeveloped in terms of storage with only a few small farm dams. The catchment is mountainous with the river rising on the Highveld escarpment and descending over 800 m to the low-lying plateau on which the Vygeboom Dam is located. There are large areas of forestry in the upper reaches of the IUA but grazing is also a prominent land use activity. There is limited dry land agriculture in the lower reaches of this IUA. There is also a large Nickel mine in this IUA which has recently expanded from a purely underground operation to an open-cast operation. Water use in this IUA consists mainly of transfers to the Vygeboom Dam in support of the transfers to the Olifants system. Other water use is limited irrigation in the lower reaches and water use by the mine, which is also limited.

The PES consists of D and C ECs. The causes and sources are both flow, non-flow and water quality related. The water quality issues are linked to the mine in the upper area reach X11J-01106. The flow impacts are related to abstraction and an interbasin transfer from the Gladdespruit catchment to the Vygeboom Dam. Non-flow related impacts are the barrier and inundation effect of numerous farm dams and impacts with reference to farm dams.

IUA X1-4 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-4 GLADDESPRUIT

PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Komati G	*X11J-01106 EWR G1*	*Mngubhudle*	D	D	3
	X11K-01179	*Gladdespruit*	C	C	
	X11K-01194	*Gladdespruit*	C	C	
RU K7	*X11K-01165*	*Poponyane*	C	C	2
	X11K-01199		D	D	

The RQOs are provided below for a ***Water Resource Class III*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

7.2 RQOs FOR MRU KOMATI G: HIGH PRIORITY – 3 (EWR G1 (X11J-01106); INCLUDING X11K-01179, 01194)

The TECs is provided for EWR G1 below. Note that EWR G1 represents the Gladdespruit and is not impacted by the scenarios. Scenario K42 was the preferred scenario for the Komati River System (refer to section 1.6.1).

Table 7.1 TECs for EWR G1

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	C	C	C	C
Geomorphology	D	D	D	D
Fish	D	D	D	D
Invertebrates	D	D	D	D
Riparian vegetation	D	D	D	D
EcoStatus	D	D	D	D

7.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 7.2 MRU KOMATI G: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X11J-01106 (EWR G1)										
D	*29.5*	*21.2*	*5.89*	*19.9*	*7.94*	*26.9*	*0.041*	*0.063*	*0.122*	*0.205*

7.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *TEACHA and PAI model version available at the time.*
Users: *Mining, including the Komati gold mine and mining residues; trout farms.*
Water quality issue: *Toxics (Cn, As), turbidity, and nutrients.*
Narrative and numerical: *Details for MRU KOMATI G are provided in Tables 7.3 and 7.4. Data used for water quality assessments should be collected from X1H029Q01 or X1H027Q01.*

Table 7.3 MRU KOMATI G: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
Ensure that nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than 0.02 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that As levels are within Ideal limits or A categories.	*95^{th} percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).*
Ensure that (free) Cn levels are within Ideal limits or A categories.	*95^{th} percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*
Ensure water quality state maintains biotic	*See specified biota requirements.*

requirements as specified by RQOs for biota.	

Table 7.4 EWR G1: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Gladdespruit **Monitoring site: X1H029Q01 or X1H027Q01**	**PES: B Category**	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*0.25 mg/L.*
PO_4-P		*0.02 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*3 µg/L in Driekoppies Dam.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.

(b) Current monitoring does not include any toxics other than Fluoride.

(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.

7.2.3 Habitat and biota RQOs (EcoSpecs)

7.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish assemblage of the EWR G1 in this MRU was indicated as a D (AfriDev, 2006a; DWA, 2014) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates the EWR site is estimated to be eleven species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU and are valuable indicators of potential change. The primary indicator fish species for this MRU include the small rheophilic mountain catfish (AURA)* *and shortspine suckermouth (CPRE). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition and water quality. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration and bed modification.*

Numerical: *EcoSpecs and TPCs for a D Category are provided in Table 7.5 and were derived from AfriDev (2006a).*

Table 7.5 EWR G1: Fish EcoSpecs and TPCs (PES and TEC: C) (derived from AfriDev, 2006a)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) indicated this reach to fall in a Category D (in terms of fish).*	*Any decreased FROC[2] of indicators in the reach species (mentioned in this table) OR FRAI[3] EC decreasing below a D.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated eleven species are present in this SQ reach under the PES (DWS, 2014b).*	*Any decrease in the species richness of this unit (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD habitats, FS habitats, substrate	**AURA**	*AfriDev (2006a): FROC of 5 under the PES.*	*Species should be present in all surveys.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b). Decreased water quality.*
	CPRE	*AfriDev (2006a): FROC of 5 under PES.*	*Species should be present in all surveys.*	
FD habitats, FS habitats	*BARG*	*May be useful once it is established that they are still present. TPCs also to be determined once their presence is confirmed.*		
	BMAR			
Substrate	*BPOL*			*Reduced suitability (abundance and quality) of substrates, increased sedimentation, and excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BANO*			*Significant change in overhanging vegetation habitats (bank erosion, overgrazing and trampling, alien vegetation encroachment) (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS, BMAR/ BPOL*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		in terms of their migratory requirements, requiring movement between river reaches.		*quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

7.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The Ecological Category for the macro-invertebrates at EWR G1 is a Category D for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a small mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa are provided in Table 7.6 and Table 7.7 provides EcoSpecs and TPCs for a D Category at EWR G1*

Table 7.6 EWR G1: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
2	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 7.7 EWR G1: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: D)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score 60 to 150; ASPT 5.0 to 5.7	*SASS5 score <80 and ASPT < 5.2.*
Ensure that the MIRAI score is within the range for Category D (i.e. 40 to 59).	*MIRAI score <42.*
Ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	*Any taxon abundance D (>1000) in two consecutive surveys.*
Maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ Elmidae: Abundance A. ▪ Hydropsychidae - 2 species: Abundance B.	*▪ Elmidae absent from two or more consecutive surveys. ▪ Hydropsychidae less than one species in any one survey.*
To maintain suitable conditions for the following species in the cobble biotope: ▪ Leptoceridae: Abundance B. ▪ Ancylidae: Abundance A.	*▪ Leptoceridae absent from two or more consecutive surveys. ▪ Ancylidae absent from two or more consecutive surveys.*
Maintain suitable conditions for the following species in the vegetation: Leptoceridae: Abundance A.	*Leptoceridae absent from two or more consecutive surveys.*
Maintain suitable conditions for the following five key taxa: ▪ Leptophlebiidae. ▪ Elmidae. ▪ Hydropsychidae. ▪ Leptoceridae. ▪ Ancylidae.	*Less than four of the five key taxa listed.*

7.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR G1 (as at March 2014) for riparian vegetation was a Category D (51.1%) (DWA, 2014). Vegetation cover (woody and non-woody) should be maintained in a* *range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS, 2014b).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 7.8.*

Table 7.8 EWR G1: Riparian vegetation EcoSpecs and TPCs (PES and TEC: D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain S. brachyceras cover between 5 - 25%.*	*Less than 5% S. brachyceras cover.*
Vegetation cover	*Maintain 65 - 75% vegetation cover.*	*Less than 65% vegetation cover.*
	Maintain cover of P. dilatatum between 25 - 50%.	*Less than 25% P. dilatatum cover.*
Species richness	*Maintain 5 or more grass or sedge species.*	*Absence of 5 or more grass or sedge species.*
		Absence of Cyathea dregei.
Species composition	*Maintain absence of perennial alien species.*	*Presence of perennial alien species.*
Lower zone		
Vegetation cover	*Maintain more than 50% vegetation cover.*	*Less than 50% vegetation cover.*
	Maintain cover of Cynodon dactylon at 5% or more.	*Less than 5% C. dactylon cover.*
Species richness	*Maintain indigenous riparian species diversity at 9 or more species.*	*Less than 9 indigenous riparian species.*
		Absence of woody riparian species such as Combretum erythrophyllum and Leucosidea sericea.
Species composition	*Maintain perennial alien cover below 35%.*	*An increase in perennial alien cover above 35%.*
Upper zone		
Vegetation cover	*Maintain more than 55% vegetation cover.*	*Less than 55% vegetation cover.*
Species richness	*Maintain indigenous species diversity at 15 species or more.*	*Less than 15 indigenous riparian species.*
		Absence of forest species such as Dais cotinifolia, Maesa lanceolata, Ficus sur, L. sericea, Rhamnus prinoides (left bank) and Pittosporum.

Note: EcoSpecs and TPCs to be assessed in summer.

7.2.4 Wetland RQOs

Wetland RQOs are provided in Table 7.9.

Table 7.9 MRU KOMATI G: Wetland RQOs

SQ	TEC	Wetland RQO
X11K-01194	**B/C**	*Maintain TEC and Moderate EIS.* *Cessation of land use encroachment on pans, seeps and channelled valley bottom wetlands.*

7.3 RQOs FOR RU K7: MODERATE PRIORITY - 2 (X11K-01165, X11K-01199)

7.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013) for X11K-01165 and DRM (Hughes and Hunnart, 2003) for X11K-01199.*

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

Table 7.10 RU K7: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X11K-01165										
C	*13.7*	*10.8*	*2.01*	*14.7*	*3.12*	*22.7*	*0.01*	*0.012*	*0.047*	*0.071*
X11K-01199										
D	*2.4*	*1.5*	*0.36*	*15.1*	*0.53*	*22.3*	*0.002*	*0.004*	*0.004*	*0.006*

7.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 7.11.

Table 7.11 RU K7: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of forestry or agricultural activities into the riparian zone and existing forestry and agriculture should not expand or intensify towards or within the riparian zone.*	
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (Ilex mitis var. mitis)*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 15 riparian plant taxa within the RU.*

8 KOMATI: IUA X1-5 - RESOURCE QUALITY OBJECTIVES

8.1 IUA OVERVIEW AND DESCRIPTION

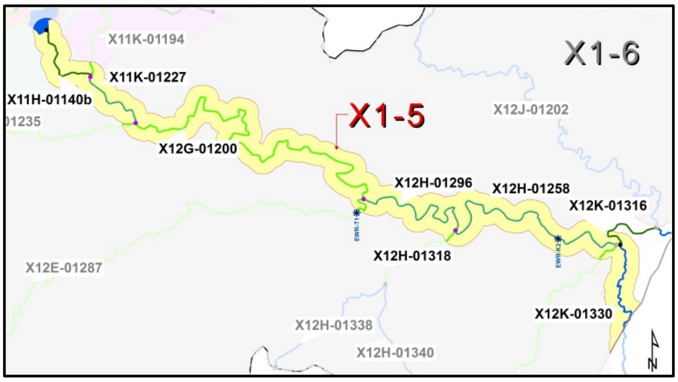
This IUA consists of the main stem of the Komati River from the outlet of the Vygeboom Dam down to the Swaziland border. This stretch of river is relatively flat but flows through a deeply incised valley. Land use in this IUA is mainly grazing with limited dryland crops. There are no dams along this stretch of river although there are a few small weirs.

The main water use in this IUA is domestic use which is abstracted directly from the river to supply the numerous villages in the area. In addition there is limited irrigation supplied out of the river.

The main Komati River ranges from a B/C to a C EC. Most of the impacts are flow related due to upstream dams and the operation of the dams. The river is still in a reasonable condition, mostly as it is situated in some protected areas such as Songimvelo and is inaccessible in other areas. One SQ (X12K-01316) is in D PES due to the same flow-related issues as the upstream SQs, but also include barriers and inundation impacts from weirs, as well as water quality issues from mining and extensive agricultural fields and vegetation removal.

IUA X1-5 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-5 - KOMATI RIVER DS OF VYGEBOOM DAM PRIORITY RATINGS TO SWAZILAND



RU	SQ	RIVER	PES	REC	PR
MRU Komati C	*X11H-01140b*	*Komati*	**D**	**D**	**3**
	X11K-01227	*Komati*	**B/C**	**B**	
	X12G-01200	*Komati*	**C**	**B**	
	X12H-01296	*Komati*	**B/C**	**B**	
	X12H-01258 EWR K2	*Komati*	**C**	**C**	
	X12K-01316	*Komati*	**D**	**D**	

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

8.2 RQOs FOR MRU KOMATI C: HIGH PRIORITY – 3 (EWR K2 (X12H-01258), INCLUDING X11H-01140B, X11K-01227, X12G-01200, X12H-01296, X12K-01316)

The TECs is provided for EWR K2 below. Note that EWR K2 represents the Komati River downstream of Vygeboom Dam to Swazilandand is not impacted by the scenarios. Scenario K42 was the preferred scenario for the Komati River System (refer to section 1.6.1).

Table 8.1 TECs for EWR K2

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	B/C	B/C	B/C	B/C
Geomorphology	C	C	C	C
Fish	C	C	C	C
Invertebrates	C	C	C	C
Riparian vegetation	C	C	C	C
EcoStatus	C	C	C	C

8.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 8.2 MRU KOMATI G: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X12H-01258 (EWR K2)										
C	*545.6*	*318.6*	*50.87*	*9.3*	*99.87*	*18.3*	*0.599*	*0.82*	*1.156*	*1.649*

8.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *TEACHA and PAI model version available at the time.*
Users: *Settlements with extensive grazing and limited cultivated lands, WWTW. Sewage effluents from Badplaas and Teespruit enter this section.*
Water quality issue: *Elevated nutrients, salts and turbidity.*
Narrative and numerical: *Details for MRU KOMATI C are provided in Tables 8.3 and 8.4. Data used for water quality assessments should be collected from X1H001Q01.*

Table 8.3 MRU KOMATI C: 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 0.02 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 42 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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 water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 8.4 EWR K2: Water quality EcoSpecs and TPCs (PES and TEC: B/C)

River: Komati Monitoring site: X1H001Q01	PES: B/C Category	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*0.129 mg/L.*
PO_4-P		*0.017 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*3 µg/L in Vygeboom Dam.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) Current monitoring does not include any toxics other than Fluoride.
(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.

8.2.3 Habitat and biota RQOs (EcoSpecs)

8.2.3.1 Fish EcoSpecs and TPCs

***Narrative:** The PES, based on fish assemblage of the EWR K2 in this MRU, was estimated to fall in a Category C (DWA, 2014) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates the EWR site is estimated to be nineteen species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU and are valuable indicators of potential change. The primary indicator fish species for this MRU include the small rheophilic mountain catfish (AURA) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and* *migratory success. Various other secondary indicators species are also present which can be used to monitor other aspects of the ecosystem. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the presence of alien predatory fish species.*

***Numerical:** EcoSpecs and TPCs for a C Category are provided in Table 8.5 and were derived from AfriDev (2006a).*

Table 8.5 EWR K2: Fish EcoSpecs and TPCs (PES and TEC: C) (derived from AfriDev, 2006a)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) indicated this reach to fall in a Category B/C while a revision done as part of the classification study (DWA, 2014) indicated the PES to be in a category C (FRAI = 73.2%).*	*Any decreased FROC[2] of indicators in the reach species (mentioned in this table) OR FRAI[3] EC decreasing below a C.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated nineteen species are present in this SQ reach under the PES (DWS, 2014b).*	*Any decrease in the species richness of this MRU (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD habitats, FS habitats, substrate	**AURA**	*AfriDev (2006a): FROC of 4 under the PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every three surveys.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b). Decreased water quality.*
	CPRE	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	
FD habitats, FS habitats	*CPAR*	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	
	CEMA	*AfriDev (2006a): FROC of 2 under PES.*	*This species should be present in some surveys. Habitat can be limited for this species and is expected to occur at least in one in five surveys.*	
	BARG	*AfriDev (2006a): FROC of 2 under PES.*	*This species should be present in some surveys. Habitat can be limited for this species and is expected to occur at*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			least in one in five surveys.	
	BMAR	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	
	LMOL	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present in most surveys. This species is expected to occur at least in three out of four surveys.*	
	LCYL	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present in most surveys. This species is expected to occur at least in three out of four surveys.*	
Substrate	*CSWI*	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every three surveys.*	*Reduced suitability (abundance and quality) of substrates, increased sedimentation, and excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BANO*	*AfriDev (2006a): FROC of 3 under PES.*	*This species should be present in most surveys. Habitat can be limited for this species and is expected to occur at least in one in two surveys.*	*Significant change in overhanging vegetation habitats (bank erosion, overgrazing and trampling, alien vegetation encroachment) (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS, BMAR,*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

8.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The Ecological Category for the macro-invertebrates at EWR K2 is a Category C for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa are provided in Table 8.6 and Table 8.7 provides EcoSpecs and TPCs for a C Category at EWR K2*

Table 8.6 EWR K2: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Trichorythidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 8.7 EWR K2: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: C)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score 110 to 180; ASPT 5.8 to 6.6.	*SASS5 score < 160 and ASPT < 6.0.*
Ensure that the MIRAI score is within the range for Category C (i.e. 60 to 79).	*MIRAI score <62.*
To ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	*Any taxon abundance D (>1000) in two consecutive surveys.*
To maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ Perlidae: Abundance A. ▪ Trichorythidae: Present in all seasons except winter. ▪ Hydropsychidae - 3 species: Abundance A.	*▪ Perlidae absent from two or more consecutive surveys. ▪ Trichorythidae absent from two or more consecutive surveys, except winter (June - August). ▪ Hydropsychidae less than three species in two or more consecutive surveys.*
To maintain suitable conditions for the following species in the cobble biotope: ▪ Heptageniidae: Abundance B. ▪ Leptophlebiidae: Abundance B.	*▪ Heptageniidae absent from two or more consecutive surveys. ▪ Leptophlebiidae absent from more than two consecutive surveys.*
To maintain suitable conditions for the following species in the vegetation: ▪ Leptoceridae: Abundance A. ▪ Simulium lumbwanum: Abundance A.	*▪ Leptoceridae absent from two or more consecutive surveys. ▪ S. lumbwanum absent from two or more consecutive surveys.*
To maintain suitable conditions for the following seven key taxa: ▪ Leptophlebiidae. ▪ Polymitarcyidae. ▪ Perlidae. ▪ Trichorythidae. ▪ Heptageniidae. ▪ Hydropsychidae. ▪ Leptoceridae.	*Less than five of the seven key taxa listed.*

8.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR K2 (as at March 2014) for riparian vegetation was a Category C (75.6%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2012; DWS, 2014b).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 8.8.*

Table 8.8 EWR K2: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain Phragmites cover between 50 - 75%.*	*More than 75% Phragmites cover.*
Species richness	*Maintain indigenous riparian species at 18 or more.*	*Less than 18 indigenous riparian species.*
Lower zone		
Vegetation abundance	*Maintain Phragmites cover between 50 - 75%.*	*More than 75% Phragmites cover.*
Vegetation cover	*Maintain vegetation cover between 55 - 80%.*	*Less than 55% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 26 or more species.*	*Less than 26 indigenous riparian species.*
	Maintain less than 5% P. dilatatum cover.	*More than 5% P. dilatatum cover.*
Species composition	*Maintain perennial alien cover below 15%.*	*An increase in perennial alien cover above 15%.*
Upper zone		
Species composition	*Maintain perennial alien cover below 10%.*	*An increase in perennial alien cover above 10%.*

9 KOMATI: IUA 1-6 - RESOURCE QUALITY OBJECTIVES

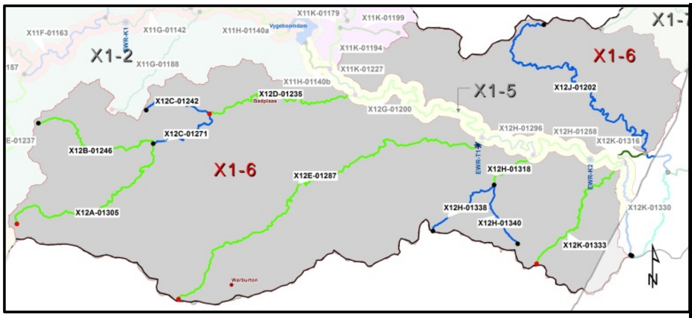
9.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of all the tributaries flowing into the Komati River within X1-5. The terrain is similar to that of X1-2, i.e., a flat high-lying escarpment area with tributaries flowing steeply to the Komati through deeply incised valleys. There are no significant dams in this IUA and a limited number of small farm dams. Land use consists mostly of forestry as well as grazing with limited dry land agriculture. Water use in this area consists of domestic supply to villages and small areas of irrigation.

The SQs consists of various tributaries. Of the 12 SQs, five SQs form part of the Seekoeispruit. Two of these five SQs are in a B and three in a C PES. The major reasons are forestry in the upper reaches and agricultural practices with resulting overgrazing and trampling in the lower reaches. The other seven SQs are situated in five different tributaries. Four of the SQs are in a B and three in a C PES. The reasons are all non-flow related linked and dominated by overgrazing, trampling and vegetation removal. Forestry is present in one tributary and some water quality issues due to urbanisation are present in some of the SQs. The SQs with a B PES is mostly due to areas that are protected due to the nature of the topography.

IUA X1-6 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-6 - ALL TRIBUTARIES DS OF VYGEBOOM DAM IN X1-6 EXCLUDING GLADDESPRUIT



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Komati T	*X12E-01287 (EWR T1)*	*Teespruit*	C	C	3
RU K8	*X12A-01305*	*Buffelspruit*	C	B	2
	X12B-01246	*Hlatjiwe*	C	C	
	X12C-01242	*Phophenyane*	B	B	
	X12C-01271	*Buffelspruit*	B	B	
	X12D-01235	*Seekoeispruit*	C	C	
RU K9	*X12H-01338*	*Sandspruit*	B	B	2
	X12H-01340		B	B	
	X12H-01318	*Sandspruit*	C	C	
	X12K-01333	*Mlondozi*	C	B/C	
	X12K-01332	*Mhlangampepa*	B	B	
RU K10	*X12J-01202*	*Mtsoli*	B	B	1

*The RQOs are provided below for a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

9.2 RQOs FOR MRU KOMATI T: HIGH PRIORITY – 3 (EWR T1 (X12E-01287))

The TECs is provided for EWR T1 below. Note that EWR T1 represents the Teespruit and is not impacted by the scenarios. Scenario K42 was the preferred scenario for the Komati River System (refer to section 1.6.1).

Table 9.1 TECs for EWR T1

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	C	C	C	C
Geomorphology	C	C	C	C
Fish	C	C	C	C
Invertebrates	C	C	C	C
Riparian vegetation	C	C	C	C
EcoStatus	C	C	C	C

9.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 9.2 MRU KOMATI T: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X12E-01287 (EWR T1)										
C	*56.4*	*45.1*	*12.75*	*22.6*	*19.9*	*35.3*	*0.206*	*0.272*	*0.294*	*0.349*

9.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *TEACHA and PAI model version available at the time.*
Users: *WWTW in lower reaches, and overgrazing.*
Water quality issue: *Elevated nutrients; turbidity.*
Narrative and numerical: *Details for MRU KOMATI T are provided in Tables 9.3 and 9.4.*

Table 9.3 MRU KOMATI T: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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 water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 9.4 EWR T1: Water quality EcoSpecs and TPCs (PES and TEC: C)

River: Teespruit **Monitoring site: To be established**	**PES: C Category**	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*0.25 mg/L.*
PO_4-P		*0.125 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*10 µg/L.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) Current monitoring does not include any toxics other than Fluoride.
(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.

9.2.3 Habitat and biota RQOs (EcoSpecs)

9.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES, based on fish assemblage of the EWR T1 in this MRU, was estimated to fall in a Category C (DWA, 2014) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates the EWR site is estimated to be nineteen species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this RU and are valuable indicators of potential change. The primary indicator fish species for this RU include the small rheophilic mountain catfish (AURA) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory* *success. Various other secondary indicators species are also present which can be used to monitor other aspects of the ecosystem. Fish in this RU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the presence of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 9.5 and were derived from AfriDev (2006a).*

Table 9.5 EWR T1: Fish EcoSpecs and TPCs (PES and TEC: C) (derived from AfriDev, 2006a)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) indicated this reach to fall in a Category B/C while a revision done as part of the classification study (DWA, 2014) indicated the PES to be in a Category C (FRAI = 73.92%).*	*Any decreased FROC[2] of indicators in the reach species (mentioned in this table) OR FRAI[3] EC decreasing below a C.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated twenty species are present in this SQ reach under the PES (DWS, 2014b).*	*Any decrease in the species richness of this MRU (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD habitats, FS habitats, substrate	**AURA**	*AfriDev (2006a): FROC of 5 under the PES.*	*This species should be present during all surveys.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b). Decreased water quality.*
	CPRE	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
	CPAR	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
FD habitats, FS habitats	*CEMA*	*AfriDev (2006a): FROC of 2 under PES.*	*This species should be present during some surveys. Expected at least in one of five surveys.*	
FD habitats, FS habitats, substrate	*BARG*	*AfriDev (2006a): FROC of 2 under PES.*	*This species should be present during some surveys. Expected at least in one of five surveys.*	
	BMAR	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
	LMOL	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
	LCYL	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
	CSWI	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	*Reduced suitability (abundance and quality) of substrates, increased sedimentation, and excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BANO*	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	*Significant change in overhanging vegetation habitats (bank erosion, overgrazing and trampling, alien vegetation encroachment) (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS, BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

9.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR T1 is a Category C for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa are provided in Table 9.6 and Table 9.7 provides EcoSpecs and TPCs for a C Category at EWR T1*

Table 9.6 EWR T1: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Psephenidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 9.7 EWR T1: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: C)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score 160 to 200; ASPT 6.3 to 7.2.	*SASS5 score <170 and ASPT <6.5.*
Ensure that the MIRAI score is within the range for Category C (i.e. 60 to 79).	*MIRAI score <62.*

EcoSpecs	TPCs
Ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	*Any taxon abundance D (>1000) in two consecutive surveys.*
Maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ *Perlidae: Abundance A.* ▪ *Hydropsychidae - 2 species: Abundance B.* ▪ *Psephenidae: Abundance A.*	▪ *Perlidae absent from two or more consecutive surveys.* ▪ *Psephenidae absent from two or more consecutive surveys.* ▪ *Hydropsychidae less than three species in two or more consecutive surveys.*
Maintain suitable conditions for the following species in the Cobble biotope: ▪ *Heptageniidae: Abundance B.* ▪ *Ancylidae: Abundance A.*	▪ *Heptageniidae absent from two or more consecutive surveys.* ▪ *Ancylidae absent from two or more consecutive survey.*
Maintain suitable conditions for the following species in the vegetation: ▪ *Leptoceridae: Abundance A.*	*Leptoceridae absent from two or more consecutive surveys.*
Maintain suitable conditions for the following three key taxa: ▪ *Hydroptilidae.* ▪ *Psephenidae.* ▪ *Ancylidae.*	*Less than three of the seven key taxa listed.*

9.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR T1 (as at March 2014) for riparian vegetation was a Category C (70.1%) (DWAF, 2014). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS, 2014b).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 9.8.*

Table 9.8 EWR T1: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain Phragmites cover between 25 - 50% in the main channel.*	*Less than 25% Phragmites cover in the main channel.*
Vegetation cover	*Maintain vegetation cover more than 30%.*	*Less than 30% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 23 species or more.*	*Less than 23 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 15%.*	*An increase in perennial alien cover above 15%.*
Vegetation structure	*Evidence of recruitment of F. sur.*	*Absence of recruiting F. sur individuals.*
Lower zone		
Vegetation cover	*Maintain more than 30% vegetation cover.*	*Less than 30% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 23 or more species.*	*Less than 23 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 20%.*	*An increase in perennial alien cover above 20%.*
Vegetation structure	*Evidence of recruitment of Cliffortia strobulifera and Morella serrate.*	*Absence of recruiting C. strobulifera and M. serrata individuals.*
Upper zone		

Assessed Metric	EcoSpec	TPC
Vegetation structure	*Evidence of recruitment of indigenous tree species on left bank.*	*Absence of indigenous tree seedlings on left bank.*

9.2.4 Wetland RQOs

Wetland RQOs are provided in Table 9.9.

Table 9.9 MRU KOMATI T: Wetland RQOs

SQ	TEC	Wetland RQO
X12E-01287	**B/C**	*Maintain TEC and High EIS.* *Cessation of land use encroachment on pans, seeps and channelled valley bottom wetlands.*

9.3 RQOs FOR RU K8: MODERATE PRIORITY - 2 (X12A-01305, X12B-01246, X12C-01242, 01271, X12D-01235)

X12A-01305 and X12D-01235 situated in RU K8 requires improvement to achieve the TEC of a B and a B/C respectively. The actions required to achieve the TECs are mostly non flow-related and provided below for the respective SQs:

- *X12A-01305: A significant improvement is needed in order for riparian vegetation to improve and includes the reinstatement of the buffer zone (DWS, 2014a).*
- *X12D-01235: An improvement is needed in all metrics which would be difficult to achieve as catchment management is the key factor. It was acknowledged that and improvement is unlikely and it was recommended that that the PES of a C should be maintained (DWS, 2014a) and become the TEC.*

9.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 9.10 RU K8: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X12A-01305										
B	*32*	*24.2*	*9.96*	*31.2*	*12.74*	*39.9*	*0.085*	*0.168*	*0.195*	*0.261*
X12B-01246										
C	*22.1*	*17.1*	*5.04*	*22.8*	*6.75*	*30.5*	*0.035*	*0.06*	*0.1*	*0.153*
X12C-01242										
B	*6.3*	*5.9*	*1.8*	*28.7*	*2.35*	*37.5*	*0.016*	*0.024*	*0.032*	*0.041*
X12C-01271										
B	*71.1*	*56.4*	*22.53*	*31.7*	*28.76*	*40.5*	*0.261*	*0.367*	*0.495*	*0.789*
X12D-01235										
C	*97*	*80*	*22.54*	*23.2*	*29.58*	*30.5*	*0.155*	*0.374*	*0.446*	*0.716*

9.3.2 Water quality

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*

Model: *N/A.*
Users: *Settlements.*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU K8 are provided in Table 9.11.

Table 9.11 RU K8: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).*

9.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 9.12.

Table 9.12 RU K8: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	*To improve the presence of agriculture within the riparian zone or directly adjacent to it should be reduced by 10% (aerial cover).*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 20 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be seventeen species in the lower reaches of this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be*	*Maintain indigenous species richness of seventeen species in the lower reaches of this RU (AMOS, ANAT, AURA, BANO, BPOL, BPAU, BMAR, CGAR, CPRE, CEMA, CSWI, LCYL, LMOL, OMOS, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*

Indicators	Narrative RQO	Numerical RQO
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)	*optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Flow and substrate: ANAT, CPRE, BPOL, CSWI, LMOL Water quality: ANAT, CPRE, BARG Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, BPOL		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Perlidae Prosopistomatidae Oligoneuridae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: >0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae, Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: >0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat with moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Pyralidae	*Marginal vegetation habitat and water quality should be adequate to accommodate this key taxon.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae Hydraenidae	*Marginal vegetation habitat should be adequate to accommodate these key taxa.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

9.3.4 Wetland RQOs

Wetland RQOs are provided in Table 9.13.

Table 9.13 RU K8: Wetland RQOs

SQ	TEC	Wetland RQO
X12A-01305	B	*Maintain TEC for each SQ.* *Cessation of land use, urban and forestry encroachment on seeps.*
X12C-01271	B	
X12D-01235	C	

9.4 RQOs FOR RU K9: MODERATE PRIORITY - 2 (X12H-01338, 01340, 01318, X12K-01333, 01332)

X12K-01333 situated in RU K9 requires improvement to achieve the TEC of a B/C. The actions required are mostly flow-related which mainly includes water quality improvements. Important to note is that the upper section of the river is in a B EC and if riparian vegetation can be improved the REC can be achieved (DWS, 2014a).

9.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 9.14 RU K9: Flow RQOs

REC (EWR)	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X12H-01338										
B	4.4	4.3	1.24	27.9	1.64	36.7	0.035	0.056	0.069	0.12
X12H-01340										
B	4.8	4.3	1.48	30.6	1.92	39.5	0.022	0.031	0.031	0.043
X12H-01318										
C	13.9	13.3	3.36	24.1	4.43	31.7	0.025	0.043	0.043	0.076
X12K-01333										
B/C[1]	22.4	22.3	5.6	25	7.51	33.5	0.052	0.091	0.103	0.143
X12K-01332										
B	3.4	3.4	1.06	30.7	1.38	40	0.015	0.022	0.021	0.029

1 Flows provided for the PES of a C as improvement is related to non-flow related actions.

9.4.2 Water quality

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Settlements; over-grazing (erosion).*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU K9 are provided in Table 9.15.

Table 9.15 RU K9: 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 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).*

9.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 9.16.

Table 9.16 RU K9: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	*To improve the presence of agriculture within the riparian zone or directly adjacent to it should be reduced by 10% (aerial cover).*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Ten endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (C. macowanii, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 130 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be nineteen species in the lower reaches of this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of nineteen species in the lower reaches of this RU (AMOS, ANAT, AURA, BANO, BPAU, BPOL, BMAR, BTRI, BUNI, CGAR, CPAR, CPRE, CSWI, LCYL, LMOL, MACU, OMOS, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Flow and substrate: ANAT, CPRE, BPOL, CSWI, LMOL Water quality: ANAT,		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further*

Indicators	Narrative RQO	Numerical RQO
CPRE Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, BPOL		*migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*To maintain suitable conditions for this flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent species (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent species (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*MV habitat should be adequate to accommodate these key taxa.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

9.4.4 Wetland RQOs

Wetland RQOs are provided in Table 9.17.

Table 9.17 RU K9: Wetland RQOs

SQ	TEC	Wetland RQO
X13J-01205	**D**	*Maintain TEC and Moderate EIS. Cessation of land use and agricultural encroachment on floodplain and non-artificial channelled valley bottom wetlands.*

9.5 RQOs FOR RU K10: LOW PRIORITY - 1 (X12J-01202)

9.5.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 9.18 RU K10: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X12J-01202										
B	*4.4*	*4.3*	*1.24*	*27.9*	*1.64*	*36.7*	*0.035*	*0.056*	*0.069*	*0.12*

10 KOMATI: IUA X1-7 - RESOURCE QUALITY OBJECTIVES

10.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of the headwater catchments of the Lomati River. There are two small but significant dams in this IUA, the Lomati Dam which transfers water to Barberton and the Shiyalongubo Dam which transfers water to irrigators in the Louws Creek River, a tributary of the Kaap River.

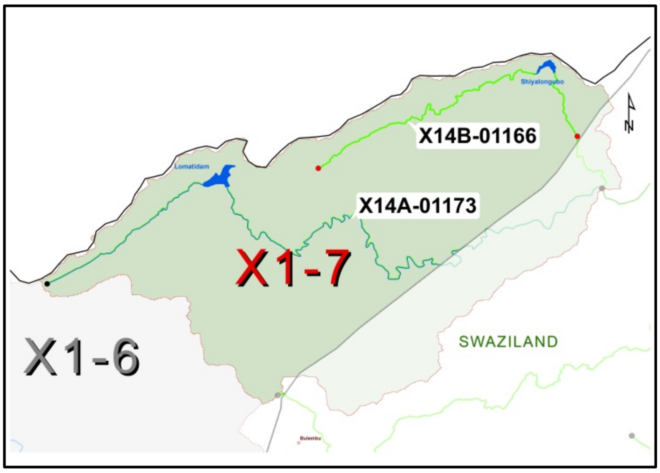
This IUA is located on the escarpment in a relatively mountainous area. The dominant land use is forestry although there is also some grazing.

While there is no direct water use in this catchment, the yield made available from the two dams is transferred out of the catchment.

This IUA consists of only two SQs, both in the upper Lomati catchment and in a reasonably good state (B/C PES). The impacts are mostly non-flow related in the form of forestry, vegetation removal and aliens, and bed or channel disturbance.

IUA X1-7 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-7 - HEADWATER CATCHMENT OF THE LOMATI



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU K12	*X14A-01173*	*Lomati*	B/C	B	1
	X14B-01166	*Ugutugulo*	C	C	

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

10.2 RQOs FOR RU K12: LOW PRIORITY - 1 (X14A-01173, X14B-01166) AND MODERATE PRIORITY – 2 (X14F-01085)

X14A-01173 and X14B-01166 situated in RU K12 requires improvement to achieve the TEC of a B and a B/C respectively. The actions required to achieve the TECs are mostly non flow-related and provided below for the respective SQs:

- *X14A-01173: The most impacted area is in the lower reaches of the SQ which ends in Swaziland. If this section is not considered, the river reach in SA will already be a B EC (DWS, 2014a).*
- *X14B-01166: Removal of alien vegetation is needed in order for riparian vegetation to improve and includes an improvement of the buffer zone. (DWS, 2014a). Flow-related improvement*

includes EWR releases from dam and improved water quality. It is unlikely that the REC is attainable and therefore the PES has to be maintained (DWS, 2014a).

10.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 10.1 RU K12: Flow RQOs

REC (EWR)	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X14A-01173										
B/C	*84.38*	*72*	*19.35*	*22.9*	*26.3*	*31.2*	0.220	0.285	0.390	0.603
X14B-01166										
C	*20.87*	*14.25*	*4.88*	*23.4*	*6.61*	*31.7*	0.051	0.072	0.117	0.131

10.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 10.2.

Table 10.2 RU K12 (X14F-01085): Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 50% of existing perennial alien vegetation should be removed.*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Three endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (Balanites maughamii subsp. maughamii).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 130 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be twenty six species in the lower reaches of this RU under the PES. Flows should be adequate to*	*Maintain indigenous species richness of twenty six species in the lower reaches of this RU (AMOS, ANAT, AURA, BANO, BEUT, BBRI, BPAU,*

Indicators	Narrative RQO	Numerical RQO
	ensure suitable habitats for small rheophilic (CANO) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.	*BRAD, BMAR, BTRI, BUNI, BVIV, CBRE, CGAR, CANO, CEMA, CPRE, LCYL, LMOL, MACU, OMOS, PCAT, PPHI, TREN, TSPA and VNEL). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: Flow and substrate: ANAT, CPRE, BPOL, CSWI, LMOL Water quality: ANAT, CPRE Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, BPOL		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae, Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent species (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*Marginal vegetation habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

11 KOMATI: IUA X1-8 - RESOURCE QUALITY OBJECTIVES

11.1 IUA OVERVIEW AND DESCRIPTION

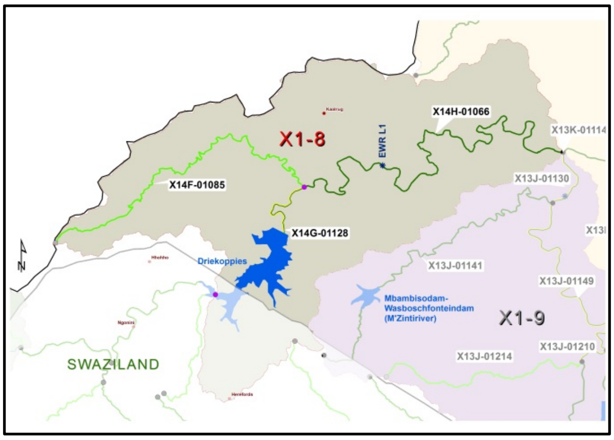
This IUA consist of the Lomati River downstream of the Swaziland border and down to the confluence with the Komati River. The large Driekoppies Dam is located in this IUA although there are also numerous farm dams as well.

The area is mostly very flat although bordered by mountains in the North West. Land use consists mostly of extensive irrigated crops although there is also some grazing of livestock. There are also numerous villages in this area.

The Lomati main stream in this IUA flows from the Driekoppies Dam immediately downstream of Swaziland, and due to the impact of the large dam, the first SQ has a PES of a D/E. The main stream is further influenced by flow-related impacts of upstream flow modification, abstraction for irrigation, and increased flows, as well as non-flow impacts such as large dams and inundation, and poor land-use, resulting in a D PES river. The one tributary (Mhlambanyatsi) is impacted by non-flow factors such as forestry and vegetation removal, and present a C PES river.

IUA X1-8 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-8 - LOMATI AND TRIBUTARY DS OF DRIEKOPPIES DAM



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Komati M	*X14G-01128*	*Lomati*	D/E	D/E	3
	X14H-01066 EWR L1	*Lomati*	C	C	

The RQOs are provided below for a ***Water Resource Class III*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

11.2 RQOs FOR MRU KOMATI M: HIGH PRIORITY – 3 (EWR L1 (X14H-01066); INCLUDING X14G-01128)

The TECs is provided for EWR L1 below. Note that EWR L1 represents the Lomati River downstream of Driekoppies Dam and is impacted by scenarios. Scenarios K42 was the preferred scenario for the Komati River System (refer to section 1.6.2).

Table 11.1 TECs for EWR L1

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	**B/C**	**B/C**	**B/C**	**B**
Geomorphology	**D**	**D**	**D**	**D**
Fish	**C**	**C**	**C**	**C**
Invertebrates	**C**	**C**	**C**	**C**
Riparian vegetation	**B/C**	**B/C**	**B/C**	**C/D**
EcoStatus	**C**	**C**	**C**	**C/D**

11.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 11.2 MRU KOMATI M: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X14H-01066 (EWR L1)										
C	*294.3*	*229.5*	*34.46*	*11.7*	*50.96*	*17.3*	*0.502*	*0.664*	*0.989*	*1.168*
C/D *(Sc K42)*			*27.73*	*9.4*	*43.93*	*14.9*	*0.883*	*1.37*	*1.934*	*2.386*

11.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *TEACHA and PAI model version available at the time.*
Users: *Settlements, WWTW, sand-mining, extensive crop farming.*
Water quality issue: *Nutrients, salts, toxics, turbidity.*
Narrative and numerical: *Details for MRU KOMATI M are provided in Tables 11.3 and 11.4. Data used for water quality assessments should be collected from X1H049Q01.*

Table 11.3 MRU KOMATI M: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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 nutrient levels (phosphate) are within Tolerable limits.	*50th percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that nutrient levels (TIN) are within Acceptable limits.	*50th percentile of the data must be less than 1.0 mg/L TIN (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).*

Narrative RQO	Numerical RQO
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 11.4 EWR L1: Water quality EcoSpecs and TPCs (PES and TEC: B/C)

River: Lomati	**PES: B/C Category**	
Monitoring site: X1H049Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*1.0 mg/L.*
PO_4-P		*0.05 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*10 µg/L.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) Current monitoring does not include any toxics other than Fluoride.
(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.

11.2.3 Habitat and biota RQOs (EcoSpecs)

11.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES, based on fish assemblage of the EWR L1 in this MRU, was estimated to fall in a Category C (AfriDev, 2006a; DWA, 2014) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates the EWR site is estimated to be thirty six species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this RU and are valuable indicators of potential change. The primary indicator fish species for this RU include the small rheophilic pennant-tail suckermouth (CANO) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present which can be used to monitor other aspects of the ecosystem. Fish in this RU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the presence of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 11.5 and were derived from AfriDev (2006a).*

Table 11.5 EWR L1: Fish EcoSpecs and TPCs (PES and TEC: C) (derived from AfriDev, 2006a)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) and the revision done as part of the classification study (DWA, 2014) indicated the PES to be in a Category C (FRAI = 64.8%).*	*Any decreased FROC[2] of indicators in the reach species (mentioned in this table) OR FRAI[3] EC decreasing below a C.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated thirty six species are present in this SQ reach under the PES (DWS, 2014b).*	*Any decrease in the species richness of this MRU (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD habitats, FS habitats, substrate	*BEUT*	*AfriDev (2006a): FROC of 5 under the PES.*	*This species should be present during all surveys.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b). Decreased water quality.*
	CANO	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
	CPAR	*None specified.*		
	BMAR	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present during most surveys.*	
	LMOL	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present during all surveys.*	
	LCYL	*AfriDev (2006a): FROC of 4 under PES.*	*This species should be present during all*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			surveys.	
	CSWI	*AfriDev (2006a): FROC of 3 under PES.*	*This species should be present during all surveys.*	
FD habitats, FS habitats	*OPER*	*AfriDev (2006a): FROC of 5 under PES.*	*This species should be present during all surveys.*	
Migratory requirement[4]	*AMOS, BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

11.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR L1 is a Category C for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized Lowveld river associated with perennial flows; a slow-flowing river with a sandy substrate (alluvial), and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools surrounded by reeds.*

Numerical: *Indicator taxa are provided in Table 11.6 and Table 11.7 provides EcoSpecs and TPCs for a C Category at EWR L1*

Table 11.6 EWR L1: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
3	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
4	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 11.7 EWR L1: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: C)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score 110 to 180; ASPT 5.8 to 6.6	*SASS5 score <130 and ASPT <6.0.*
To ensure that the MIRAI score is within the range for Category C (i.e. 60 to 79).	*MIRAI score <62.*
To ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	*Any taxon abundance D (>1000) in two consecutive surveys.*
To maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ Perlidae: Abundance A ▪ Hydropsychidae - 2 species: Abundance B. ▪ Baetidae - 2 species: Abundance B. ▪ Elmidae: Abundance A.	*▪ Perlidae absent from two or more consecutive surveys. ▪ Perlidae absent from two or more consecutive surveys. ▪ Hydropsychidae absent from any one survey.*

EcoSpecs	TPCs
	▪ *Less the 2 species of Baetidae in any one survey.* ▪ *Elmidae absent in two or more consecutive surveys.*
To maintain suitable conditions for the following species in the Cobble biotope: Heptageniidae: Abundance B.	*Heptageniidae absent from two or more consecutive surveys.*
To maintain suitable conditions for the following species in the vegetation: Leptoceridae: Abundance A.	*Leptoceridae absent from two or more consecutive surveys.*
To maintain suitable conditions for the following six key taxa: ▪ *Perlidae* ▪ *Heptageniidae* ▪ *Hydropsychidae* ▪ *Elmidae* ▪ *Chlorocyphidae* ▪ *Leptoceridae*	*Less than five of the six key taxa listed.*

11.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR L1 (as at March 2014) for riparian vegetation was a Category B/C (79.0%) (DWAF, 2014). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS, 2014b).*

Numerical: *EcoSpecs and TPCs for a C Category are provided in Table 11.8.*

Table 11.8 EWR L1: Riparian vegetation EcoSpecs and TPCs (PES and TEC: B/C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain Phragmites cover under 80%.*	*More than 80% Phragmites cover.*
Vegetation cover	*Limit vegetation cover 80%*	*More than 80% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 30 species or more.*	*Less than 30 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 5%.*	*An increase in perennial alien cover above 5%.*
Lower zone		
Vegetation cover	*Limit vegetation cover 75%.*	*More than 75% vegetation cover.*
Vegetation abundance	*Combined cover of trees F. sycomorus, S. guineense, Nuxia oppositifolia and Kraussia floribunda limited to 50%.*	*More than 50% combined cover of trees F. sycomorus, S. guineense, N. oppositifolia and K. floribunda.*
Species richness	*Maintain indigenous riparian species diversity at 20 or more species.*	*Less than 20 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 10%.*	*An increase in perennial alien cover above 10%.*
Vegetation structure	*Evidence of recruitment of C. erythrophyllum and F. sycomorus.*	*Absence of recruiting C. erythrophyllum and F. sycomorus individuals.*
Upper zone		
Species composition	*Maintain perennial alien cover below 10%.*	*An increase in perennial alien cover above 10%.*
Species richness	*Maintain indigenous riparian species*	*Less than 25 indigenous riparian*

Assessed Metric	EcoSpec	TPC
	diversity at 25 or more Species.	*species.*

12 KOMATI: IUA X1-9 - RESOURCE QUALITY OBJECTIVES

12.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of the lower Komati River from the Swaziland border to the confluence with the Lomati River. There are two small but significant dams in this IUA, the Mambiso and Masibikela dams, the latter of which is an off-channel storage dam. The area is flat and dominated by irrigated crops, mostly sugar cane although there is also extensive stock grazing taking place.

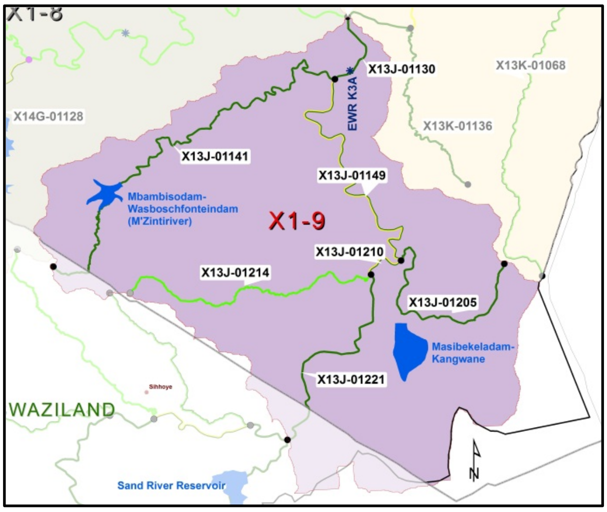
Water in this area, supplied from the Maguga Dam, is used mostly to irrigate sugar cane while there is also significant domestic use.

The Komati main stem leaves Swaziland as a PES D river, and the three downstream SQs deteriorate all to PES D/E status, mainly due to upstream flow modification and abstraction for irrigation. Additional impacts are non-flow related with the main influences being dams and associated inundation, as well as changes in land cover due to agriculture and human inhabitation.

The three tributaries (PES D rivers) flowing into the Komati are mostly affected by non-flow aspect comprising agriculture (fields, grazing, large dams and associated inundation) and other impacts on land cover (urbanization, vegetation removal and alien plants).

IUA X1-9 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-9 - KOMATI FROM BORDER TO LOMATI CONFLUENCE



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU K11	*X13J-01141*	*Mzinti*	D	D	2
	X13J-01205	*Mbiteni*	D	D	
MRU Komati D	*X13J-01221*	*Komati*	D	D	3
	X13J-01210	*Komati*	D/E	D/E	
	X13J-01149	*Komati*	D/E	D/E	
	X13J-01130 (EWR K3)	*Komati*	D	D	

*The RQOs are provided below for a **Water Resource Class III** (DWS, 2014a) and the catchment configuration as illustrated above.*

12.2 RQOs FOR RU K11: MODERATE PRIORITY – 2 (X13J-01214, 01141, 01205)

12.2.1 Flow RQOs

***Source:** DWA (2014).*
***Model:** RDRM (Hughes et al., 2013).*

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

Table 12.1 RU K11: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X13J-01141										
D	6.3	4.2	0.66	10.5	1.21	19.1	0.003	0.011	0.006	0.016
X13J-01205										
D	5.9	5.1	0.5	8.6	1.04	17.6	0.005	0.007	0.007	0.011

12.2.2 Water quality

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Settlements; over-grazing (erosion); some agriculture (sugar cane).*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU K11 are provided in Table 12.2.

Table 12.2 RU K11: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).*

12.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 12.3.

Table 12.3 RU K11: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*

Indicators	Narrative RQO	Numerical RQO
	maintained.	
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (B. maughamii subsp. maughamii and C. macowanii).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 55 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness is estimated to be eight species in the lower reaches of this RU under the PES. Flows should be adequate to ensure suitable habitats for small rheophilic (AURA) and large semi-rheophilic indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Do not allow an increase in migration barriers or spread of alien fish species.*	*Maintain indigenous species richness of eight species in the lower reaches of this RU (AMOS, BPAU, BVIV, BMAR, CGAR, OMOS, PPHI and TSPA). Maintain current habitat diversity to meet the requirements of the expected species.*
Primary indicator species: AURA/BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable fast (0.3 m/s) flows (all seasons) to sustain the small rheophilic species and maintain suitable velocities (>0.3 m/s) and depth (>0.3 m) during especially the wet season for large semi-rheophilic species (BMAR) in reach where they occur. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: *Substrate: ANAT, AMOS* *Water quality: BVIV* *Vegetation: BVIV, BPAU, PPHI* *Migration: AMOS*		*Ensure the habitat requirements of the secondary indicator species are maintained. These include adequate vegetative and substrate cover and limit the construction of any further migration barriers to fish movement. Prevent increase in alien fish species.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15cm depth).*
Psephenidae *Trichorythidae* *Philopotamidae*	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this species.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

12.3 RQOs FOR MRU KOMATI D: HIGH PRIORITY – 3 (EWR K3A (X13J-01130); INCLUDING (X13J-01221, X13J-01210, X13J-01149)

The TECs is provided for EWR K3A below. Note that EWR K3A represents the Komati River from the border to the Lomati River confluence and is not impacted by the scenarios. Scenario K42 was the preferred scenario for the Komati River System (refer to section 1.6.1).

Table 12.4 TECs for EWR K3A

Component	PES	REC	Immediately applicable	Sc K42
Physico chemical	D	D	D	D
Geomorphology	D/E	D/E	D/E	D/E
Fish	D	D	D	D
Invertebrates	D	D	D	D
Riparian vegetation	D	D	D	D
EcoStatus	D	D	D	D

12.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 12.5 MRU KOMATI D: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X13J-01130 (EWR K3)										
D	*1021.7*	*489.8*	*101.1*	*9.9*	*175.55*	*17.2*	*0.672*	*1.547*	*1.552*	*2.802*

12.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2006 Komati River Comprehensive Reserve study (AfriDev, 2006b).*
Model: *TEACHA and PAI model version available at the time.*
Users: *Irrigation return flows, Tongo WWTW.*
Water quality issue: *Nutrients, salts, toxics.*
Narrative and numerical: *Details for MRU KOMATI D are provided in Tables 12.6 and 12.7. Data used for water quality assessments should be collected from X1H003Q01.*

Table 12.6 MRU KOMATI D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that electrical conductivity (salt) levels are within Tolerable limits.	*95th percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).*
Ensure that nutrient levels (phosphate) are within Tolerable limits.	*50th percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that nutrient levels (TIN) are within Acceptable limits.	*50th percentile of the data must be less than 1.0 mg/L TIN (aquatic ecosystems: driver).*

Narrative RQO	Numerical RQO
Ensure that periphyton levels are within Acceptable limits.	*50th percentile of the data must be less than 21 mg/m^2 (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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 12.7 EWR K3A: Water quality EcoSpecs and TPCs (PES and TEC: C/D)

River: Komati	**PES: C/D Category***	
Monitoring site: X1H003Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be less than the TPC.*	*16 mg/L.*
Na_2SO_4		*20 mg/L.*
$MgCl_2$		*15 mg/L.*
$CaCl_2$		*21 mg/L.*
NaCl		*45 mg/L.*
$CaSO_4$		*351 mg/L.*
Physical variables		
pH	*The 95th percentile of the data must be less than the TPC.*	*6.5 - 8.0*
Temperature		
Dissolved oxygen		*7 - 8 mg/L.*
Turbidity		*Small change allowed - largely natural and related to natural catchment processes such as rainfall run-off.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be less than the TPC.*	*0.18 mg/L.*
PO_4-P		*0.025 mg/L.*
Response variables		
Chl-a phytoplankton	*The 50th percentile of the data must be less than the TPC.*	*10 µg/L.*
Chl-a periphyton		*21 mg/m^2.*
Instream toxicity	*Instream toxicity should not occur.*	*Any indication of instream toxicity.*
Toxics[(b)]		
Fluoride	*The 95th percentile of the data must be less than the TPC.*	*1500 µg/L*
Ammonia		*15 µg/L*
Aluminium		*20 µg/L*
Cu (soft)[(c)]		*0.5 µg/L*
Cu (medium)[(c)]		*1.5 µg/L*
Cu (hard)[(c)]		*2.4 µg/L*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) Current monitoring does not include any toxics other than Fluoride.
(c) Note that the TPC for metals such as copper, cadmium and lead is dependent on the hardness of the water. Hardness levels (Soft water: < 60 mg/L $CaCO_3$, Moderately hard water: 60 – 119 mg/L $CaCO_3$, Hard water: >120 mg/L $CaCO_3$) must therefore be calculated before metal data can be interpreted.
** Note that the PES of a C/D was taken from a PAI table prepared using the data in the water quality table for EWR K3 in AfriDev (2006b), i.e. the Water Quality Report for the Komati EWR study. It is not known what Present Day (or Scenario 1) refers to in this*

report, as it mentions a water quality category of a D/E (PAI table for EWR K3 Scenario: PD = Sc1; pg. 64), while the overall site classification for water quality on the table for EWR K3 was a C/D (pg. 42).

12.3.3 Habitat and biota RQOs (EcoSpecs)

12.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish assemblage of the EWR K3A in this MRU was estimated as a C/D (DWA, 2014) and it should be aimed to at least maintain this EC in future. The indigenous fish species richness of the SQ reach that incorporates the EWR site is estimated to be as high as thirty five species. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU and are valuable indicators of potential change. The primary indicator fish species for this MRU include the small rheophilic orangefin barb (BEUT) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the presence of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for a C/D Category are provided in Table 12.8. No EcoSpecs or TPCs were defined in AfriDev (2006a). Therefore some preliminary values were set for the purpose of this study which would have to be refined in future).*

Table 12.8 EWR K3A: preliminary Fish EcoSpecs and TPCs (PES and TEC: C/D)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*AfriDev (2006a) indicated that this MRU was in an E/F Category. The revision done as part of the classification study (DWA, 2014) indicated the PES to be in a Category C/D (FRAI = 60.5%).*	*Any decreased FROC[2] of indicators in the reach species (mentioned in this table) OR FRAI[3] EC decreasing below a C.*	*Deterioration in any habitat components.*
Species richness	*All spp.*	*An estimated thirty five species are present in this SQ reach under the PES (DWS, 2014b).*	*Any decrease in the species richness of this MRU (loss of any species).*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
FD habitats, FS habitats, substrate	**BEUT**	*DWA (2014): FROC of 4 under the PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every two surveys.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by*
	CANO	*DWA (2014): FROC of 3 under PES.*	*This species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
	OPER	*DWA (2014): FROC of 3 under PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every two surveys.*	*RHAM; DWA, 2009b). Decreased water quality.*
FD habitats, FS habitats	*CSWI*	*DWA (2014): FROC of 2 under PES.*	*This species should be present in most surveys and is expected to occur in at least two out of every two surveys.*	
	BMAR	*DWA (2014): FROC of 3 under PES.*	*These species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	
	LMOL	*DWA (2014): FROC of 4 under the PES.*		
	LCYL	*DWA (2014): FROC of 4 under the PES.*		
Overhanging vegetation	*BVIV*	*DWA (2014): FROC of 4 under the PES.*	*These species should be present in all surveys. The absence of this species from any survey is considered an indication of change.*	*Significant change in overhanging vegetation habitats (bank erosion, overgrazing and trampling, alien vegetation encroachment) (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS, BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

12.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR K3A is a Category D for the PES and the REC (DWA, 2014). The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a larger-sized Lowveld river associated with perennial flows; a large slow-flowing river with a sandy substrate (alluvial), and a band of tall riparian trees and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools with favourable MV overhanging the stream banks and islands. Patches of SIC occur below in-stream controls.*

Numerical: *Indicator taxa are provided in Table 12.9 and Table 12.10 provides EcoSpecs and TPCs for a C Category at EWR K3A.*

Table 12.9 EWR K3A: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Trichorythidae*	*> 0.6*	*Cobbles*	*Moderate*
2	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*

Table 12.10 EWR K3A: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: D)

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score 60 to 150; ASPT 5.0 to 5.7.	*SASS5 score < 100 and ASPT <5.1.*
To ensure that the MIRAI score is within the range for Category D (i.e. 40 to 59).	*MIRAI score <42.*
To ensure that no group consistently dominates the fauna, defined as D abundance for more than two consecutive surveys.	▪ *Any taxon abundance D (>1000) in two consecutive surveys.* ▪ *Melanoides abundance C (>100) in two consecutive surveys.*
To maintain suitable conditions for the following flow-dependent species in the SIC biotope: ▪ *Trichorythidae: Abundance A to C: Present in all seasons except winter.* ▪ *Hydropsychidae 1 sp. Abundance B.* ▪ *Baetidae 3 spp.: Abundance B.* ▪ *Elmidae: Abundance A.*	▪ *Trichorythidae absent from two or more consecutive surveys, except winter (Jun - Aug).* ▪ *Hydropsychidae absent on any one survey.* ▪ *Less than 3 species of Baetidae on any one survey.* ▪ *Elmidae absent from two or more consecutive surveys.*
To maintain suitable conditions for the following species in the Cobble biotope: Heptageniidae: Abundance A.	*Heptageniidae absent from two or more consecutive surveys.*
To maintain suitable conditions for the following species in the vegetation: ▪ *Leptoceridae: Abundance A to B.* ▪ *Atyidae: Abundance A to B.*	▪ *Leptoceridae absent from two or more consecutive surveys.* ▪ *Atyidae absent from two or more consecutive surveys.*
To maintain suitable conditions for the following nine key taxa: ▪ *Leptophlebiidae* ▪ *Trichorythidae* ▪ *Heptageniidae* ▪ *Hydropsychidae* ▪ *Leptoceridae* ▪ *Elmidae* ▪ *Corduliidae* ▪ *Chlorocyphidae* ▪ *Atyidae*	*Less than seven of the nine key taxa listed.*
To ensure that the exotic freshwater crayfish does not colonise this RU (Maguga Dam to Balekane Bridge).	*The presence of freshwater crayfish.*

12.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR K3A (as at March 2014) for riparian vegetation was a Category D (51.1%) (DWAF, 2014). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent the EC from deteriorating. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS, 2014b).*

Numerical: *EcoSpecs and TPCs for a D Category are provided in Table 12.11.*

Table 12.11 EWR K3A: Riparian vegetation EcoSpecs and TPCs (PES and TEC: D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Vegetation abundance	*Maintain Phragmites cover between 25 - 50%.*	*Less than 25% Phragmites cover.*
	Maintain presence of S. guineense.	*Absence of S. guineense.*
Vegetation cover	*Maintain 65 - 75% vegetation cover.*	*Less than 65% vegetation cover.*
Species richness	*Maintain indigenous riparian species diversity at 5 species or more.*	*Less than 5 indigenous riparian species.*
Species composition	*Maintain absence of perennial aliens.*	*Presence of perennial aliens.*
Lower zone		
Vegetation cover	*Maintain vegetation cover between 50 - 60%.*	*Less than 50% vegetation cover.*
Vegetation abundance	*Maintain Phragmites cover between 25 - 50%.*	*Phragmites cover less than 25%.*
Species richness	*Maintain indigenous riparian species diversity at 27 or more species.*	*Less than 27 indigenous riparian species.*
Species composition	*Maintain perennial alien cover below 15%.*	*An increase in perennial alien cover above 15%.*
Upper zone		
Vegetation cover	*Maintain more than 50% vegetation cover.*	*Less than 50% vegetation cover.*
Species composition	*Maintain perennial alien cover below 15%.*	*An increase in perennial alien cover above 15%.*
Species richness	*Maintain indigenous riparian species diversity at 16 or more species.*	*Less than 16 indigenous riparian species.*

13 KOMATI: IUA X1-10 - RESOURCE QUALITY OBJECTIVES

13.1 IUA OVERVIEW AND DESCRIPTION

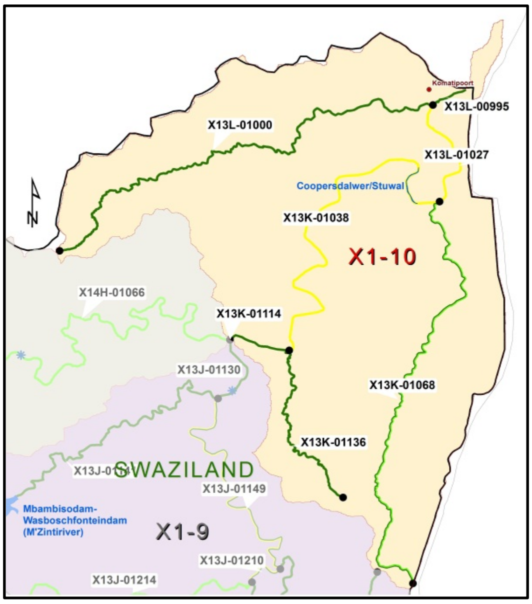
This IUA consist of the catchment upstream of the Kwena Dam. In addition to farm dams and numerous trout dams, the Kwena Dam, the largest and most important dam in the Crocodile River catchment, is located at the outlet to this this IUA.

This IUA rises at over 2 000 m on the escarpment and forms increasingly deep valleys moving downstream towards Kwena Dam. Landuse consists of forestry, grazing, irrigation and dry-land crops, trout farming. Water use in the IUA consists of limited irrigation and domestic use.

The reaches in this zone are all moderately modified falling in a PES of C to C/D. The impacts are mostly non-flow related in the form of small farm and trout dams, livestock farming (grazing) and recreation. Some water quality related impacts are also associated with this land-use type (increased nutrients and sediment runoff). The large number of small dams also impact on the flow to some extent

IUA X1-10 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X1-10 - KOMATI CATCHMENT DS OF THE LOMATI RIVER



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RUK13	*X13K-01136*	*Mambane*	D	D	2
	X13K-01068	*Nkwakwa*	C/D	C/D	
	X13L-01000	*Ngweti*	D	D	3WQ
MRU Komati E	*X13K-01114*	*Komati*	D	D	3WQ
	X13K-01038	*Komati*	E	E	
	X13L-01027	*Komati*	E	E	
	X13L-00995	*Komati*	D	D	

The RQOs are provided below for a ***Water Resource Class III*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

13.2 RQOs FOR RU K13: MODERATE PRIORITY – 2 (X13K-01136, 01068, X13L-01000)

13.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 13.1 RU K13: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X13K-01136										
D	*1.8*	*1.8*	*0.24*	*13.1*	*0.41*	*22.4*	*0.001*	*0.003*	*0.001*	*0.004*
X13K-01068										
C/D	*5.4*	*5.4*	*0.61*	*11.2*	*1.23*	*22.7*	*0.003*	*0.009*	*0.006*	*0.012*
X13L-01000										
D	*4.6*	*2.5*	*0.35*	*7.5*	*0.67*	*14.5*	*0.002*	*0.008*	*0.003*	*0.009*

13.2.2 Water quality

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Livestock, agriculture, trout farming.*
Water quality issue: *Nutrients, turbidity, salts.*

Narrative and numerical details for RU K13 are provided in Table 13.2.

Table 13.2 RU K13: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that electrical conductivity (salt) levels are within Tolerable limits.	*95^{th} percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (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).*

13.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 13.3.

Table 13.3 RU K13: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should*	

Indicators	Narrative RQO	Numerical RQO
	not expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*One endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (B. maughamii subsp. maughamii and C. macowanii).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 20 riparian plant taxa within the RU.*

13.3 RQOs FOR MRU KOMATI E: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X13K-01114, 01038, X13L-01027, 00995)

X13K-01038 and X13L-01027 are currently in an E PES. The major impacts are linked to inundation and barriers and improvement is impossible (DWS, 2014a).

13.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 13.4 MRU KOMATI E: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X13K-01114										
D	*1341.4*	*645.6*	*172.51*	*12.9*	*242.23*	*18.1*	*3.75*	*3.942*	*5.529*	*6.121*
X13K-01038										
E	*No flow RQO for an E Category and for a section where inundation and barriers are the issue.*									
X13L-01027										
E	*No flow RQO for an E Category and for a section where inundation and barriers are the issue.*									
X13L-01000										
D	*1356.6*	*504.8*	*97.4*	*7.2*	*150.08*	*11.1*	*0.485*	*0.5*	*0.481*	*2.956*

13.3.2 Water quality

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Urban (Komatipoort) impacts impacting on water quality, including Komati mill; extensive irrigation return flows. Note that this reach extends to the Mozambican border, so a more detailed list of objectives is provided (as required by the 2002 IncoMaputo agreement).*
Water quality issue: *Nutrients, salts, toxics, international obligations.*

Narrative and numerical details for MRU KOMATI E are provided in Table 13.5.

Table 13.5 MRU KOMATI E: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver, EWR C6).*
Ensure that electrical conductivity (salt) levels are within Tolerable limits.	*95^{th} percentile of the data must be less than or equal to 85 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity.*
Ensure that temperatures stay within Acceptable limits.	*A moderate change to instream temperatures should occur infrequently, i.e. vary by no more than 2ºC. Highly temperature sensitive species will occur in lower abundances (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 the Chronic Effect Value (CEV) limits.	*95^{th} percentile of the data must be within the CEV for toxics or the B category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b) (aquatic ecosystems: driver).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

13.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 13.6.

Table 13.6 RU Komati E: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION *Relevant for X13K-01114 and X13L-01000 (D EC) as the other two SQs are in a E.*		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland and woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*One endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 10 riparian plant taxa within the RU.*

14 IUA X2-1: RESOURCE QUALITY OBJECTIVES

14.1 IUA OVERVIEW AND DESCRIPTION

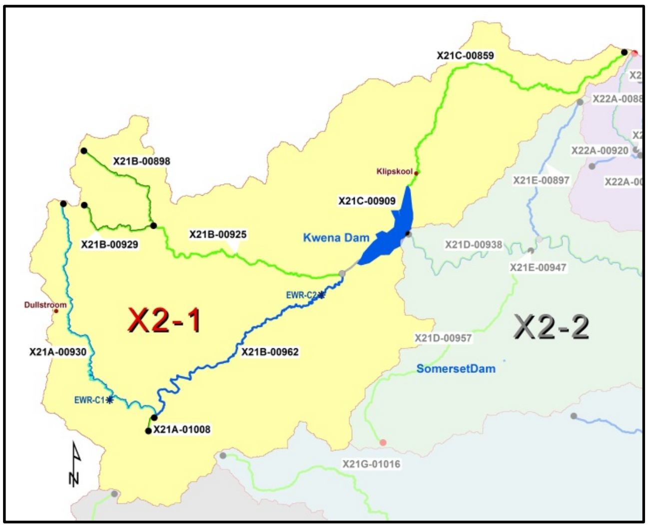
This IUA consist of the catchment upstream of the Kwena Dam. In addition to farm dams and numerous trout dams, the Kwena Dam, the largest and most important dam in the Crocodile River System, is located at the outlet to this this IUA.

This IUA rises at over 2000 m on the escarpment and forms increasingly deep valleys moving downstream towards Kwena Dam. Landuse consists of forestry, grazing, irrigation and dry-land crops, trout farming. Water use in the IUA consists of limited irrigation and domestic use.

The reaches in this zone are all moderately modified falling in a PES of C to C/D. The impacts are mostly non-flow related in the form of small farm and trout dams, livestock farming (grazing) and recreation. Some water quality related impacts are also associated with this land-use type (increased nutrients and sediment runoff). The large number of small dams also impact on the flow to some extent.

IUA X2-1 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-1 - CROCODILE US OF KWENA DAM



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
MRU Croc A	*X21A-00930 EWR C1*	*Crocodile*	A/B	A/B	
	X21B-00962 EWR C2	*Crocodile*	B	B	
RU C1	*X21B-00929*	*Gemsbokspruit*	C/D*	C/D	2
	X21B-00898	*Lunsklip*	C/D*	C/D	
	X21B-00925	*Lunsklip*	C	C	
RU C2	*X21C-00859*	*Alexanderspruit*	C	C	2

** The RQOs are set for the PES as it was felt that the actions required to improve to a C is not attainable.*

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

14.2 RQOS FOR MRU CROC A: HIGH PRIORITY – 3 (EWR C1: X21A-00930 AND EWR C2: X21B-00962)

The TEC is provided for EWR C1 and EWR C2 below. Note that these sites represent the reach upstream of Kwena Dam and will not be impacted by any scenarios.

Table 14.1 TECs for EWR C1 and EWR C2

EWR C1	
Component	**PES, REC, Immediately applicable, TEC**
Physico chemical	**A**
Geomorphology	**B**
Fish	**A**
Invertebrates	**B**
Riparian vegetation	**A**
EcoStatus	**A/B**

EWR C2	
Component	**PES, REC, Immediately applicable, TEC**
Physico chemical	**B**
Geomorphology	**B**
Fish	**B**
Invertebrates	**B**
Riparian vegetation	**A/B**
EcoStatus	**B**

14.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 14.2 MRU Croc A: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X21A-00930 (EWR C1)										
A/B	*15.19*	*14.90*	*3.8*	*24.8*	*4.7*	*30.9*	*0.033*	*0.059*	*0.121*	*0.205*
X21B-00962 (EWR C2)										
B	*47.11*	*44.80*	*23.5*	*49.9*	*27*	*57*	*0.246*	*0.373*	*0.673*	*1.162*

14.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Reserve study (DWAF, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Trout farming and some irrigation.*
Water quality issue: *Water is abstracted for irrigation and trout farming. Nutrient elevations are therefore the main water quality issue.*
Narrative and Numerical: *Details for MRU Croc A are provided in Tables 14.3 - 14.5. The latter two tables refer to the EWR sites, i.e. EWR C1 and EWR C2 respectively. Data used for water quality assessments should be collected from X2H074Q01.*

Table 14.3 MRU Croc A: 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 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 (Aquatic ecosystems: driver).*
Meet faecal coliform targets for recreational (intermediate) use.	*Meet the TWQR of 0 - 1000 counts per 100 ml (DWAF, 1996a).*
Ensure water quality state maintains biotic	*See specified biota requirements.*

Narrative RQO	Numerical RQO
requirements as specified by RQOs for biota.	

Table 14.4 EWR C1: Water quality EcoSpecs and TPCs (PES and TEC: A)

River: Crocodile Monitoring site: X2H074Q01	PES: A 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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature	*Small deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7.5 mg/L.*	*The 5th percentile of the data must be 7.8 - 7.5 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.*	*Initiate baseline monitoring for this variable.*
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 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 0.012 - 0.015 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

Table 14.5 EWR C2: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Crocodile Monitoring site: X2H074Q01	PES: B EC	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be 16 - 20 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 27 mg/L.*	*The 95th percentile of the data must be 22 - 27 mg/L.*
$MgCl_2$	*The 95th percentile of the data must be ≤ 22 mg/L.*	*The 95th percentile of the data must be 18 - 22 mg/L.*
$CaCl_2$	*The 95th percentile of the data must be ≤ 39 mg/L.*	*The 95th percentile of the data must be 32 - 39 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 118 mg/L.*	*The 95th percentile of the data must be 95 - 118 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be 280 - 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 43 mS/m.*	*The 95th percentile of the data must be 35 - 43 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature	*Small deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7.5 mg/L.*	*The 5th percentile of the data must be 7.8 - 7.5 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.*	*Initiate baseline monitoring for this variable.*
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 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 0.012 - 0.015 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a) or the A Category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity 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.

14.2.3 Habitat and biota RQOs (EcoSpecs)

14.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish of the two EWR sites within this MRU was indicated as an A for EWR C1 and a B/C for EWR C2 (DWAF, 2010a) and it should be aimed to maintain these ECs in* *future. The indigenous fish species richness ranged from very low (one species) in the upper reaches (EWR C1) to five in the lower reaches (EWR C2). Some fish species that are intolerant to alteration or with a high preference for specific habitat features are present in especially the lower end of this reach. These species provide valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach include the chubbyhead barb (BANO) in the upper reaches and mountain catfish (ANAT and AURA) and shortspine suckermouth (CPRE) in the lower reaches. The latter species are especially good indicators of flow modification (fast flowing habitats), rocky substrate condition and water quality. Fish in this unit is vulnerable to flow modification (reduced baseflows and floods), water quality deterioration and the spread of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for EWR C1 and EWR C2 are provided in Table 14.6 and 14.7 respectively.*

Table 14.6 EWR C1: Fish EcoSpecs and TPCs (PES and TEC: A)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*PES of fish determined to fall in Category A (FRAI[3] = 92.6%) (DWA, 2010a).*	*Decrease of PES to a lower EC than PES (<87%).*	*Any deterioration in habitat that results in decrease in FROC[2] of species.*
Species richness	*All indigenous spp.*	*One indigenous fish species has been sampled at EWR C1.*	*Loss of indigenous species from reach.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features that lead to a loss of species.*
Alien fish species.	*Any alien/intro-duced spp.*	*Present status of alien species is uncertain.*	*Presence of any alien/introduced fish species in reach during any survey.*	*N/A.*
Overhanging vegetation, instream vegetation, Slow Deep (SD) habitats, Slow Shallow (SS) habitats (Substrate)	**BANO[5]**	*BANO will be the most appropriate indicator of SD, SS, overhanging vegetation and instream vegetation habitats at the site. Although not generally recognised as having a high preference for substrate, this species often utilises substrate in slow areas as cover. BANO should, under present conditions be sampled at the site 100% of time at relative abundance of > 0.5 individuals per minute (ind/min) and is estimated to occur at >75% of suitable sites in the reach.*	*BANO absent during any survey or with relative abundance <0.5 ind/min. Any decreased in the FROC of BANO in the reach (<75 of sites in reach).*	*Significant change in overhanging vegetation (over grazing, alien vegetation encroachment, flow modification), instream vegetation (flow modification, herbicides), SD and SS habitats (flow modification, abstraction) and substrate (sedimentation, eutrophication-excessive algal growth).*
Migratory requirement[4]	*BANO*	*BANO can be described as a potamodromous species, requiring movement (migration) between river reaches (approximately 10 km).*	*Loss or decreased FROC of BANO in reach.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
				chemical barriers).
Alien fish species	*Presence of any alien/ introd. spp.*	*Although not sampled during EWR study, 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.*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.
5 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

Table 14.7 EWR C2: Fish EcoSpecs and TPCs (PES and TEC: B/C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*PES of fish determined to fall in Category B/C (FRAI[3] = 82%) (DWA, 2010a).*	*Decrease of PES to a lower EC than PES (<77%).*	*Any deterioration in habitat that results in decrease in FROC[2] of species.*
Species richness	*All indigenous spp.*	*Five indigenous fish species have been sampled during the baseline survey (PES determination).*	*Less than five fish species sampled during a survey when habitat can be sampled efficiently. Any decreased FROC in reach of indicator species*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During recent surveys (baseline/PES) fish were sampled at 2.2 ind/min electrofishing.*	*Relative abundance of less than 1.5 ind/min electrofishing at the site (during same season as baseline data).*	
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during baseline surveys. OMYK potentially present in reach under baseline condition.*	*Presence of more than one alien/introduced fish species in reach during any survey (or increased spatial FROC or abundance of OMYK).*	*N/A.*
FD[2] Habitats	**CPRE** **ANAT** *(AURA)*	*During baseline survey CPRE was present at site at relative abundance of 1.4 ind/min electrofishing, while ANAT was present at 0.2 ind/min.*	*CPRE and ANAT present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of CPRE below one ind/min electrofishing, and <0.1 ind/min for ANAT at EWR site. Any decreased FROC of AURA (<3) and CPRE (<5) in reach.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*
FS[3] habitats				
Flow dependant spp. (flow alteration).				
Water quality intolerance				
Substrate	*CPRE* **BNEE**	*During baseline survey CPRE was present at site at relative abundance of 1.4 ind/min electrofishing, while BNEE was present at 0.24 ind/min.*	*CPRE and BNEE present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of CPRE below one ind/min electrofishing, and <0.1*	*Reduced suitability (abundance and quality) of substrates (i.e. excessive algal growth on substrates, sedimentation) (to be quantified by RHAM; DWA, 2009b).*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			ind/min for BNEE. Any decreased FROC of CPRE (<5) and BNEE (<5) in reach.	
SD and SS habitats	*BNEE*	*During baseline survey BNEE was present at 0.24 ind/min.*	*BNEE present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of <0.1 ind/min for BNEE. Any decreased FROC of BNEE (<5) in reach.*	*Reduced suitability (abundance and quality) of substrates (i.e. excessive algal growth on substrates, sedimentation) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*PPHI BNEE*	*During baseline survey PPHI was present at site at relative abundance of 0.29 ind/min electrofishing, while BNEE was present at 0.24 ind/min.*	*PPHI and BNEE present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of PPHI below 0.15 ind/min electrofishing, and <0.1 ind/min for BNEE. Any decreased FROC of BNEE (<5) and PPHI (<5) in reach.*	*Reduced suitability (abundance and quality) of overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*PPHI BNEE*			*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009).*
Instream vegetation	*BANO[5]*	*Although BANO was not sampled at EWR site, it is estimated to be present in this reach.*	*Any decreased FROC in reach of BANO (<4) and TSPA (<4)*	*Significant change in overhanging vegetation habitats (overgrazing, flow modification, use of herbicides, agriculture).*
Migratory requirement[4]	*BANO CBIF CPRE TSPA*	*These indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.
5 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

14.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The Ecological Category for the macro-invertebrates at EWR C1 and EWR C2 is a Category B (PES and REC) for both sites. The macro-invertebrate communities at these sites should be representative of a small mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa for EWR C1 and C2 are provided in Table 14.8 and EcoSpecs and TPCs are provided for EWR C1 (Table 14.9) and EWR C2 (Table 14.10).*

Table 14.8 EWR C1 and EWR C2: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Trichorythidae* *Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
2	*Prosopistomatidae* *Psephenidae* *Perlidae*	*> 0.6*	*Cobbles*	*High*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Table 14.9 EWR C1: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: *SASS5 score: >180; ASPT: >6.2.*	*SASS5 scores below 190 and ASPT below 6.3.*
Ensure that the MIRAI score remains within the range of a B category (82% - 88%), using the same reference data used in the 2010 study (DWAF, 2010a).	*MIRAI score of 83% or less.*
Maintain suitable flow velocity(maximum >0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the very fast flow over coarse sediment (VFCS) biotope: ▪ *Philopotamidae: Abundance A.* ▪ *Trichorythidae: Abundance A.* ▪ *Prosopistomatidae: Abundance A.* ▪ *Psephenidae: Abundance A.*	*Any one of these taxa missing or present as a single individual in any two consecutive surveys.*
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the fast flow over coarse sediment (FFCS) biotope: ▪ *Heptageniidae: Abundance B.* ▪ *Elmidae: Abundance B.*	*Any one of these taxa missing or present in an A abundance or less for two consecutive surveys.*
Maintain suitable water quality, shading, temperature and habitat conditions for the following six key taxa: ▪ *Psephenidae.* ▪ *Trichorythidae.* ▪ *Philopotamidae.* ▪ *Elmidae.* ▪ *Heptageniidae.* ▪ *Prosopistomatidae.*	*Presence of less than five of the six key taxa listed in any survey.*
Ensure that no group consistently dominates the fauna, defined as D abundance (>1000).	*Any taxon occurring in an abundance of >500 for two consecutive surveys.*
The REC is the same as the PES thus these values also refer to the REC.	

Table 14.10 EWR C2: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: *SASS5 score: >180; ASPT: >6.2.*	*SASS5 scores below 190 and ASPT below 6.3.*
Ensure that the MIRAI score remains within the range of a B category (82% - 88%), using the same reference data used in the 2010 study (DWAF, 2010a).	*MIRAI score of 83% or less.*
Maintain suitable flow velocity(maximum >0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: ▪ *Perlidae: Abundance B.* ▪ *Trichorythidae: Abundance B.*	*Any one of these taxa missing or present as a single individual in any two consecutive surveys.*

EcoSpecs	TPCs
▪ Prosopistomatidae: Abundance A.	
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ Heptageniidae: Abundance B. ▪ Elmidae: Abundance B.	Any one of these taxa missing or present in an A abundance or less for two consecutive surveys.
Maintain suitable water quality, shading, temperature and habitat conditions for the following six key taxa: ▪ Perlidae. ▪ Trichorythidae. ▪ Elmidae. ▪ Heptageniidae. ▪ Prosopistomatidae.	Presence of less than five key taxa listed in any survey.
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 >500 for two consecutive surveys.
The REC is the same as the PES thus these values also refer to the REC.	

14.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The PES and REC (as at October, 2007) for riparian vegetation was a Category A (92.5%) at EWR C1 and Category A/B (89.8%) at EWR C2. Vegetation cover (woody and non-woody) has to be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species have to be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b). As such agricultural activities should not encroach into the riparian zone or floodplain.*

Numerical: *EcoSpecs and TPCs for EWR C1 and EWR C2 are provided in Table 4.11 and Table 4.12 respectively. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (Kleynhans et al., 2007) data were available for both EWR sites.*

Table 14.11 EWR C1: Riparian vegetation EcoSpecs and TPCs (PES and TEC: A)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	Maintain an absence of perennial alien species.	An occurrence of perennial alien species
	The marginal zone was (under baseline conditions) free of alien species; the presence of which would reduce the EC.	
Terrestrialisation	Maintain cover (%) of terrestrial grasses at 5% or lower.	An increase in terrestrial grass species cover >10%.
	Miscanthus junceus (endemic) is not considered terrestrial; terrestrial grasses only expected to and occur in the non-marginal zone.	
Non-marginal zone		
Alien invasion (perennial alien species)	Maintain cover (%) of perennial alien species at 1% or lower.	An increase in perennial alien species cover >5%.
	Alien species cover was observed at <1% in the non-marginal zone. This is the level at which it should be maintained, or reduced, but an increase above 5% is likely to reduce the EC.	
Riparian zone		
Terrestrialisation	Maintain absence of terrestrial woody species.	An increase in terrestrial woody species cover >2%.
	Grass dominated vegetation type, should not have woody terrestrial species,	

Assessed Metric	EcoSpec	TPC
	even beyond the riparian zone.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species below 5%.*	*An increase in riparian woody species cover above 10%.*
	RHAM data shows current value at 5%, but an increase beyond 10% would reduce the EC because the site occurs in a grass-dominated system where indigenous riparian woody species are expected to be scattered, with low cover and abundance.	
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover between 80% and 100%.*	*A decrease in sedge, grass and dicotyledonous forb cover below 70%.*
	80 - 90% non-woody in RHAM woody data; 81% average for non-woody data.	
Phragmites (reed) cover	*Maintain absence of reed cover.*	*An increase in reed cover above 5%.*
	Phragmites spp. do not and should not occur at this site, hence colonization by reeds would change the riparian characteristics of the site and reduce the EC.	

Table 14.12 EWR C2: Riparian vegetation EcoSpecs and TPCs (PES and TEC: A/B)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Alien invasion (perennial alien species)	*Maintain an absence of perennial alien species.*	*An occurrence of perennial alien species.*
	The marginal zone was (under baseline conditions) were free of perennial alien species; the presence of which would reduce the EC.	
Terrestrialisation	*Maintain cover (%) of terrestrial grasses at 5% or lower.*	*An increase in terrestrial grass species cover >10%.*
	M. junceus is not considered terrestrial; terrestrial grasses only expected to occur in the non-marginal zone.	
Non-marginal zone		
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 1% or lower.*	*An increase in perennial alien species cover >5%.*
	Alien species cover was observed at <1% in the non-marginal zone. This is the level at which it should be maintained, or reduced, but an increase above 5% is likely to reduce the EC	
Riparian zone		
Terrestrialisation	*Maintain absence of terrestrial woody species.*	*An increase in terrestrial woody species cover >2%.*
	Grass dominated vegetation type, should not have woody terrestrial species.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species below 5%.*	*An increase in riparian woody species cover above 15% (15% based on VEGRAI max).*
	RHAM data show current value at 2.5%; but an increase beyond 10% would reduce the EC because the site occurs in a grass-dominated system where indigenous riparian woody species are expected to be scattered, with low cover and abundance.	
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover between 80% and 100%.*	*A decrease in sedge, grass and dicotyledonous forb cover below 70%.*
	85 - 95% non-woody in RHAM woody data; 93% average for non-woody data. Trampling of the marginal zone was a major impact at this site: should trampling reduce value below 70% then EC would reduce.	
Phragmites (reed) cover	*Maintain reed cover at 2% or lower*	*An increase in reed cover above 5%*
	On average, Phragmites spp. comprised 1% of vegetation in the riparian zone (RHAM data), which is keeping with the grassland characteristics of this site, hence expansion of reeds would change the riparian characteristics of the site and reduce the EC.	

14.2.4 Wetland RQOs

Wetland RQOs are provided in Table 14.13.

Table 14.13 MRU Croc A: Wetland RQOs

SQ	TEC	Wetland RQO
X21A-00930	**B/C**	*Maintain TEC and Very High EIS.* *Cessation of land use encroachment on pans, seeps and channelled valley bottom wetlands.* *To improve to B/C improve wetland buffers, remove alien woody species in wetlands, don't allow any more dams and rehabilitate those not in use.*

14.3 RQOs FOR RU C1: MODERATE PRIORITY - 2 (X21B-00929, 00898, 00925)

X21B-00929 and X21B-00898 situated in RU C1 requires improvement to achieve the TEC of a C/D. The actions required are mostly non flow-related and include:

- *Barrier and inundation impacts of small farm dams as well as the impact on flow as these dams do not have operating capabilities.*
- *Water quality issues.*

It should be possible to increase the PES by half a category but will be difficult and it must first be established what the driving impacts are. The necessity for improvement is acknowledged, but due to uncertainty whether this is achievable, the catchment configuration of an overall C/D is recommended (DWS, 2014a).

14.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 14.14 RU C1: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X21B-00929										
C/D	*3.8*	*3.3*	*0.709*	*18.9*	*0.988*	*26.3*	*0.013*	*0.014*	*0.013*	*0.019*
X21B-00898										
C/D	*9.6*	*8.4*	*1.775*	*18.4*	*2.489*	*25.8*	*0.030*	*0.033*	*0.022*	*0.052*
X21B-00925										
C	*25.8*	*22.2*	*6.011*	*23.3*	*8.067*	*31.3*	*0.062*	*0.109*	*0.192*	*0.201*

14.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Trout farming.*
Water quality issue: *Water is abstracted for trout farming. Nutrient elevations are therefore the main water quality issue.*

Narrative and numerical details for RU C1 are provided in Table 14.5.

Table 14.15 RU C1: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Meet faecal coliform targets for recreational (intermediate) use.	*Meet the TWQR of 0 - 1000 counts per 100 ml (DWAF, 1996a).*

14.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 14.16. SQ X21B-00929 (Gemsbokspruit) was selected to represent riparian vegetation in RU C1 and data from the PES 2011 project used to support RQOs (DWS, 2014b).

Table 14.16 RU C1: Narrative and numerical habitat and biota RQOs

<table>
<tr><th>Indicators</th><th>Narrative RQO</th><th>Numerical RQO</th></tr>
<tr><td colspan="3">RIPARIAN VEGETATION</td></tr>
<tr><td>Dominant vegetation cover</td><td>The dominant vegetation cover should remain grassland.</td><td>N/A.</td></tr>
<tr><td>Presence of alien plant species in the riparian zone</td><td>The extent of perennial alien plant species within the riparian zone should remain small or decrease.</td><td>To improve, remove 50% of existing alien perennial species within riparian zone</td></tr>
<tr><td>Riparian zone continuity</td><td>Riparian zone continuity should remain moderately modified, or improve.</td><td>N/A</td></tr>
<tr><td>Plant endemism</td><td>Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.</td><td>Seven endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).</td></tr>
<tr><td>Threatened riparian species</td><td>Viable populations of riparian plant species with IUCN status should remain within the RU.</td><td>Both listed riparian species should remain within the RU (I. mitis var. mitis; and C. macowanii).</td></tr>
<tr><td>Taxon richness</td><td>Maintain riparian taxon richness within the RU.</td><td>Maintain the presence of at least 60 riparian plant taxa within the RU.</td></tr>
<tr><td colspan="3">FISH</td></tr>
<tr><td>Species richness</td><td rowspan="3">Indigenous fish species richness estimated to range between three and eight species under the PES. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.</td><td>Maintain indigenous species richness (ANAT, AURA, BANO, BARG, BNEE, CPRE, PPHI and TSPA) of between 3 and 8 species within this RU and prevent further spread or increase in diversity and abundance of predatory alien species. Maintain current habitat diversity.</td></tr>
<tr><td>Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)</td><td>Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).</td></tr>
<tr><td>Secondary indicators:
Flow: BARG, ANAT
Water quality: ANAT, BARG, CPRE
Substrate: ANAT, BARG, CPRE
Vegetation: BNEE, PPHI, TSPA</td><td>Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reaches. Prevent the construction of any further migration barriers to fish movement.</td></tr>
</table>

Indicators	Narrative RQO	Numerical RQO
Migration: BANO[1], TSPA		
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for both these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

14.3.4 Wetland RQOs

Wetland RQOs are provided in Table 14.17.

Table 14.17 RU C1: Wetland RQOs

SQ	TEC	Wetland RQO
X21B-00929	**B/C**	*Maintain TEC and Very High EIS.* *Cessation of land use and forestry encroachment on wetlands.* *To improve to B/C improve wetland buffers and remove perennial aliens within wetlands.*
X21B-00898	**B/C**	

14.4 RQOs FOR RU C2: MODERATE PRIORITY - 2 (X21C-00859)

14.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
A summary of the flow RQOs are provided below and the full EWR rule is provided electronically.

Table 14.18 RU C2: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	*28.8*	*26.2*	*6.814*	*23.6*	*9.09*	*31.5*	*0.069*	*0.134*	*0.172*	*0.188*

14.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 4.19.

Table 14.19 RU C2: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Nine endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Four listed riparian species should remain within the RU (B. maughamii subsp. maughamii; C. macowanii; G. perpensa; I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 130 riparian plant taxa within the RU.*

14.4.3 Wetland RQOs

Wetland RQOs are provided in Table 14.20.

Table 14.20 RU C2: Wetland RQOs

SQ	TEC	Wetland RQO
X21C-00859	**C**	*Maintain TEC and Very High EIS.* *Cessation of land use and agricultural encroachment on natural wetlands.* *To improve to C improve wetland buffers by reducing extent of agriculture within wetlands*

15 IUA X2-2: RESOURCE QUALITY OBJECTIVES

15.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Crocodile River and tributaries from the Kwena Dam to the confluence of the Elands River. There are a few small farms dams in the IUA.

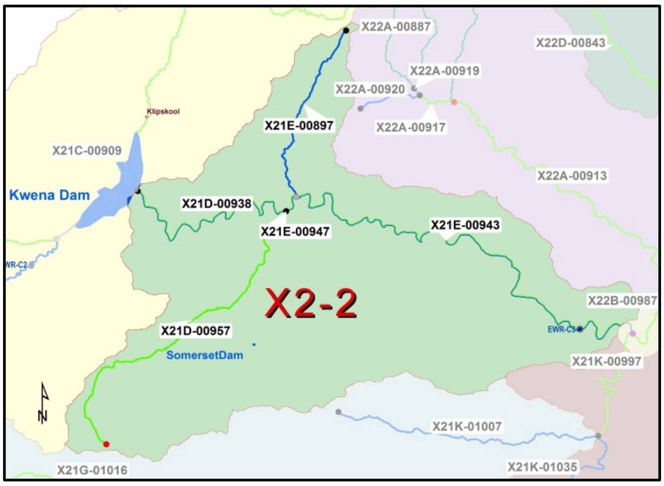
The terrain consists of a deeply incised valley although the valley bottom is sufficiently wide for extensive agricultural lands. Land consists mostly of forestry and grazing with irrigation in lower lying areas. Water use consists of irrigation, with water supplied out of the Kwena Dam and tributaries.

The reaches in this zone ranges from largely natural (B PES) for the upper Crocodile River and northern Buffelkloofspruit to moderately modified condition (C PES) for the southern Buffelkloofspruit and lower Crocodile River reaches. The primary impact in this zone is related to flow regulation by the Kwena Dam, while non-flow related impacts (especially in the tributaries) are related to forestry, agriculture and livestock farming activities.

The main river is dominated by the releases of Kwena Dam to the Elands River. As the Elands River contributes significant flow (and natural patterns) to the Crocodile River, the impact of Kwena Dam is somewhat mitigated. The two tributaries in this IUA have mostly non-flow regulated impacts.

IUA X2-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-2 - CROCODILE DS OF KWENA DAM TO ELANDS RIVER



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C3	*X21D-00957*	*Buffelskloof-spruit*	**C**	**B/C**	**2**
RU C4	*X21E-00897*	*Buffelskloof-spruit*	**B**	**B**	**2**
MRU Croc B	*X21D-00938**	*Crocodile*			**3**
	*X21E-00947**	*Crocodile*			
	X21E-00943 EWR C3	*Crocodile*	**B/C**	**B/C**	

** Where SQ does not have a EC the EC is different from the EWR site. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this RU.*

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

15.2 RQOs FOR RU C3: MODERATE PRIORITY - 2 (X21D-00957)

X21D-00957 requires improvement to achieve the TEC of a B/C. All impacts are non flow-related and improved agricultural practices in general are needed to achieve the REC, implying that most metrics will require improvement. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

15.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 15.1 RU C3: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B/C*	16.88	12.9	4.223	25	5.5	32.6	0.032	0.064	0.069	0.116

* Rule curve for the PES of a C were used as the improvements required are non-flow related.

15.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 15.2.

Table 15.2 RU C3: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	*To improve remove 50% of existing perennial aliens within riparian zone*
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	*N/A*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve, riparian zone buffers should be ahered to and extended where violation currently occurs.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Four listed riparian species should remain within the RU (B. maughamii subsp. maughamii; C. macowanii; G. perpensa and Kniphofia typhoides.*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 90 riparian plant taxa within the RU.*

15.3 RQOs FOR RU C4: MODERATE PRIORITY - 2 (X21E-00897)

15.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 15.3 RU C4: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B	8.39	6.64	2.145	25.5	2.963	35.3	0.03	0.043	0.047	0.067

15.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 15.4.

Table 15.4 RU C4: Narrative and numerical habitat and biota RQOs

RIPARIAN VEGETATION		
Indicators	**Narrative RQO**	**Numerical RQO**
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs) but with grassland remaining common.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain absent.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of forestry activities into the riparian zone and existing forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Five endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (B. maughamii subsp. maughamii; C. macowanii and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 85 riparian plant taxa within the RU.*

15.4 RQOs FOR MRU CROC B: HIGH PRIORITY - 3 (EWR C3: X21E-00943; INCLUDING X21D-00938, X21E-00947)

Note that EWR C3 represents the reach downstream of Kwena Dam and will be impacted by scenarios. Scenarios C3, C62 and C82 were the preferred scenarios for the Crocodile River System (refer to section 1.6.2). The short term (prior to dam construction) recommendation is that Sc C3 is implemented. Senario C3 is very similar to the PES, but includes IIMA with some impact on the fish and geomorphology. Scenarios which are not immediately relevant include Sc C62 which includes Mountain View Dam in the Kaap River and is relevant in the medium term while Sc C82 which includes Mountain View and Boschjeskop Dam is relevant in the long term.

Table 15.5 TECs for EWR C3

Component	PES	REC	Immediately applicable	Sc C3	Sc C62	Sc C82
Physico chemical	C	B/C	C	B	B	B
Geomorphology	C	C	C	C/D	C/D	C/D
Fish	B	B	B	C	C	C/D
Invertebrates	C	B	C	C	C	C
Riparian vegetation	C	B	C	C	C	C
EcoStatus	B/C	B	B/C	C	C	C

15.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 15.6 MRU CROC B: Flow RQOs

PES	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
								90%	60%	90%	60%
X21E-00943 (EWR C3)											
B/C	B/C	*194*	*159*	*78.1*	*40.26*	*94.7*	*48.81*	*1.237*	*2.46*	*1.665*	*2.97*
B/C	C *(Sc C3)*			*75.8*	*39.01*	*160.5*	*39.07*	*0.913*	*1.624*	*1.236*	*1.913*
B/C	C *(Sc C62)*			*82.8*	*42.68*	*158.8*	*81.86*	*1.081*	*2.086*	*1.505*	*2.208*
B/C	C *(Sc C82)*			*81.6*	*42.06*	*157.7*	*42.06*	*1.244*	*2.263*	*1.521*	*2.197*

15.4.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Irrigation, particularly citrus.*
Water quality issue: *Elevated nutrients, salts and toxics (e.g. pesticides).*
Narrative and Numerical: *Details for MRU Croc B are provided in Tables 15.17 and 15.18, with the EcoSpecs and TPCs outlined in Table 5.18. Data used for water quality assessments should be collected from X2H013Q01.*

Table 15.7 MRU CROC B: 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 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 (Aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A	*95^{th} percentile of the data must be within the TWQR*

Narrative RQO	Numerical RQO
categories.	*for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 15.8 EWR C3: Water quality EcoSpecs and TPCs (PES and TEC: C)

River: Crocodile		**PES and Target: C EC**
Monitoring site: X2H013Q01		**Note: The scenario is likely to improve the water quality to a B 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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature	*Small to moderate deviation from the natural temperature range. Some highly temperature sensitive species in lower abundances and frequency of occurrence than expected for reference.*	*Vary by more than 2°C, i.e. a large change to the temperature regime occurs often. Most moderately temperature sensitive species would be in lower abundances and frequency of occurrence than expected for reference. Biological assessments therefore recommended and initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 6 mg/L.*	*The 5th percentile of the data must be 6.2 - 6 mg/L. Biological assessments recommended and initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes to the catchment land-use resulting in <u>temporary</u> unnaturally high sediment loads and high turbidities.*	*Initiate baseline monitoring for this variable.*
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 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 0.02 - 0.025 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 µg/L.*
Chl-a periphyton[(c)]	*The 50th percentile of the data must be ≤ 52.5 mg/m^2.*	*The 50th percentile of the data must be 42 - 52 mg/m^2.*

River: Crocodile		PES and Target: C EC Note: The scenario is likely to improve the water quality to a B EC
Monitoring site: X2H013Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.
(c) Periphyton (29.81 mg/m^2) is actually in a C/D category (C = 12 - 21 and D = 21 - 84 mg/m^2, DWAF, 2008b), so have defined the upper boundary of a C/D as the EcoSpec for PES.

15.4.3 Habitat and biota RQOs (EcoSpecs)

15.4.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish of EWR C3 in this MRU was indicated as a B EC (DWAF, 2010a). It is estimated that the ecological status of the fish may deteriorate to a C under the Sc C3, and it should not be allowed to deteriorate lower than this EC. The fish species richness of the reach should be maintained under this scenario but reduced FROC (distribution within a reach) is expected for most species (primarily related to change in seasonality). The indigenous fish species richness of EWR C3 is estimated to be seven species (six species confirmed during the EWR study) while ten species occur naturally within this SQ reach. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU. These species are valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach include the mountain catfish (AURA) and shortspine suckermouth (CPRE). These species are especially good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Fish in this MRU is especially vulnerable to flow modification (reduced or increased flows as a result of releases from Kwena Dam, alteration of flood regime), water quality deterioration and the spread of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for EWR C3 are provided in Table 15.9.*

Table 15.9 EWR C3: Fish EcoSpecs and TPCs (PES: B; TEC: C; Sc C3 and C62: C; Sc C82: C/D)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C82
Ecological status	**All spp.**	*Baseline FRAI score of 84.7% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially AURA, CPRE OR FRAI[3] scores decreasing below 80% (B/C EC).*	*Deterioration in any habitat components.*	*Overall EC, based on fish, expected to decrease to C*	*Overall EC, based on fish, expected to decrease to C/D*
Species richness	**All indigenous spp.**	*Six naturally occurring indigenous fish species have been sampled during the baseline survey (DWA, 2010a).*	*Less than four naturally occurring indigenous fish species sampled during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*	*No change in species richness, only decreaed FROC*	*No change in species richness, only decreaed FROC*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys, but one introduced species CGAR present at relative abundance of 0.03 ind/min electrofishing.*	*Presence of any alien/introduced fish species in reach during any survey or increased abundance (> 0.06 ind/min) of CGAR.*	*Replacement of fast habitats with slow habitats (decreased flows) and increase in organic input (eutrophication).*	*No change expected (potential decrease in alien species FROC).*	*No change expected (potential decrease in alien species FROC).*
FD Habitats	**CPRE AURA**	*During baseline survey CPRE was present at site at relative abundance of 0.63 ind/min electrofishing, while AURA was present at 0.6 ind/min.*	*CPRE and AURA present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of < 0.3 ind/min for CPRE or AURA. Any decreased FROC in reach of AURA and CPRE.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b). Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*	*A decreased FROC of these species (especially due to reduced breeding succes).*	*A natoable decrease in FROC of these species due to altered flow regime (seasonal reversal, flushing of juveniles in dry season, geomorphological changes).*
FS habitats						
Flow dependant spp. (flow alteration).						
Water quality intolerance						

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C82
Substrate	*AURA BARG CPRE*	*During baseline survey CPRE was present at site at relative abundance of 0.63 ind/min electrofishing, while AURA was present at 0.6 ind/min. BARG were only sampled with cast net.*	*CPRE and AURA present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of < 0.3 ind/min for CPRE or AURA. Absence of BARG during two consecutive surveys. Any decreased FROC in reach of AURA and BARG*	*Reduced suitability (abundance and quality) of substrates, increased sedimentation, and excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*	*A decreased FROC of these species (especially due to reduced breeding succes).*	*A natoable decrease in FROC of these species due to altered flow regime (seasonal reversal, flushing of juveniles in dry season, geomorphological changes).*
SD habitats	*AMOS*	*AMOS is the only indicator species for SD habitats. The sampling of this species is however generally coincidental and it will therefore not be a useful indicator species. Any decreased FROC in reach of AMOS.*				
SS habitats	*PPHI*	*PPHI is the best indicators of SS, overhanging and undercut banks and was be present at site during the baseline (DWAF, 2010a) survey at a relative abundance > 0.05 ind/min.*	*PPHI absent more than 50% of time (absent during two consecutive surveys) or present with relative abundance < 0.03 ind/min. Any decreased FROC in reach of PPHI and TSPA.*	*Significant change in SS, overhanging vegetation and undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*	*A decrease in FROC of species expected due to increased flows (velocities) especially in dry season.*	*A natoable decrease in FROC due to alteration of slow vegetated habitats (high flows in early dry season result in loss of slow habitats, flushing of juveniles in dry season, riparian vegetation changes).*
Overhanging vegetation						
Undercut banks						
Instream vegetation	*TSPA*	*TSPA the only indicator species for instream vegetation in this reach. This species was however not sampled during the baseline (DWAF, 2010a) surveys, and therefore EcoSpecs and TPCs cannot be derived for EWR site.*	*Any decreased FROC in reach of TSPA.*		*A decrease in FROC of species expected due to increased flows (velocities) especially in dry season.*	*A natoable decrease in FROC due to alteration of slow vegetated habitats (high flows in early dry season result in loss of slow habitats, flushing of juveniles in dry season, riparian vegetation changes).*
Migratory	*AMOS*	*AMOS is a catadromous*	*Any decreased FROC in*	*Alteration of*	*Alterations in flow*	*Alterations in flow*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C82
requirement[4]	*CBIF* *CPRE* *TSPA*	*species while the rest of the indicator species can be described as potamodromous[1] species in terms of their migratory requirements, requiring movement between river reaches.*	*reach of indicator species.*	*longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	*regime may reduce migratory success (altered cues, habitats and depth) of some species (especially rheophilic spp.)*	*regime may reduce migratory success (altered cues, habitats and depth) of some species (especially rheophilic spp.)*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

15.4.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR C3 is a C for the PES and a REC of a B. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: medium-sized foothill river associated with perennial flows; U-shaped channel incised in a bed-rock dominated substrate. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation overhanging the stream banks.*

Numerical: *Indicator taxa for EWR C3 are provided in Table 15.10 and EcoSpecs and TPCs in Table 15.11.*

Table 15.10 EWR C3: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Trichorythidae Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
2	*Prosopistomatidae Psephenidae Perlidae*	*> 0.6*	*Cobbles*	*High*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Table 15.11 EWR C3: Macro-invertebrate EcoSpecs and TPCs (PES, TEC, Sc C3, C62 and C82: C)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 150; ASPT: > 6.4.	*SASS5 scores below 160 and ASPT below 6.5.*
Ensure that the MIRAI score remains within the range of a C category (62% - 78%), using the same reference data used in this study (DWA, 2010a).	*MIRAI score of 64% or less.*
Maintain suitable flow velocity(maximum >0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS: ▪ Perlidae: Abundance A. ▪ Trichorythidae: Abundance B. ▪ Psephenidae: Abundance B.	*Any one of these taxa missing or present as a single individual in any two consecutive surveys. Trichorythidae and/or Psephenidae present in an A abundance in any two consecutive surveys.*
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ Heptageniidae: Abundance B. ▪ Elmidae: Abundance B.	*Any one of these taxa missing or present in an A abundance or less for two consecutive surveys.*
Maintain suitable water quality, shading, temperature and habitat conditions for the following five key taxa: ▪ Perlidae. ▪ Trichorythidae. ▪ Elmidae. ▪ Heptageniidae. ▪ Psephenidae.	*Presence of less than four of the five key taxa listed in any survey.*
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 >500 for two consecutive surveys.*

15.4.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR C3 (as at October 2007) for riparian vegetation was a Category C (77.3%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR C3 are provided in Table 15.11. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 15.12 EWR C3: Riparian vegetation EcoSpecs and TPCs ((PES, TEC, Sc C3, C62 and C82: C)

<table>
<tr><th>Assessed Metric</th><th>EcoSpec</th><th>TPC</th><th>Target EcoSpec</th></tr>
<tr><td colspan="4">Marginal zone</td></tr>
<tr><td rowspan="2">Alien invasion (perennial alien species)</td><td>Maintain cover (%) of perennial alien species at 5% or lower.</td><td>An increase in perennial alien species cover >10%</td><td>Maintain cover (%) of perennial alien species at 5% or lower.</td></tr>
<tr><td colspan="3">Alien perennial species cover was low in marginal zone (<10% in VEGRAI data and average 7.5% in RHAM data): Since the marginal zone has less alien species than the remainder of the riparian zone and is also directly more important for aquatic habitat, the aim is to keep alien cover low.</td></tr>
<tr><td rowspan="2">Phragmites (reed) cover</td><td>Maintain reed cover < 10%.</td><td>An increase in reed cover > 10% on the marginal zone.</td><td>Maintain reed cover <15%.</td></tr>
<tr><td colspan="3">Reeds did not occur in RHAM data and cover was low <10% in the VEGRAI: An increase in reeds would trap sediment and change instream habitat types.</td></tr>
<tr><td colspan="4">Upper and Lower zones</td></tr>
<tr><td rowspan="2">Alien invasion (perennial alien species)</td><td>Maintain cover (%) of perennial alien species at 15% or lower.</td><td>An increase in perennial alien species cover >20%.</td><td>Maintain cover (%) of perennial alien species at 15% or lower.</td></tr>
<tr><td colspan="3">Higher cover on lower and upper zones should be kept in check at observed average (VEGRAI and RHAM), but expansion above 20% likely to reduce EC to C/D.</td></tr>
<tr><td rowspan="2">Terrestrialisation</td><td>Maintain cover (%) of terrestrial woody species at 25% or lower.</td><td>An increase in terrestrial woody species cover >40%.</td><td>Maintain cover (%) of terrestrial woody species at 25% or lower.</td></tr>
<tr><td colspan="3">RHAM data show average cover of 28%; an increase above 40% likely to reduce EC by a category due to the reduction of indigenous riparian species.</td></tr>
<tr><td rowspan="2">Indigenous riparian woody cover</td><td>Maintain cover (%) of riparian woody species between 20 and 70% within the riparian zone.</td><td>A decrease in riparian woody species cover below 20% OR an increase above 70%.</td><td>Maintain cover (%) of riparian woody species between 20 and 70% within the riparian zone.</td></tr>
<tr><td colspan="3">RHAM data show average of 48%, VEGRAI data show average of 40% for PES: Woody vegetation removal for firewood is an impact at this site and a decrease in riparian woody cover below 20% would reduce the EC by a category. Similarly an increase above 70% cover may indicate loss of flooding disturbance, which would also reduce the EC.</td></tr>
<tr><td colspan="4">Riparian zone</td></tr>
<tr><td rowspan="2">Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)</td><td>Maintain grass, sedge and dicotyledonous forb cover between 30% and 90%.</td><td>A decrease in sedge, grass and dicotyledonous forb cover below 30% OR above 90%.</td><td>Maintain grass, sedge and dicotyledonous forb cover between 30% and 90%.</td></tr>
<tr><td colspan="3">RHAM average: 31%; VEGRAI range 20 - 60%. Linked mostly to woody cover (indigenous and alien) by way of shading i.e. too much shading reduces cover and</td></tr>
</table>

Assessed Metric	EcoSpec	TPC	Target EcoSpec
	none allows for a situation where 100% cover is possible. This site occurs where a mix of woody and non-woody is always expected.		

16 IUA X2-3: RESOURCE QUALITY OBJECTIVES

16.1 IUA OVERVIEW AND DESCRIPTION

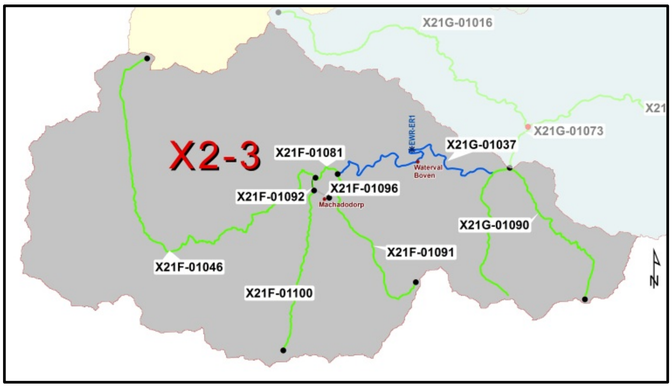
This IUA consists of the upper reaches of the Elands River catchment. There are a few farms dams and trout dams in the catchment and a small dam which supplies water to Machadodorp. The catchment rises on the escarpment and is generally undulating although becoming increasingly mountainous as the river drops down the escarpment in near Waterval Boven. Land uses consist of forestry, grazing and dry-land crops.

There is limited water use in this IUA, consisting mostly of domestic use in towns such as Machadodorp, Waterval Boven and increasing water use by eco-resorts. There is limited irrigation in this catchment and the water use by the smelter located near Machadodorp is also limited.

The reaches in this zone are all moderately modified falling in a PES of C to C/D. The impacts are mostly non-flow related in the form of small farm and trout dams, livestock farming (grazing) and recreation. Some water quality related impacts are also associated with this land-use type (increased nutrients and sediment runoff) as well as the runoff and waste water treatment works of Machadodorp and Waterfall Boven towns.

IUA X2-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-3 - UPPER ELANDS AND TRIBUTARIES TO WATERVAL BOVEN



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
MRU Elan A	*X21F-01046*	*Elands*	C	C	3 3WQ
	X21F-01081	*Elands*	C	C	
	X21G-01037 ER 1	*Elands*	B	B	
RU C7	*X21F-01100*	*Leeuspruit*	C	C	3WQ
	X21F-01091	*Rietvleispruit*	C	C	2
	X21F-01092	*Leeuspruit*	C/D	C/D	

*The RQOs are provided below for a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

16.2 RQOs FOR MRU ELAN A: HIGH PRIORITY - 3 (EWR ER 1: X21G-01037)

The RU is a high priority area, but moderate priority habitat and biota RQOs will be provided. The Reserve work was undertaken during 2004 and EcoSpecs were not set as part of the study. The monitoring baseline is also now obsolete, therefore the level at which the RQOs will be set is moderate.

16.2.1 Flow RQOs

***Source:** DWA (2014).*
***Model:** RDRM (Hughes et al., 2013).*

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

Table 16.1 MRU ELAN A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X21G-01037 (EWR ER1)											
B	B	60.00	54.00	6.24	10.39	28.28	47.12	0.100	0.177	0.293	0.613

16.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2000 Elands River Intermediate Reserve study (DWAF, 2000) and the 2004 re-assessment of the results by Environmentek, CSIR, as part of the Elands Catchment Comprehensive Reserve Determination Study. O'Brien (2003) and Beukes et al. (2012) informed the assessment.*
Model: *Water quality methods available at the time. The 2004 version of the PAI model was used for the Comprehensive Reserve Study.*
Users: *Urban impacts (Waterval Boven) including Waste Water Treatment Works (WWTW) and ferro-chrome processing.*
Water quality issue: *Nutrient, salt and toxics elevations; Cr-VI and Mn.*
Narrative and Numerical: *Note that EcoSpecs and TPCs were not prepared during the 2000 or 2004 studies. Narrative and numerical details for MRU ELAN A are provided in Table 16.2.*

Table 16.2 MRU ELAN A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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 (aquatic ecosystems: 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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996b) and DWAF (2008b).*
Ensure that Cr-VI levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.014 mg/L Cr-VI (aquatic ecosystems: driver).*
Ensure that Mn levels are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR of 0.180 mg/L Mn (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 water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

16.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 16.3.

Table 16.3 MRU ELAN A: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland, woodland and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa and K. typhoides).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 60 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be nine species under the PES. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMOS, AURA, BANO, BARG, BPOL, CBIF, CPRE, PPHI and TSPA) of nine species within this RU. Maintain current habitat diversity.*
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).*
Secondary indicators: *Flow: BARG, CBIF, BPOL* *Water quality: BARG, CPRE, CBIF* *Substrate: BARG, CBIF* *Vegetation: BANO[1], PPHI, TSPA* *Migration: AMOS, BPOL*		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae	*Flows should be adequate to ensure*	*Maintain suitable conditions for these*

Indicators	Narrative RQO	Numerical RQO
Trichorythidae Philopotamidae	*suitable habitats for these flow dependant taxa.*	*flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

16.3 RQOs FOR RU C7: MODERATE PRIORITY – 2 (X21F-01100, 01091, 01092) HIGH PRIORITY WQ (X21F-01100)

16.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 16.4 RU C7: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X21F-01100										
C	*11.88*	*11.23*	*3.66*	*30.80*	*4.69*	*39.50*	*0.065*	*0.069*	*0.065*	*0.098*
X21F-01091										
C	*3.31*	*3.13*	*0.90*	*27.10*	*1.17*	*35.50*	*0.017*	*0.019*	*0.030*	*0.032*
X21F-01092										
C/D	*11.88*	*11.23*	*2.81*	*23.60*	*3.70*	*31.20*	*0.065*	*0.068*	*0.043*	*0.064*

16.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. O'Brien (2003) and Beukes et al. (2012) informed the assessment.*
Model: *N/A.*
Users: *Assmang (ferrous metals plant (ferro-chrome smelter) in Machadodorp), WWTW and urban impacts (Machadodorp).*
Water quality issue: *Nutrient, salt and toxics elevations; Cr-VI and Mn.*

Narrative and numerical details for RU C7 are provided in Table 16.5.

Table 16.5 RU C7: 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 0.025 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 (aquatic ecosystems: driver).*
Ensure that pH stays within Ideal limits.	*5^{th} and 95^{th} 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 or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF*

Narrative RQO	Numerical RQO
	(1996c) and DWAF (2008b).
Ensure that Cr-VI levels are within Ideal limits or A categories.	*95^{th} percentile of the data must be less than 0.014 mg/L Cr-VI (aquatic ecosystems: driver).*
Ensure that Mn levels are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR of 0.180 mg/L Mn (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 nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*

16.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 16.6.

Table 16.6 RU C7: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Nine endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Five listed riparian species should remain within the RU (C. bulbispermum, C. macowanii; G. perpensa, I. mitis var. mitis and K. typhoides)*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 95 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be low (four species) under PES in the RU. It is important to maintain adequate water quality and vegetation and substrate as cover for the indicator species and not to allow any further obstructions to fish migration.*	*Maintain indigenous species richness (AMOS, BANO, PPHI and TSPA) of four species within this RU. Maintain current habitat diversity to meet the requirements of these species.*
Primary indicator species: BANO[1] (water quality, vegetation, substrate condition)		*Maintain suitable vegetated habitats and substrate of good quality to sustain the indicator species.*
Secondary indicators: Vegetation:, PPHI,		*Ensure the habitat requirements of the secondary indicator species are*

Indicators	Narrative RQO	Numerical RQO
TSPA *Migration: AMOS, BANO*		*maintained. These include adequate vegetative and substrate cover and prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Psephenidae *Trichorythidae*	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for both these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

17 IUA X2-4 AND X2-5: RESOURCE QUALITY OBJECTIVES

17.1 IUA OVERVIEW AND DESCRIPTION

IUA X2-4 consists of the Elands River and tributaries downstream of Waterval Boven and ending at the confluence with the Ngodwana River. The Lupelele River is included in this IUA. In addition to small farm dams, the Ngodwana dam is located in this IUA. This dam supplies water to the SAPPI paper mill. The landscape consists of a deeply incised but wide-bottom valley. The landuse consists of extensive forestry with grazing and irrigators crops. Water in this IUA is used equally for irrigation and industrial use at the SAPPI Paper Mill. IUA X2-5 consists of the Elands River commencing at the confluence of the Ngodwana River and ending with the confluence of the Crocodile River. Landuse consists mostly of forestry with grazing and limited irrigation. There are no significant dams in this IUA. The only water use in the IUA is limited irrigation and domestic water supply to the village of Elandshoek.

All of the reaches in IUA X2-4 is moderately modified (C PES) except the Lupelule stream (X21K-01007) that is largely natural (B PES). Impacts are mostly non-flow related associated with forestry, farming, irrigation and the presence of small (farm) dams. Some water quality deterioration, associated with these land-uses (irrigation return flows, recreation and upstream towns) is also prevalent. Impacts in IUA X2-5 are mostly related to potential water quality deterioration associated with industries and irrigation return flows, while non-flow related impacts are associated with forestry, farming, irrigation and the presence of small (farm) dams.

IUA X2-4 and 2-5 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

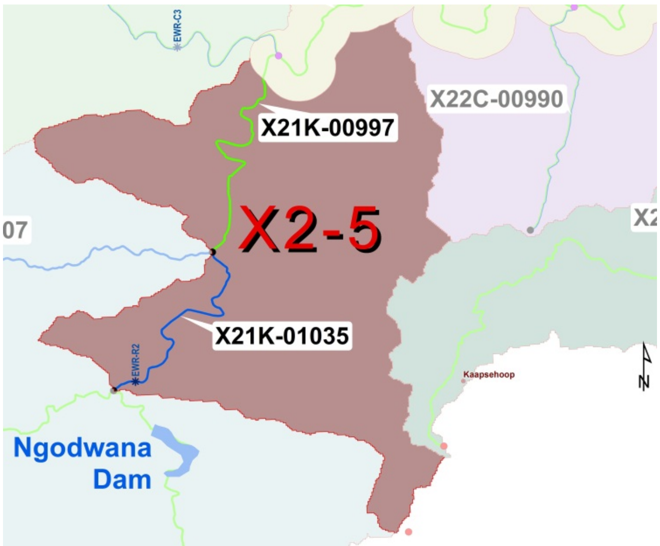
IUA X2-4 - ELANDS RIVER AND TRIBS DS OF WATERVAL BOVEN TO NGODWANA CONFLUENCE

PRIORITY RATINGS

RUs	SQ number	River	PES	REC	PR
RU C8	*X21G-01090*	*Weltevredespruit*	C	C	2
	X21G-01016	*Swartkoppiespruit*	C	C	
RU C10	*X21K-01007*	*Lupelule*	B	B	2
RU C9	*X21H-01060*	*Ngodwana*	B*	B	2
MRU Elan B	*X21G-01073*	*Elands*	C	C	3 3WQ
	X21J-01013	*Elands*	C	B/C	

**EC relevant for upstream of the dam.*

IUA X2-5 - ELANDS RIVER DOWNSTREAM OF THE NGODWANA RIVER



PRIORITY RATINGS

RUs	SQ number	River	PES	REC	PR
MRU Elan B	*X21K-01035 ER 2*	*Elands*	B	B	3 3WQ
	X21K-00997	*Elands*	C	C	

*The RQOs are provided below for a **Water Resource Class I** for IUA X2-4 and X2-5 respectively (DWS, 2014a) and the catchment configuration as illustrated above.*

17.2 RQOs FOR RU C8: MODERATE PRIORITY - 2 (X21G-01090, 01016)

17.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 17.1 RU C8: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X21G-01090										
C	*5.53*	*4.73*	*1.306*	*23.6*	*1.772*	*32.1*	*0.028*	*0.029*	*0.017*	*0.027*
X21G-01016										
C	*11.36*	*9.72*	*2.77*	*24.4*	*3.697*	*32.6*	*0.06*	*0.065*	*0.035*	*0.061*

17.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Trout farming.*
Water quality issue: *Water is abstracted for trout farming. Nutrient elevations are therefore the main water quality issue.*

Narrative and numerical details for RU C8 are provided in Table 17.2.

Table 17.2 RU C8: 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 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Meet faecal coliform targets for recreational (intermediate) use.	*Meet the TWQR of 0 - 1000 counts per 100 ml (DWAF, 1996a).*

17.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 17.3.

Table 17.3 RU C8: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Nine endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Five listed riparian species should remain within the RU (C. bulbispermum, C. macowanii; G. perpensa, I. mitis var. mitis and K. typhoides).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 90 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be ten species under the PES. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMOS, ANAT, AURA, BANO, BARG, BPOL, CBIF, CPRE, PPHI and TSPA) of ten species within this RU. Maintain current habitat diversity.*
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).*
Secondary indicators: Flow: BARG, CBIF, BPOL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction*

Indicators	Narrative RQO	Numerical RQO
Water quality: BARG, CBIF *Substrate: BARG, CBIF* *Vegetation: BANO[1], PPHI, TSPA* *Migration: AMOS, BPOL*		*of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae *Trichorythidae* *Philopotamidae*	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

17.3 RQOS FOR RU C9: MODERATE PRIORITY - 2 (X21H-01060)

17.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 17.4 RU C9: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
B[1]	*59.64*	*36.17*	*7.605*	*12.8*	*13.202*	*22.1*	*0.04*	*0.052*	*0.103*	*0.242*

1 The flows are relevant for the reach upstream of Ngodwana Dam.

17.3.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 17.5.

Table 17.5 RU C9: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of*	

Indicators	Narrative RQO	Numerical RQO
	agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Nine endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 20 riparian plant taxa within the RU.*

17.4 RQOS FOR RU C10: MODERATE PRIORITY - 2 (X21K-01007)

17.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 17.6 RU C10: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X21K-01007										
B	*29.4*	*22.86*	*7.337*	*25*	*10.366*	*35.3*	*0.051*	*0.07*	*0.143*	*0.257*

17.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 17.7.

Table 17.7 RU C10: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland woodland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011*	*One endemic riparian plant species should remain present within the RU*

Indicators	Narrative RQO	Numerical RQO
	project (DWS, 2014b) should be maintained.	*(refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 20 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be nine species under the PES in the RU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMOS, ANAT, AURA, BANO, BARG, BPOL, CPRE, PPHI and TSPA) of nine species within this RU. Maintain current habitat diversity.*
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).*
Secondary indicators: Flow: BARG, BPOL Water quality: BARG Substrate: BARG Vegetation: BANO[1] Migration: AMOS, BPOL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

17.5 RQOs FOR MRU ELAN B: HIGH PRIORITY - 3 (EWR ER 2: X21K-01035; INCLUDING X21G 01073, X21J-01013, X21K-00997)

The RU is a high priority area, but moderate priority habitat and biota RQOs will be provided. The Reserve work was undertaken during 2004 and EcoSpecs were not set as part of the study. The monitoring baseline is also now obsolete, therefore the level at which the RQOs will be set is moderate.

17.5.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 17.8 MRU ELAN B: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X21K-01035 (EWR ER2)											
B	B	*217.19*	*159.3*	*10.8*	*4.97*	*93.54*	*43.07*	*0.369*	*0.502*	*1.429*	*2.090*

17.5.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2000 Elands River Intermediate Reserve study (DWAF, 2000) and the 2004 re-assessment of the results by Environmentek, CSIR, as part of the Elands Catchment Comprehensive Reserve Determination Study. O'Brien (2003) informed the assessment.*

Model: *Water quality methods available at the time. The 2004 version of the PAI model was used for the Comprehensive Reserve Study.*

Users: *SAPPI (Ngodwana Mill); Elandshoek settlement; WWTW.*

Water quality issue: *Elevated nutrients, salts and toxics; turbidity levels.*

Narrative and Numerical: *Note that EcoSpecs and TPCs were not prepared during the 2000 or 2004 studies. Narrative and numerical details for MRU ELAN B are provided in Table 17.9.*

Table 17.9 MRU ELAN B: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

17.5.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 17.10.

Table 17.10 MRU ELAN B: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed grassland, woodland and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state).*	

Indicators	Narrative RQO	Numerical RQO
	There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Four listed riparian species should remain within the RU (C. macowanii; G. perpensa, I. mitis var. mitis and K. typhoides).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 65 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be nine species under the PES in the MRU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMOS, AURA, BANO, BARG, BPOL, CBIF, CPRE, PPHI and TSPA) of nine species within this RU. Maintain current habitat diversity.*
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).*
Secondary indicators: Flow: BARG, CBIF, BPOL Water quality: BARG, CBIF Substrate: BARG, CBIF Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, BPOL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae Prosopistomatidae Polycentropodidae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15cm deep).*
Pyralidae	*MV habitat and water quality should*	*Maintain suitable conditions in the MV*

Indicators	Narrative RQO	Numerical RQO
	be adequate to accommodate this key taxon.	*in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

18 IUA X2-6 AND PART OF IUA X2-9: RESOURCE QUALITY OBJECTIVES

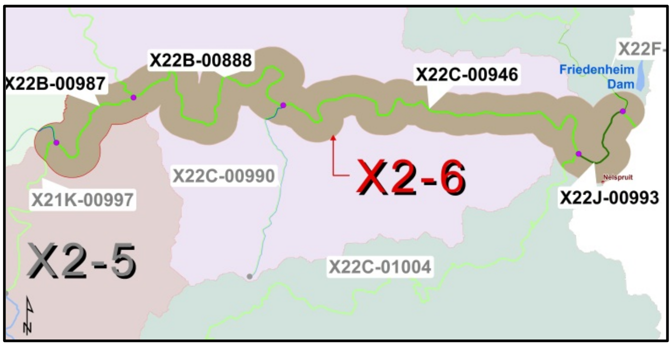
18.1 IUA OVERVIEW AND DESCRIPTION

This IUA X2-6 consists of the main stem of the Crocodile River from the confluence with the Elands down to the confluence with the Nels River. The river flows through a wide valley with high mountains on either side. There are no dams on the stretch of river, only a weir just upstream of Nelspruit which diverts water to the Nelspruit WWTW. The main land use is irrigation. Water use in this IUA consists of irrigation, supplemented with releases from the Kwena Dam, and supply to Nelspruit and surrounding towns for domestic and industrial purposes.

The upper section (two SQ reaches) is moderately modified (C PES) and it deteriorates further in the lower reach after the inclusion of Nelspruit urban impacts. The primary source of deterioration is flow related due to the Kwena Dam flow modification as well as abstraction for agriculture. Water quality deterioration is associated with the Elands River inflow, irrigation return flows while non-flow related impacts are related to agriculture, urban areas and its associated infrastructure.

IUA X2-6 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-6 - CROCODILE FROM ELANDS TO NELS



PRIORITY RATINGS

RUs	SQ number	River	PES	REC	PR
IUA X2-6					
MRU Croc C	*X22B-00987**	*Crocodile*	C	B	**3WQ 3b**
	*X22B-00888**	*Crocodile*	C	B	
	*X22C-00946**	*Crocodile*	C	B	
	*X22J-00993**	*Crocodile*	D	C	
Part of IUA X2-9					
MRU Croc C	*X22J-00958**	*Crocodile*	C	B	**3WQ 3b**
	*X22K-00981**	*Crocodile*	C	B	

** These SQs form part of EWR C4, which is situated in IUA X2-9, MRU Croc D. Please refer to Section 21.3 for further details.*

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

The SQs falling within MRU Croc C in IUA X2-6 and part of IUA X2-9 have a 3 Priority Rating for water quality and biota. While water quality RQOs are provided in the following section for MRU Croc C, the flow and biotic requirements are represented by EWR C4, which is situated largely in IUA X2-9 in MRU Croc D. Please refer to Section 21.3 for further detail on flow as well as habitat and biotic RQOs respectively.

18.2 RQOs FOR MRU CROC C IN IUA X2-6: HIGH PRIORITY – 3 (X22B-00987, 00888, X22C-00946, X22J-00993)

18.2.1 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*

Users: *Irrigation activities upstream Nelspruit; upper parts of Nelspruit urban area; Papas quarry.*
Water quality issue: *Nutrients, salts, toxics (Mn), turbidity.*

Narrative and numerical details for MRU CROC C are provided in Table 18.1.

Table 18.1 MRU CROC C in IUA X2-6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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 Mn levels are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR of 0.180 mg/L Mn (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

18.3 RQOs FOR MRU CROC C IN IUA X2-9: HIGH PRIORITY - 3 FOR WATER QUALITY (X22J-00958, X22K-00981)

18.3.1 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. Results of the water quality assessment for EWR C4 conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a) were considered.*
Model: *N/A.*
Users: *Nelspruit urban and industrial area.*
Water quality issue: *Nutrients, salts, toxics.*

Narrative and numerical details for MRU CROC C are provided in Table 18.2.

Table 18.2 MRU CROC C in IUA X2-9: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 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).*
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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

19 IUA X2-7: RESOURCE QUALITY OBJECTIVES

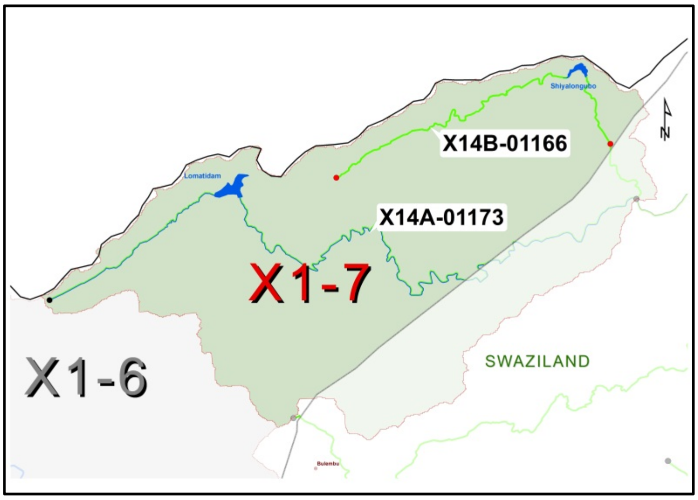
19.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of the major tributaries of the Crocodile River flowing within IUA 7. This included the Houtbosloop, State and the Visspruit rivers. These tributaries rise on the escarpment and have steep gradients flowing through mountainous areas. There are no significant dams in this IUA. Land use consists of forestry, grazing and irrigation. Water use in this IUA consists of irrigation.

The upper reaches of the Houtbosloop, including the Beestekraalspruit and Blystaanspruit, are currently in a slightly to modified condition, falling in a PES of B to B/C. This is predominantly impact by forestry (non-flow related impact). The lower reaches of the Houtbosloop are slightly more deteriorated falling in a PES of C (Moderately modified), with the primary impacts being non-flow related (forestry and agriculture). The Visspruit is also in a slightly modified condition (B/C PES) due to primarily non-flow related impacts (forestry and irrigation).

IUA X2-7 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-7 - CROCODILE FROM ELANDS TO NELS



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C5	*X22A-00875*	*Houtbosloop*	B/C	B	2
	X22A-00887	*Beestekraalspruit*	B/C	B/C	
	X22A-00824	*Blystaanspruit*	B/C	B	
	X22A-00920		B	B	
	X22A-00919	*Houtbosloop*	B/C	B/C	
	X22A-00917	*Houtbosloop*	C	C	
RU C6	*X22A-00913*	*Houtbosloop*	C	B	2
RU C11	*X22C-00990*	*Visspruit*	B/C	B/C	2

The RQOs are provided below for a ***Water Resource Class I*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

19.2 RQOs FOR RU C5: MODERATE PRIORITY – 2 (X22A-00875, 00887, 00824, 00920, 00919, 00917)

X22A-00875 and X22A-00824 requires improvement to achieve the TEC. All impacts are non flow-related and impacts are linked to forestry. Improvement is achievable with riparian zone improvement. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

19.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 19.1 RU C5: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22A-00875										
B[1]	6.92	4.96	2.118	30.6	2.703	39	0.024	0.033	0.051	0.074
X22A-00887										
B/C	3.72	2.67	0.963	25.9	1.26	33.9	0.013	0.021	0.027	0.032
X22A-00824										
B[1]	21	15.03	6.77	32.2	8.535	40.6	0.072	0.095	0.142	0.219
X22A-00920										
B	1.69	1.22	0.521	30.8	0.666	39.4	0.007	0.011	0.015	0.017
X22A-00919										
B/C	10.64	7.63	3.219	30.3	4.115	38.7	0.037	0.064	0.078	0.109
X22A-00917										
C	14.8	10.62	4.684	31.4	5.893	39.8	0.054	0.076	0.111	0.149

1 The EWR rule is provided for a B/C as the improvements to a B are based on non flow-related measures.

19.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 19.2.

Table 19.2 RU C5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woodland grassland, and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	*To improve 25% of existing perennial aliens within the riparian zone should be removed*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry encroachment into or within the riparian zone should be reduced by 25%*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Eight endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 90 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be ten species under the PES in the various reaches of this RU.*	*Maintain indigenous species richness (AMOS, ANAT, AURA, BANO, BARG, BNEE, CBIF, CPRE, PPHI and TSPA)*

Indicators	Narrative RQO	Numerical RQO
	Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	of ten species within this RU. Maintain current habitat diversity and conditions to support the requirements of all these species.
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).
Secondary indicators: Flow: BARG, CBIF, BPOL Water quality: BARG, CBIF, BNEE Substrate: BARG, CBIF Vegetation: BANO[1], BNEE, PPHI, TSPA Migration: AMOS, BPOL		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.	Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).
Psephenidae Trichorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant taxa.	Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).
Heptageniidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.
Elmidae	Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.	Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15cm deep).
Pyralidae	MV habitat and water quality should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.
Coenagrionidae	MV habitat should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

19.3 RQOs FOR RU C6: MODERATE PRIORITY – 2 (X22A-00913)

X22A-00913 requires improvement to achieve the TEC. All impacts are non flow-related and improved agricultural practices in general are needed. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

19.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 19.3 RU C6: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22A-00913										
B[1]	75.26	53.87	24.835	33	31.114	41.3	0.336	0.376	0.566	0.821

1 The EWR rule is provided for a C as the improvements to a B are based on non flow-related measures.

19.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Old gold mining decant.*
Water quality issue: *Suspended solids (turbidity); toxics (As, Cn).*

Narrative and numerical details for RU C6 are provided in Table 19.4.

Table 19.4 RU C6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996b) and DWAF (2008b).*
Ensure that As levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).*
Ensure that (free) Cn levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*

19.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 19.5.

Table 19.5 RU C6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 25% of existing perennial aliens within the riparian zone should be removed*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A.*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing*	*To improve forestry encroachment into or within the riparian zone should be reduced by 25%.*

Indicators	Narrative RQO	Numerical RQO
	agriculture or forestry should not expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Eight endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 140 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 15 species under the PES in the various reaches of this RU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (AURA/CPRE). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMOS, AURA, BANO, BARG, BMAR, BNEE, BPOL, CBIF, CGAR, CPRE, MACU, PPHI and TSPA) of 15 species within this RU. Maintain current habitat diversity and conditions to support the requirements of all these species.*
Primary indicator species: AURA/CPRE (flow and flow related water quality, substrate condition)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth (>10 cm) should also be facilitate migration (especially wet season).*
Secondary indicators: *Flow: ANAT, BARG, CBIF, BPOL, BMAR* *Water quality: BARG, CBIF, BNEE* *Substrate: BARG, CBIF* *Vegetation: BANO[1], BNEE, PPHI, TSPA* *Migration: AMOS, BPOL, BMAR*		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae *Oligoneuridae*	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae *Trichorythidae* *Philopotamidae*	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15cm deep).*
Ephemeridae	*Flows, sandy stretches and water quality should be adequate to ensure suitable habitats for this flow*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and high water*

Indicators	Narrative RQO	Numerical RQO
	dependant taxon.	quality in the sandy/gravel biotope (10 cm depth).
Pyralidae	MV habitat and water quality should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.
Coenagrionidae	MV habitat should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

19.4 RQOs FOR RU C11: MODERATE PRIORITY – 2 (X22C-00990)

19.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 19.6 RU C11: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22C-00990										
B/C	3.36	3.01	0.671	20	1.046	31.1	0.005	0.012	0.007	0.016

19.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 19.7.

Table 19.7 RU C11: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	The dominant vegetation cover should remain woody (trees and shrubs).	N/A.
Presence of alien plant species in the riparian zone	The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.	
Riparian zone continuity	Riparian zone continuity should remain moderately modified, or improve.	
Riparian zone fragmentation	Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.	
Plant endemism	Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.	Eight endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).
Threatened riparian species	Viable populations of riparian plant species with IUCN status should	Three listed riparian species should remain within the RU (C. macowanii; G.

Indicators	Narrative RQO	Numerical RQO
	remain within the RU.	*perpensa, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 135 riparian plant taxa within the RU.*

20 IUA X2-8: RESOURCE QUALITY OBJECTIVES

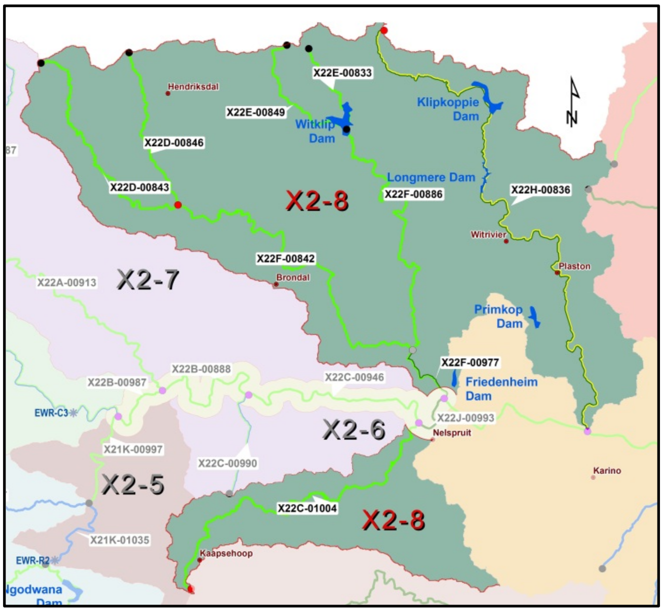
20.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the major tributaries entering the Crocodile River downstream of IUA 6 and 7. These tributaries included the Nels, Wit and Gladdespruit rivers. There are several significant dams in this IUA, namely, the Witklip, Klipkopjes, Longmere and Primkop dams. The landscape is undulating and landuse consists mainly of forestry, irrigation as well as urban and industrial areas. Water use in this IAU is domestic and industrial as well as irrigation.

Six of the upper tributaries (Gladdespruit, Sand and upper Nels Rivers) are mostly influenced by forestry and associated impacts, which place them all in a C PES. Downstream flow becomes more of a problem as abstraction for irrigation result in the deterioration of the Sand, lower Nels and Wit rivers. This along with some water quality issues and non-flow impacts such as many dams, the PES declines from a C to a C/D and D/E respectively

IUA X2-8 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-8 - NELS, WIT, GLADDESPRUIT



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C12	*X22C-01004*	*Gladdespruit*	B/C*	B/C	3WQ 2
RU C13	*X22D-00843*	*Nels*	C	C	2
	X22D-00846		C	C	
	X22E-00849	*Sand*	C	C	
	X22E-00833	*Kruisfonteinspruit*	C	C	
	X22F-00842	*Nels*	C	C	
	X22F-00886	*Sand*	C	C	
	X22F-00977	*Nels*	C/D	C/D	
RU C14	*X22H-00836*	*Wit*	D/E	D	3WQ 2

** Representative of the top section of the River*

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a). The catchment configuration is illustrated above.*

20.2 RQOs FOR RU C12: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X22C-01004)

X22C-01004 requires improvement to achieve the TEC. The top section of the SQ is probably already in a better state than the C PES. General improvement will be difficult to achieve the REC. Therefore the top section should be maintained in a B/C and this category is then relevant for the whole SQ and therefore no action is required (DWS, 2014a).

20.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 20.1 RU C12: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22C-01004										
B/C[1]	*16.26*	*10.74*	*2.041*	*12.5*	*3.757*	*23.1*	*0.018*	*0.022*	*0.021*	*0.037*

1 The EWR rule is representative of a C river which represents the PES for the whole river. The B/C is the TEC for the upper section due to improved riparian conditions, with the C flows.

20.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Mining, landfills.*
Water quality issue: *Suspended solids (turbidity); toxics (Mn).*

Narrative and numerical details for RU C12 are provided in Table 20.2.

Table 20.2 RU C12: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that Mn levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.080 mg/L Mn (aquatic ecosystems: driver).*

20.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 20.3.

Table 20.3 RU C12: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not*	

Indicators	Narrative RQO	Numerical RQO
	expand or intensify towards or within the riparian zone.	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Eight endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 135 riparian plant taxa within the RU.*

20.2.4 Wetland RQOs

Wetland RQOs are provided in Table 20.4.

Table 20.4 RU C12: Wetland RQOs

SQ	TEC	Wetland RQO
X22C-01004	**B/C**	*Maintain TEC and EIS.* *Maintain species composition and vegetative cover.* *No increase in the cover or abundance of woody alien invasive species.* *No increase in wetland fragmentation.* *Cessation of land use and forestry encroachment on natural wetlands (seeps and channelled valley bottom).*

20.3 RQOs FOR RU C13: MODERATE PRIORITY – 2 (X22D-00843, 00846, X22E-00849, 00833, X22F-00842, 00886, 00977)

X22F-00842 requires improvement to achieve the TEC. All impacts are non flow-related and linked to forestry, bed and channel disturbance, vegetation removal and alien vegetation. Riparian zone improvement and management, as well as erosion control will be required to achieve the REC. It should be possible to increase the PES by half a category but will be difficult and it must first be established what the driving impacts are. The necessity for improvement is ackmowledged, but due to uncertainty whether this is achievable, the catchment configuration of an overall C was recommended (DWS, 2014a).

20.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 20.5 RU C13: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22D-00843										
C	*20.58*	*14.94*	*4.507*	*21.9*	*6.093*	*29.6*	*0.034*	*0.059*	*0.072*	*0.12*
X22D-00846										
C	*13.78*	*9.97*	*3.323*	*24.1*	*4.393*	*31.9*	*0.078*	*0.082*	*0.052*	*0.082*
X22E-00849										
C	*8.66*	*6.39*	*1.714*	*19.8*	*2.403*	*27.8*	*0.019*	*0.027*	*0.021*	*0.043*
X22E-00833										

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
C	11.2	8.23	2.077	18.7	2.962	26.6	0.022	0.032	0.027	0.07
X22F-00842										
C	74.94	45.14	8.373	11.2	14.214	19	0.064	0.087	0.100	0.184
X22F-00886										
C	48.9	28.58	9.475	19.4	13.414	27.4	0.092	0.179	0.135	0.238
X22F-00977										
C/D	125.41	72.81	21.08	16.8	30.242	24.1	0.401	0.539	0.615	0.767

20.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Irrigation returns flows; chicken farms.*
Water quality issue: *Elevated nutrients and salts.*

Narrative and numerical details for RU C13 are provided in Table 20.6.

Table 20.6 RU C13: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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 (Aquatic ecosystems: driver).*

20.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 20.7.

Table 20.7 RU C13: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 25% of existing perennial aliens within the riparian zone should be removed.*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A.*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry encroachment into or within the riparian zone should be reduced by 10%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Seven endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*

Indicators	Narrative RQO	Numerical RQO
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, and I. mitis var. mitis).
Taxon richness	Maintain riparian taxon richness within the RU.	Maintain the presence of at least 125 riparian plant taxa within the RU.
FISH		
Species richness	Indigenous fish species richness estimated to be 17 species under PES in the various reaches of this RU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (CPRE/BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.	Maintain indigenous species richness (AMOS, ANAT, AURA, BANO, BEUT, BARG, BMAR, BTRI, BUNI, CGAR, CPRE, LCYL, LMOL, MACU, PPHI and TSPA) of 17 species within this RU. Maintain current habitat diversity and conditions to support the requirements of all these species.
Primary indicator species: CPRE and BMAR (flow and flow related water quality, substrate, migration)		Maintain suitable flows (all seasons) to sustain the rheophilic species and adequate flow and depth during wet season for large semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).
Secondary indicators: Flow: AURA, ANAT, BEUT, BARG Water quality: BEUT, BARG Substrate: AURA, BARG, LCYL, LMOL Vegetation: BANO[1], PPHI, TSPA Migration: AMOS, CGAR, LMOL		Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.
MACRO-INVERTEBRATES		
Perlidae	Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.	Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).
Psephenidae Trichorythidae Philopotamidae	Flows should be adequate to ensure suitable habitats for these flow dependant taxa.	Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).
Heptageniidae	Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.	Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.
Elmidae	Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.	Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15cm deep).
Pyralidae	MV habitat and water quality should be adequate to accommodate this key taxon.	To maintain suitable conditions in the marginal vegetation in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.
Coenagrionidae	MV habitat should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

20.4 RQOs FOR RU C14: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X22H-00836)

X22H-00836 requires improvement to achieve the TEC which is related to:

- *Removal of alien vegetation.*
- *Improvement of buffer zones and water quality from Wit River.*

It is assumed these mitigation measures are more likely to occur rather than EWR releases from the dam, but this will be sufficient to improve to a D EC. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

20.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 20.8 RU C14: 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%
X22H-00836										
D[1]	*42.99*	*20.02*	*3.409*	*7.9*	*6.385*	*14.9*	*0.035*	*0.044*	*0.054*	*0.093*

1 The EWR rule is provided for a D as the RDRM cannot provide flows below a D (PES is a D/E). These improvements can however be achieved by means of non-flow related actions other than managing the dam to change the flows.

20.4.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Urban impacts from White River and Kabokweni and agricultural impacts.*
Water quality issue: *Nutrients, salts and toxics.*

Narrative and numerical details for RU C14 are provided in Table 20.9.

Table 20.9 RU C14: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 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).*
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 or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

20.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 20.10.

Table 20.10 RU C14: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs) and grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 10% of existing perennial aliens within the riparian zone should be removed.*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A.*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry encroachment into or within the riparian zone should be reduced by 10%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Twelve endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 170 riparian plant taxa within the RU.*

20.4.4 Wetland RQOs

Wetland RQOs are provided in Table 20.11.

Table 20.11 RU C14: Wetland RQOs

SQ	TEC	Wetland RQO
X22H-00836	**D**	*Maintain TEC and EIS.* *Maintain species composition and vegetative cover.* *No increase in the cover or abundance of woody alien invasive species.* *No increase in wetland fragmentation.* *Cessation of farm dam construction.*

21 IUA X2-9: RESOURCE QUALITY OBJECTIVES

21.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the main stem of the Crocodile River from Nelspruit down to the confluence with the Kaap River, including the Blinkwater River. There are no dams in this IUA. The landscape is undulating flat although the Blinkwater River flows through a mountainous area. Water use in the area consists of irrigation and domestic use. Water is abstracted out of this section of river for supply the Nsikazi South area.

The main stem of the Crocodile River in IUA X2-9 is subject to upstream flow modification all the way to the Kwena Dam, as well as additional abstraction for irrigation as it flows towards the Lowveld. The Blinkwater catchment is reasonably healthy, and most of it is in a B PES, however lower down increased agriculture and alien vegetation push the PES into a C EC.

IUA X2-9 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-9 - CRODODILE FROM NELS TO KAAP INCLUDING BLINKWATER

PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C15	*X22K-01042*	*Mbuzulwane*	B	B	2
	X22K-01043	*Blinkwater*	B	B	
	X22K-01029	*Blinkwater*	C	C	
MRU Croc D	*X22K-01018 EWR C4*	*Crocodile*	C	C	3WQ 3

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

21.2 RQOs FOR RU C15: MODERATE PRIORITY – 2 (X22K-01042, 01043, 01029)

21.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 21.1 RU C15: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X22K-01042										
B	1.19	1.09	0.342	28.6	0.458	38.4	0.005	0.007	0.005	0.01
X22K-01043										
B	5.93	5.37	1.434	24.2	2.069	34.9	0.025	0.027	0.025	0.037
X22K-01029										
C	7.55	6.84	1.435	19	2.054	27.2	0.023	0.028	0.016	0.016

21.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 21.2.

Table 21.2 RU C15: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (C. macowanii and Syzygium pondoense).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 55 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 12 species under PES in the various reaches of this MRU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (BMAR, BTRI, BUNI, CGAR, LCYL, LMOL, MACU, OMOS, PPHI, TREN and TSPA) of 12 species within this MRU. Maintain current habitat diversity and conditions to support the requirements of all these species.*
Primary indicator species: BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable flows to sustain the required flow and depth during especially the wet season for large semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in*

Indicators	Narrative RQO	Numerical RQO
		rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).
Secondary indicators: Flow: LCYL, LMOL Water quality: BVIV, MACU Substrate: LCYL, LMOL Vegetation: PPHI, TSPA Migration: CGAR, LMOL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15cm deep).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

21.3 RQOs FOR MRU CROC D: HIGH PRIORITY - 3 (EWR C4: X22K-01018)

The TECs is provided for EWR C4 below. Note that EWR C4 represents the Crocodile River from the Nels to the Kaap River and will not be impacted by scenarios. Scenarios C3, C62 and C82 were the preferred scenarios for the Crocodile River System (refer to section 1.6.2).

Table 21.3 TECs for EWR C4

Component	PES	REC	Immediately applicable	Sc C3	Sc C62	Sc C82
Physico chemical	C	B	C	C	B	C
Geomorphology	B/C	B	B/C	B/C	B/C	B/C
Fish	B	B	B	B	A	B
Invertebrates	C	B	C	C	A/B	C
Riparian vegetation	C	B	C	C	C	C
EcoStatus	C	B	C	C	B/C	C

21.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 21.4 MRU CROC D: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X22K-01018 (EWR C4)										
C	*824.8*	*537.1*	*74.82*	*9.07*	*263.35*	*31.93*	*0.772*	*1.426*	*2.44*	*4.137*
B/C *(Sc 62)*			*260.4*	*31.57*	*545.9*	*66.19*	*4.205*	*5.179*	*6.806*	*8.196*

21.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Kanyamazane urban and industrial area.*
Water quality issue: *Nutrients, salts, toxics.*
Narrative and Numerical: *Details for MRU Croc D are provided in Tables 21.5 and 21.6. Data used for water quality assessments should be collected from X2H032Q01.*

Table 21.5 MRU CROC D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 0.125 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).*
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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 21.6 EWR C4: Water quality EcoSpecs and TPCs (PES, TEC, Sc C3 and C82: C; Sc C62: B)

River: Crocodile **Monitoring site: X2H032Q01**	**PES: C EC** **Sc 62: B EC**	
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$	*The 95th percentile of the data must be ≤ 38 mg/L.*	*The 95th percentile of the data must be 30 - 38 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 191 mg/L.*	*The 95th percentile of the data must be 45 - 191 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be 280 - 351 mg/L.*
Physical variables		

River: Crocodile		PES: C EC Sc 62: B EC
Monitoring site: X2H032Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Electrical Conductivity	*The 95th percentile of the data must be ≤ 55 mS/m* *The 95th percentile of the data must be ≤ 30 mS/m.*	*The 95th percentile of the data must be 44 - 55 mS/m.* *The 95th percentile of the data must be 24 - 30 mS/m.*
pH	*The 5th percentile of the data must be 5.9 – 6.5, and the 95th percentile 8.0 – 8.8.*	*The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be ≤ 8.2 and ≥ 8.6.*
Temperature$^{(b)}$	*Small deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen$^{(b)}$	*The 5th percentile of the data must be ≥ 7.5 mg/L.*	*The 5th percentile of the data must be 7.8 - 7.5 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.*	*Initiate baseline monitoring for this variable.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 1.0 mg/L.*	*The 50th percentile of the data must be 0.8 - 1.0 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 ≤ 0.025 mg/L.*	*The 50th percentile of the data must be 0.1 - 0.125 mg/L.* *The 50th percentile of the data must be 0.02 - 0.025 mg/L.*
Response variables		
Chl-a phytoplankton$^{(b)}$	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

21.3.3 Habitat and biota RQOs (EcoSpecs)

21.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish of EWR C4 in this MRU was indicated as a B (DWAF, 2010a) and it should be aimed to maintain this EC in future. The indigenous fish species richness of the EWR site is estimated to be twenty species (eight species confirmed during EWR study) while 24 species can be expected under PES within this SQ reach. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU and are valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach include the rheophilic shortspine suckermouth (CPRE) and the semi-rheophilic largescale yellowfish (BMAR). These species are especially good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Fish in this MRU are especially vulnerable to flow modification (reduced or increased flows as a result of flow modification by Kwena Dam, alteration of flood regime) and water quality deterioration (Mbombela and agriculture).*

Numerical: *EcoSpecs and TPCs for EWR C4 are provided in Table 21.7.*

Table 21.7 EWR C4: Fish EcoSpecs and TPCs (PES, TEC, Sc C3 and C82: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI score of 84.2% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially AURA, CPRE OR FRAI[3] scores decreasing below 80% (B/C EC).*	*Deterioration in any habitat components.*
Species richness	*All indigenous spp.*	*Eight of the 20 expected indigenous fish species were sampled during the baseline (EWR) survey. Sampling conditions were not optimal due to high flows and crocodiles, and it can be expected that more species are present at the site. Twenty four species expected in this SQ reach under PES.*	*Less than ten fish species sampled during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance.	*N/A.*	*During the baseline (EWR-PES) surveys fish were sampled at 0.9 ind/min (should be higher during optimal sampling conditions).*	*Relative abundance of less than 1 ind/min sampled at the site (during optimal sampling conditions).*	*N/A.*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys. XHEL sampled in reach previously.*	*Presence of any alien/introduced fish species at site during any survey. Presence of any other alien/introduced fish species at any site during any survey or evident increase in FROC or abundance of XHEL.*	*N/A.*
FD habitats	**CPRE BMAR**	*During the baseline survey CPRE was present at site at relative abundance of 0.13 ind/min electrofishing, while BMAR was present at 0.32 ind/min.*	*CPRE and BMAR absent from site during any survey AND/OR present at relative abundance < 0.1 ind/min for CPRE and < 0.2 ind/min for BMAR.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*
FS habitats	*CPRE BMAR and LCYL if present at site).*			
Substrate	*CPRE and LMOL (LCYL if present).*	*During the baseline survey CPRE was present at site at relative abundance of 0.13 ind/min electrofishing, while LMOL was present at 0.05 ind/min electrofishing.*	*CPRE and LMOL absent from site during any survey AND/OR present at relative abundance < 0.1 ind/min for CPRE and < 0.03 ind/min for LMOL.*	
Flow dependant spp. (flow alteration)	*OPER CPRE*	*OPER and CPRE will be most appropriate indicators of flow at the site. Both species were present during baseline (EWR-PES) survey) with OPER at relative abundance of 0.26 ind/min and CPRE at 0.13*	*OPER and CPRE absent during any survey or with relative abundance < 0.15 ind/min for OPER and < 0.1 ind/min for CPRE.*	
Water quality intolerance				*Decreased water quality (as indicated by PAI, RHAM visual, or water quality*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		ind/min.		*assessments).*
SD habitats	*BMAR LMOL*	*BMAR and LMOL will be most appropriate indicators of SD habitats at the site. Both species should under baseline conditions be present at site 100% of time, with BMAR sampled during baseline survey at relative abundance of 0.32 ind/min, while LMOL were present 0.05 ind/min.*	*BMAR and LMOL absent during any survey or with relative abundance < 0.2 ind/min for BMAR and < 0.03 ind/min for LMOL.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*OPER, BMAR*	*OPER and BMAR are the best indicators of water column habitats and were present during the baseline survey at relative abundance of 0.26 ind/min for OPER and 0.32 ind/min for BMAR.*	*OPER and/or BMAR absent during any survey or present at relative abundance < 0.15 ind/min for OPER and < 0.2 ind/min for BMAR.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*PPHI BMAR*	*PPHI and BMAR will be most appropriate indicators of SS habitats at the site. Both species were present during the baseline survey at relative abundance of 0.08 ind/min for PPHI and 0.32 ind/min for BMAR.*	*PPHI and BMAR absent during any survey or PPHI present at relative abundance < 0.04 ind/min and BMAR at < 0.2 ind/min.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*PPHI BPAU*	*PPHI and BPAU are the best indicators of overhanging vegetation habitats and was present at site during the baseline survey. PPHI was sampled at abundance of 0.08 ind/min, while BPAU occurred at 0.03 ind/min.*	*PPHI and/or BPAU absent during any survey or PPHI present with relative abundance < 0.04 ind/min and BPAU < 0.01 ind/min.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*PPHI*	*PPHI is the best indicators of undercut banks, it was present during baseline surveys at a relative abundance of 0.08ind/min.*	*PPHI absent during any survey or present with relative abundance < 0.04 ind/min.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*BPAU*	*Species with high indicator value for instream vegetation is BPAU. BPAU should be present 100%, sampled during baseline surveys at 0.03 ind/min.*	*BPAU absent during any survey or with relative abundance < 0.01 ind/min.*	*Significant change in instream vegetation habitats (to be quantified by RHAM; DWA, 2009).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while various other species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

21.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro invertebrates at EWR C4 is a Category C for the PES and a REC Category of a B. The macro invertebrate communities at this site should be representative of a taxa assemblage related to the following river type: a larger-sized Lowveld river associated with perennial flows; steep open channel with rocky substrate, lower down flowing through a rocky gorge. The macro invertebrate habitats in the river are dominated by good SIC, but also backwater pools with favourable marginal vegetation overhanging the stream banks. Under Sc C62 the EC improves to an A/B due to improved water quality and macro-invertebrate habitats, especially relating to high nutrient loads and eutrophication. The important SIC habitats will improve as lower amounts of algae will be covering the stones.*

Numerical: *Indicator taxa for EWR C4 are provided in Table 21.8 and EcoSpecs and TPCs in Table 21.9.*

Table 21.8 EWR C4: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
3	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
4	*Coenagrionidae*	*0.3 - 0.6*	*Vegetation*	*Low*

Table 21.9 EWR C4: Macro-invertebrate EcoSpecs and TPCs (PES, TEC, Sc C3 and C82: C; Sc C62: A/B)

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 155; ASPT value: > 5.8.	*SASS5 scores below 160 and ASPT below 5.9.*	*The SASS5 scores and ASPT values will improve.*
Ensure that the MIRAI score remains within the range of a C category (62% – 78%), using the same reference data used in the 2010 study (DWAF, 2010a).	*A MIRAI score of 64% or less.*	*The MIRAI score will improve to an A/B Category (above 87%).*
Maintain suitable flow velocity(maximum > 0.6m/s) and clean, unembedded surface area (cobbles) to support the Perlidae (A abundance) in the VFCS biotope:	*Perlidae missing or present as a single individual in any two consecutive surveys.*	*The following indicator species should be added to the Ecospec: ▪ Philopotamidae. ▪ Tricorythidae.*
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ Heptageniidae: Abundance A. ▪ Elmidae: Abundance A.	*Any one of these taxa missing or present as a single individual for two consecutive surveys.*	*The following indicator species should be added to the Ecospec: ▪ Libellulidae.*
Maintain suitable water quality, shading, temperature and habitat conditions for the following five key taxa: ▪ Perlidae. ▪ > 2 spp. of Hydropsychidae.	*Presence of less than four of the five key taxa listed in any survey.*	*The following indicator species should be added to the Ecospec: ▪ Trichorythidae. ▪ Psephenidae.*

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62
▪ *Elmidae.* ▪ *Heptageniidae.* ▪ *Coenagrionidae.*		

21.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR C4 (as at October 2007) for riparian vegetation was a Category C (64.7%). 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 should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR C4 are provided in Table 21.10. There was moderate confidence in the EcoSpecs and TPCs since only VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 21.10 EWR C4: Riparian vegetation EcoSpecs and TPCs (PES, TEC, Sc C3, C62 and C82: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Phragmites (reed) cover	*Maintain reed cover between 10% and 20%.*	*An increase in reed cover above 80% or a decrease below 40%.*
	VEGRAI data average 40 - 60% cover: used marginal and lower zones only so that VEGRAI data would be applicable (non-woody data predominantly reed). EcoSpec set for a C EC, hence low, but TPC set to maintain current state or improve. The EC would then be better than the PES in terms of reeds only, but should reeds decrease to the EcoSpec level, degradation would be compounding due to currently high cover of aliens which would likely colonise space should reeds decline.	
Non-marginal zone		
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 20% or lower.*	*An increase in perennial alien species cover >30%.*
	VEGRAI data average of 20 - 40% on all zones. Alien invasion is a major impact on the PES at this site.	
Lower zone		
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 10% or lower.*	*An increase in terrestrial woody species cover >10%.*
	More than 10% cover by woody terrestrial species is likely to reduce the EC by one category.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 5 and 60%.*	*A decrease in riparian woody species cover below 5% OR above 60%.*
	VEGRAI data average of 10 - 20%, this is within the lower range due to high alien species cover.	
Phragmites (reed) cover	*Maintain reed cover between 10% and 20% OR between 80% and 90%.*	*An increase in reed cover above 70% or a decrease below 40%.*
	See marginal zone explanation.	
Upper zone		
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 30% or lower.*	*An increase in terrestrial woody species cover >30%.*
	More than 30% cover by woody terrestrial species is likely to reduce the EC by one category.	
Indigenous riparian	*Maintain cover (%) of riparian woody*	*A decrease in riparian woody species*

Assessed Metric	EcoSpec	TPC
woody cover	*species between 20 and 70%.*	*cover below 20% OR above 70%.*
	VEGRAI data average of 20 - 40%, this is within the lower range due to high alien species cover.	
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 30%.*	*A decrease in sedge, grass and dicotyledonous forb cover below 30%.*
	VEGRAI data average 20 - 40% cover: used upper zone only so that VEGRAI data would be applicable (non-woody data predominantly non-reed).	
	Phragmites spp. do not and should not occur at this site, hence colonization by reeds would change the riparian characteristics of the site and reduce the EC.	

22 IUA X2-10: RESOURCE QUALITY OBJECTIVES

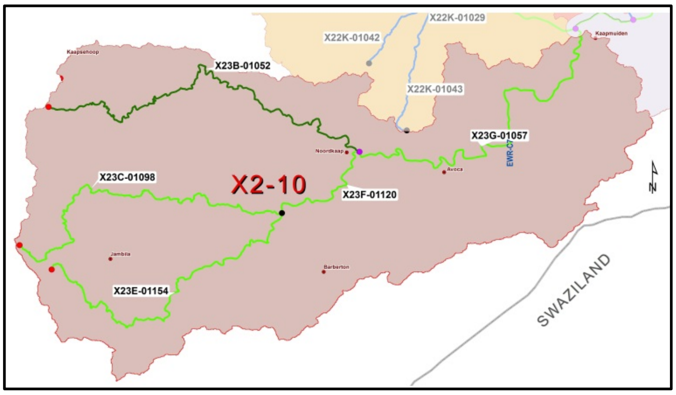
22.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Kaap River catchment, a major tributary of the Crocodile River. There are no major dams in the Kaap River catchment but there are several farm dams present. The Kaap River rises on the escarpment and drops off steeply to a wide valley floor. Landuse in this IUA consists of forestry, grazing and irrigation. Water use in this IUA consists of irrigation and limited gold mining. The water requirements of Barberton are supplied from the Komati catchment.

The upper Kaap system is covered with forestry which is the main influence on the rivers in the upper catchments. In the lower streams (Kaap and Suidkaap) dams increase and the main influences on these lower reaches are abstraction for irrigation with associated return flows that impact on the water quality of these systems.

IUA X2-10 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-10 - KAAP RIVER SYSTEM



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C16	*X23B-01052*	*Noordkaap*	**D**	**C**	**3WQ 2**
RU C17	*X23C-01098*	*Suidkaap*	**C**	**B/C**	**3WQ 2**
	X23E-01154	*Queens*	**C**	**B/C**	
	X23F-01120	*Suidkaap*	**C**	**C**	
MRU Kaap A	*X23G-01057 EWR C7*	*Kaap*	**C**	**C**	**3WQ 3**

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

22.2 RQOs FOR RU C16: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X23B-01052)

X23B-01052 requires improvement to achieve the TEC. Improvement of riparian zone integrity (forestry and agriculture) is needed to achieve the REC as well as improvement in water quality from mining. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario.

22.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 22.1 RU C16: Flow RQOs

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X23B-01052										
C[1]	*50.91*	*33.51*	*13.68*	*26.9*	*17.503*	*34.4*	*0.212*	*0.246*	*0.253*	*0.396*

1 The EWR rule is provided for a D as the improvements to a C are based on non flow-related measures.

22.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Irrigation returns flows.*
Water quality issue: *Elevated nutrients and salts, turbidity.*

Narrative and numerical details for RU C16 are provided in Table 22.2.

Table 22.2 RU C16: 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 0.025 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 (Aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*

22.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 22.3.

Table 22.3 RU C16: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (trees and shrubs) with some areas dominated by grasses.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Seven endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*

Indicators	Narrative RQO	Numerical RQO
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii, Ilex mitis var. mitis and Syzygium pondoense).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 80 riparian plant taxa within the RU.*

22.3 RQOs FOR RU C17: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X23C-01098, X23E-01154, X23F-01120)

X23C-01098 and X23E-01154 requires improvement to achieve the TEC. Improvement of riparian zone integrity (forestry and agriculture) is needed to achieve the REC in both these SQs. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario.

22.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 22.4 RU C17: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X23C-01098										
B/C[1]	*61.75*	*37.75*	*20.115*	*32.6*	*24.401*	*39.5*	*0.025*	*0.027*	*0.025*	*0.037*
X23E-01154										
B/C[1]	*39.54*	*25.02*	*9.249*	*23.4*	*12.949*	*32.7*	*0.121*	*0.146*	*0.169*	*0.22*
X23F-01120										
C	*109.79*	*57.07*	*26.513*	*24.1*	*34.035*	*31*	*0.321*	*0.482*	*0.698*	*0.979*

1 The EWR rule is provided for a C as the improvements to a B/C are based on non flow-related measures.

22.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Agriculture, gold mines, Barberton WWTW, timber processing.*
Water quality issue: *Elevated nutrients and salts, toxics (As, Cn).*

Narrative and numerical details for RU C17 are provided in Table 22.5.

Table 22.5 RU C17: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.075 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 (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	*95^{th} percentile of the data must be within the TWQR for*

Narrative RQO	Numerical RQO
categories or TWQR.	*toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that As levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).*
Ensure that (free) Cn levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*

22.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 22.6.

Table 22.6 RU C17: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (trees and shrubs) and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 50% of existing perennial aliens within the riparian zone should be removed.*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*N/A.*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture should not expand or intensify towards or within the riparian zone.*	*To improve forestry encroachment into or within the riparian zone should be reduced by 25%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (C. macowanii and Syzygium pondoense).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 55 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 23 species under PES in the various reaches of this RU. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (CPRE/BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (AMAR, AMOS, AURA, BEUT, BARG, BMAR, BTRI, BUNI, BVIV, CGAR, CPAR, CPRE, CSWI, LCYL, LMOL, MACU, MBRE, OMOS, OPER, PPHI, TREN, TSPA and VNEL) of 23 species within various reaches of this RU. Maintain current habitat diversity and conditions to support the requirements of all these species.*
Primary indicator species: CPRE and BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable flows (all seasons) to sustain the rheophilic species and adequate flow and depth during wet season for large semi-rheophilic species. Floods and catchment management should be adequate to*

Indicators	Narrative RQO	Numerical RQO
		prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).
Secondary indicators: Flow: AURA, BEUT, BARG, OPER, VNEL, CSWI Water quality: BEUT, BARG, OPER Substrate: AURA, BARG, LMOL, CSWI Vegetation: PPHI, TSPA Migration: AMOS, AMAR, BMAR		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Pyralidae	*MV habitat and water quality should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

22.3.4 Wetland RQOs

Wetland RQOs are provided in Table 22.7.

Table 22.7 RU C17: Wetland RQOs

SQ	TEC	Wetland RQO
X23E-01154	**C**	*Maintain the TEC.* *Cessation of forestry encroachment on seeps.*

22.4 RQOs FOR MRU KAAP A: HIGH PRIORITY - 3 (EWR C7: X23G-01057)

The TECs is provided for EWR C7 below. Note that EWR C7 represents the Kaap River System and will not be impacted by scenarios. Scenarios C3, C62 and C82 were the preferred scenarios for the Crocodile River System (refer to section 1.6.2).

Table 22.8 TECs for EWR C7

Component	PES	REC	Immediately applicable
Physico chemical	B	B	B
Geomorphology	B	B	B
Fish	C	B	C
Invertebrates	B	B	B
Riparian vegetation	C/D	B/C	C/D
EcoStatus	C	B	C

22.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 22.9 MRU Kaap A: Flow RQOs

REC (EWR)	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X23G-01057 (EWR C7)										
C	*179.5*	*88.9*	*11.09*	*6.18*	*34.52*	*19.23*	*0.069*	*0.144*	*0.349*	*0.559*

22.4.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Some irrigation; Lily & Barbrooke Goldmines.*
Water quality issue: *Elevated nutrients, salts and toxics (As, Cn).*
Narrative and Numerical: *Details for MRU Kaap A are provided in Tables 22.10 and 22.11, with the EcoSpecs and TPCs outlined in Table 22.11 for EWR C7. Data used for water quality assessments should be collected from X2H022Q01.*

Table 22.10 MRU Kaap A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data may be at 0.125 mg/L PO_4-P (aquatic ecosystems: driver).* *The 50th percentile of the data must be ≤ 4.0 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 200 mS/m (Aquatic ecosystems: driver).* *Note this is a naturally salinised system.*
Ensure that toxics are within Ideal limits or A categories.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that As levels are within Ideal limits or A	*95th percentile of the data must be less than 0.020*

Narrative RQO	Numerical RQO
categories.	*mg/L As (aquatic ecosystems: driver).*
Ensure that (free) Cn levels are within Ideal limits or A categories.	*95th percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 22.11 EWR C7: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Kaap		**PES: B EC**
Monitoring site: X2H022Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts		
Data not available.		
Physical variables		
Electrical Conductivity$^{(a)}$	*The 95th percentile of the data must be ≤ 100 mS/m.*	*The 95th percentile of the data must be 90 - 100 mS/m.*
pH	*The 5th percentile of the data must range from 6.5 to 8.0, and the 95th percentile from 8.0 to 8.8.*	*The 5th percentile of the data must be < 6.7 and > 7.8, and the 95th percentile must be < 8.2 and > 8.6.*
Temperature$^{(b)}$	*Small deviation from the natural temperature range.*	*Vary by more than 2°C, i.e. a large change to the temperature regime occurs often. Most moderately temperature sensitive species would be in lower abundances and frequency of occurrence than expected for reference. Biological assessments therefore recommended and initiate baseline monitoring for this variable.*
Dissolved oxygen$^{(b)}$	*The 5th percentile of the data must be ≥ 8 mg/L.*	*The 5th percentile of the data must be 6.2 - 6 mg/L. Biological assessments recommended and initiate baseline monitoring for this variable.*
Turbidity$^{(b)}$	*Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.*	*Initiate baseline monitoring for this variable.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50th percentile of the data must be ≤ 1.0 mg/L.*	*The 50th percentile of the data must be 0.2 - 0.25 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 0.02 - 0.025 mg/L.*
Response variables		
Chl-a phytoplankton$^{(c)}$	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 µg/L.*
Chl-a periphyton$^{(c)}$	*The 50th percentile of the data must be ≤ 52.5 mg/m^2.*	*The 50th percentile of the data must be 42 - 52 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) The system seems naturally saline (PES: 90.8 mS/m; RC: 70.15 mS/m (data record: 1977 = 1981)), so the upper boundary of the relevant category has been adjusted from ≤ 85 mS/m to ≤ 100 mS/m.

(b) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

(c) Periphyton (31.42 mg/m^2) is actually in a C/D category (C = 12 - 21 and D = 21 - 84 mg/m^2, DWAF 2008b), so have defined the upper boundary of a C/D as the EcoSpec for PES.

22.4.3 Habitat and biota RQOs (EcoSpecs)

22.4.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish of the EWR C7 in this MRU was indicated as a C (DWAF, 2010a) and it should be aimed to maintain this EC in future. The indigenous fish species richness of EWR C7 is estimated to be seventeen species (twelve species confirmed during the EWR study) while 28 species can be expected under PES within this SQ reach. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU. These species provide valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach include the rheophilic shortspine suckermouth (CPRE) and orangefin barb (BEUT) as well as the semi-rheophilic largescale yellowfish (BMAR). These species are especially good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Fish in this MRU are especially vulnerable to flow modification (reduced or increased flows as a result of flow modification, alteration of flood regime) and water quality deterioration (agricultural and mining activities).*

Numerical: *EcoSpecs and TPCs for EWR C7 are provided in Table 22.12.*

Table 22.12 EWR C7: Fish EcoSpecs and TPCs (PES and TEC: C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All indigenous spp.*	*Baseline FRAI[3] score of 76.8% (Category C) calculated for EWR reach (DWA, 2010a).*	*Any decreased FROC[2] especially CPRE, BEUT, BMAR, OPER OR FRAI scores decreasing below 70%.*	*Deterioration in any habitat components.*
Species richness	*All indigenous spp.*	*Twelve of an expected 17 indigenous fish species were sampled during the baseline (EWR) survey at the EWR site while an estimated 28 species may occur in the SQ reach under the PES.*	*Less than eight fish species sampled at EWR site during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance.	*N/A.*	*During recent baseline survey fish were sampled at 2.6 ind/min.*	*Relative abundance of less than 1.8 ind/min sampled at the site (during same season as baseline data).*	*N/A.*
Alien fish species	*Any alien/intro-duced spp.*	*No alien/introduced fish species sampled at site during recent baseline survey.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*
FD habitats *FS habitats* *Flow dependant spp. (flow alteration)*	**BEUT CPRE**	*During the recent baseline survey BEUT was present at relative abundance of 0.13 ind/min and CPRE at relative abundance of 0.75 ind/min.*	*BEUT and CPRE absent from the site during any survey OR present at relative abundance < 0.09 for BEUT and < 0.5 for CPRE.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*
Substrate	**BMAR** *CPRE*	*During recent baseline survey BMAR was present at a relative abundance of 1.27 ind/min and CPRE at relative abundance of 0.75 ind/min.*	*BMAR and CPRE absent from a site during any survey and/or present at relative abundance < 1 ind/min for BMAR and < 0.5 for CPRE.*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Water quality intolerance	*BEUT CPRE*	*BEUT and CPRE will be most appropriate indicators of water quality at the site. Both species should under present conditions be present at site 100% of the time. During the recent baseline survey BEUT was present at relative abundance of 0.13 ind/min and CPRE at 0.75 ind/min.*	*BEUT and CPRE absent during any survey or BEUT with relative abundance < 0.09 ind/min and CPRE < 0.5 ind/min.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*BUNI BMAR*	*BUNI and BMAR will be most appropriate indicators of SD habitats at the site. During the recent baseline survey BUNI was present at a relative abundance of 0.1 ind/min and BMAR at 1.27 ind/min.*	*BMAR absent during any survey or with relative abundance < 1 ind/min and or BUNI present less than 50% of time (absent for 2 consecutive surveys) or present with relative abundance of < 0.06 ind/min.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*BMAR, MACU*	*BMAR and MACU are the best indicators of water column habitats at the site. During the recent baseline survey BMAR was present at a relative abundance of 1.27 ind/min and MACU at 0.05 ind/min.*	*BMAR absent during any survey or present at relative abundance < 1 ind/min, and MACU resent less than 50% of time (absent for 2 consecutive surveys) or with relative abundance of < 0.02 ind/min.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*BUNI, BMAR*	*BUNI and BMAR are the species with the highest indicator value for SS. BUNI was present during the recent baseline survey at a relative abundance of 0.1 ind/min., while BMAR was present at 1.27 ind/min.*	*BUNI present less than 50% of time (absent for 2 consecutive surveys) or with relative abundance of < 0.06 ind/min AND/OR MAR absent during any survey or present at relative abundance < 1 ind/min.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BUNI, BEUT*	*BUNI and BEUT are the species with the highest indicator value for overhanging vegetation at the site. BUNI was present during the recent baseline survey at a relative abundance of 0.1 ind/min, and BEUT at 0.13 ind/min.*	*BUNI and BEUT present less than 50% of time (absent for 2 consecutive surveys) or BUNI with relative abundance of < 0.06 ind/min and BEUT with relative abundance of < 0.09 ind/min.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*BEUT*	*BEUT will be the most appropriate indicator of undercut banks at site EWR C7 and should be present 100%. It was sampled during baseline survey at 0.13 ind/min.*	*BEUT present less than 50% of time (absent for 2 consecutive surveys) with relative abundance of < 0.09 ind/min.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while various other species can be described as potamodromous species*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		in terms of their migratory requirements, requiring movement between river reaches.		*flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

22.4.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR C7 is a Category B for the PES and the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized lowveld river associated with perennial flows; a moderately steep channel with rocky substrate and extensive riverine vegetation covering both the in-stream (emerging macrophytes) and riparian habitats. The macro-invertebrate habitats in the river are dominated by good SIC, with favourable marginal vegetation overhanging the stream banks and islands, and also emerging from the shallower aquatic habitats.*

Numerical: *Indicator taxa for EWR C7 are provided in Table 22.13 and EcoSpecs and TPCs in Table 22.14.*

Table 22.13 EWR C7: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Psephenidae, Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Table 22.14 EWR C7: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 185; ASPT value: > 5.7.	*SASS5 scores below 190 and ASPT below 5.8.*
Ensure that the MIRAI score remains within the range of a B category (82% - 88%), using the same reference data used in the 2010 study (DWAF, 2010a).	*A MIRAI score of 84% or less.*
Maintain suitable flow velocity(maximum > 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the VFCS biotope: ▪ Perlidae: Abundance A. ▪ Psephenidae: Abundance A. ▪ Philopotamidae: Abundance A.	*Any one of these taxa missing or present as a single individual in any two consecutive surveys.*
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ Heptageniidae: Abundance A. ▪ Elmidae: Abundance A.	*Any one of these taxa missing or present as a single individual in two consecutive surveys.*
Maintain suitable water quality, shading, temperature and habitat conditions for the following five key taxa: ▪ Perlidae. ▪ Psephenidae. ▪ Philopotamidae. ▪ Elmidae. ▪ Heptageniidae.	*Presence of less than four of the five key taxa listed in any survey.*

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

22.4.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR C7 (as at October 2007) for riparian vegetation was a Category C/D (59.7%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity shall not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR C7 are provided in Table 22.15. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 22.15 EWR C7: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C/D)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 30% (in summer).*	*A decrease in sedge, grass and dicotyledonous forb cover below 30%.*
	RHAM data average of 30% on the marginal zone.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species below 70%, but always present.*	*An increase in riparian woody species cover above 70% OR below 1%.*
	RHAM data average of 20% cover, VEGRAI average around 10%.	
Phragmites (reed) cover	*Maintain reed cover above 10%.*	*A decrease in reed cover below 10%.*
	RHAM data average 90% cover.	
	VEGRAI data average of 20 - 40% on all zones. Alien invasion is a major impact on the PES at this site.	
Lower zone		
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 15% or lower.*	*An increase in terrestrial woody species cover >10%.*
	RHAM data show an average of 6% cover by terrestrial woody species.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 5 and 60%.*	*A decrease in riparian woody species cover below 5% OR above 60%.*
	RHAM average of 4% cover, VEGRAI observed <10%.	
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 30% (in summer).*	*A decrease in sedge, grass and dicotyledonous forb cover below 30%.*
	RHAM data average of 23% on the lower zone.	
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 30% or lower.*	*An increase in perennial alien species cover >30%.*
	RHAM data show 43% average in the riparian zone; VEGRAI data recorded 40 - 60% on the lower zone.	
Phragmites (reed) cover	*Maintain reed cover between 10% and 90%.*	*An increase in reed cover above 90% or a decrease below 10%.*
	RHAM average 10% cover.	
Upper zone		
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 30% or lower.*	*An increase in perennial alien species cover >30%.*
	RHAM data show 43% average in the riparian zone; VEGRAI data recorded 60 -	

Assessed Metric	EcoSpec	TPC
	80% on the upper zone.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 20 and 70%.*	*A decrease in riparian woody species cover below 20% OR above 70%.*
	VEGRAI data observed range between 10 - 20%.	
Phragmites (reed) cover	*Maintain reed cover below 50%.*	*An increase in reed cover above 50%.*

23 IUA X2-11: RESOURCE QUALITY OBJECTIVES

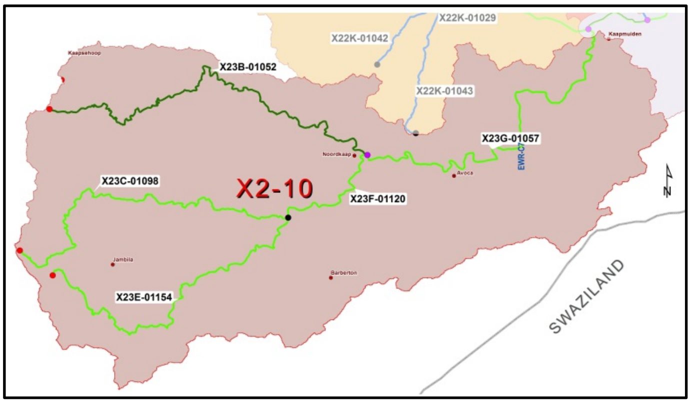
23.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Crocodile River from the confluence with the Kaap River down to the confluence with the Komati River. There are few off-channel farm dams in this IUA as well as a small dam, Van Graan se Dam, on the main stem of the river. The landscape in this IUA is very flat and landuse consists of extensive irrigation, grazing and game farming. The water use in this IUA consists of irrigation and limited domestic use from towns such as Malelane, Hectorspruit and Komatipoort.

The entire main stem of the lower Crocodile River is utilised intensively, especially for irrigation. Although most of the northern river banks are situated in the KNP, the southern bank is intensively developed. Flow modification due to abstraction for irrigation and the resultant return flows; have major impacts on water quantity and quality. These factors are exacerbated by many non-flow factors and the outcome of this pressure on the river result in a PES of a mostly a C.

IUA X2-11 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-11 - CROCODILE: KAAP TO KOMATI



PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
MRU Croc D	*X24C-01033**	*Crocodile*	C/D	C/D	3WQ 3b
MRU Croc E	*X24H-00880[#]*	*Crocodile*			3WQ 3
	X24H-00934 EWR C6	*Crocodile*	C	C	
	X24D-00994 EWR C5	*Crocodile*	C	C	
	X24E-00982[#]*	*Crocodile*			
	X24F-00953[#]*	*Crocodile*			

** This SQ forms part of EWR C6, which is situated in IUA X2-10, MRU Croc E. Please refer to Section 23.3 for further details.*

 # Where SQ does not have a EC the EC is different from the EWR site. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this RU.

The RQOs are provided below for a ***Water Resource Class II*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

The SQ falling within MRU Croc D has a 3 Priority Rating for water quality. While water quality RQOs are provided in the following section for MRU Croc D, the flow and biotic requirements are represented by EWR C6, which is situated in MRU Croc E. Please refer to Section 23.3 for further detail on flow as well as habitat and biotic RQOs respectively.

23.2 RQOs FOR MRU CROC D: HIGH PRIORITY - 3 (X24C-01033)

23.2.1 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. Results of the water quality assessment for*

EWR C5 conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a) were considered.

Model: *N/A.*

Users: *Irrigation return flows (right bank) and extensive settlements (left bank).*

Water quality issue: *Nutrients, salts, turbidity.*

Narrative and numerical details for MRU CROC C are provided in Table 23.1.

Table 23.1 MRU CROC D: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 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 85 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 turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*

23.3 RQOs FOR MRU CROC E: HIGH PRIORITY - 3 (EWR C5: X24D-00994; EWR C6: X24H-00934; INCLUDING X24H-00880, X24E-00982, X24F-00953)

The TECs is provided for EWR C5 and EWR C6 below. Note that EWR C5 and EWR C6 represent the Crocodile River from the Kaap River to the Komati River and will be impacted by scenarios. Scenarios C3, C62 and C82 were the preferred scenarios for the Crocodile River System (refer to section 1.6.2).

Table 23.2 TECs for EWR C5 and EWR C6

Component	PES	REC	Immediately applicable	Sc C3	Sc C62	Sc C82
EWR C5						
Physico chemical	C	B	C	C	C	B/C
Geomorphology	C/D	C	C/D	C/D	C/D	C/D
Fish	C	B	C	C	C	B/C
Invertebrates	C	B	C	C	C	B
Riparian vegetation	C	B	C	C	C	B/C
EcoStatus	C	B	C	C	C	B/C
EWR C6						
Physico chemical	C	B	C	C	C	C
Geomorphology	C	C	C	C	C	C
Fish	C	B	C	C/D	C/D	C/D
Invertebrates	C	B	C	C	C	C
Riparian vegetation	C	B	C	B	B	B
EcoStatus	C	B	C	C	C	C

23.3.1 Flow RQOs

Source: *EWR C5 and EWR C6: DWA (2014).*
Model: *EWR C5 and EWR C6: RDRM (Hughes et al., 2013).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 23.3 MRU CROC E: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X24D-00994 (EWR C5)										
C	*1117.4*	*654.3*	*122.08*	*10.93*	*267.72*	*23.96*	*1.616*	*2.047*	*2.7*	*4.408*
B/C *(Sc 82)*			*315.0*	*28.19*	*650.1*	*58.18*	*5.64*	*6.089*	*9.190*	*7.878*
X24H-00934 (EWR C6)										
C	*1165.6*	*570.3*	*239.6*	*20.55*	*654*	*56.11*	*2.3*	*2.5*	*4.4*	*7*
C *(Sc 3, 62, 82)*			*222.1*	*19.05*	*584.6*	*50.14*	*2.557*	*2.659*	*4.029*	*5.685*

23.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Urban (Malelane, Marloth Park, Komatipoort) impacts impacting on water quality, including sugar mill and fruit processing. Critical Risk WWTWs at Malelane, Hectorspruit and Komatipoort, and a High Risk WWTW at Mhlatikop. Note that this reach extends to the Mozambican border, so a more detailed list of objectives is provided (as required by the 2002 IncoMaputo agreement).*
Water quality issue: *Nutrients, salts, toxics, temperature (sugar mill impact); international obligations.*
Narrative and Numerical: *Details for MRU Croc E are provided in Tables 23.4, 23.5 (EWR C5) and 23.6 (EWR C6). Data used for water quality assessments should be collected from X2H017Q01 for EWR C5 and X2H016Q01 for EWR C6.*

Table 23.4 MRU CROC E: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 0.075 mg/L PO_4-P (aquatic ecosystems: driver, EWR C6).*
Ensure that electrical conductivity (salt) levels are within Acceptable limits.	*95th percentile of the data must be less than or equal to 70 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity.*
Ensure that temperatures stay within Acceptable limits.	*A moderate change to instream temperatures should occur infrequently, i.e. vary by no more than 2ºC. Highly temperature sensitive species will occur in lower abundances (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 the CEV limits.	*95th percentile of the data must be within the CEV for toxics or the B category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF*

Narrative RQO	Numerical RQO
	(2008b) (aquatic ecosystems: driver, EWR C6).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 23.5 EWR C5: Water quality EcoSpecs and TPCs (PES, TEC and Sc C3: C; Sc C62 and C82: B/C)

River: Crocodile		**PES and TEC: C EC**
Monitoring site: X2H017Q01		**Sc C62, C82: B/C**
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$[(b)]	*The 95th percentile of the data must be ≤ 45 mg/L.* *The 95th percentile of the data must be ≤ 37 mg/L.*	*The 95th percentile of the data must be 40 - 45 mg/L.* *The 95th percentile of the data must be 30 - 37 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 351 mg/L.*
Physical variables		
Electrical Conductivity[(c)]	*The 95th percentile of the data must be ≤ 70 mS/m.* *The 95th percentile of the data must be ≤ 55 mS/m.*	*The 95th percentile of the data must be 55 - 70 mS/m.* *The 95th percentile of the data must be 45 - 55 mS/m.*
pH	*The 5th percentile of the data must be 5.9 - 6.5, and the 95th percentile 8.0 - 8.8.*	*The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be < 8.2 and > 8.6.*
Temperature[(d)]	*Moderate deviation from the natural temperature range. Most highly temperature sensitive species in lower abundances and frequency of occurrence than expected for reference.*	*Vary by more than 2°C, i.e. a large change to the temperature regime occurs often. Most moderately temperature sensitive species would be in lower abundances and frequency of occurrence than expected for reference. Biological assessments therefore recommended and initiate baseline monitoring for this variable.*
Dissolved oxygen[(d)]	*The 5th percentile of the data must be ≥ 7 mg/L.*	*The 5th percentile of the data must be 7.2 - 7 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(d)]	*Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.*	*Initiate baseline monitoring for this variable.*
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 0.55 - 0.7 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 ≤ 0.025 mg/L PO_4-P*	*The 50th percentile of the data must be 0.06 - 0.075 mg/L.* *The 50th percentile of the data must be 0.02 - 0.025 mg/L.*
Response variables		

River: Crocodile		PES and TEC: C EC Sc C62, C82: B/C
Monitoring site: X2H017Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Chl-a phytoplankton[(d)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the upper limit of the A category boundary as stated in DWAF (2008b).*

(d) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(e) $MgSO_4$ concentration was 52 mg/L, i.e. an F category. The minimum category accepted would be a D category of 37 – 45 mg/L.
(f) EcoSpec for the PES generated. Although the PES value was 57.75 mS/m, boundaries for the relevant category are 55.1 – ≤ 85 mg/L. As the upper boundary was considered too high to maintain the present state for salts, a lower boundary was used.
(g) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.

Table 23.6 EWR C6: Water quality EcoSpecs and TPCs (PES, TEC and Sc C3: C; Sc C61 and C81: B)

River: Crocodile		PES and TEC: C EC Sc C62, C82: B
Monitoring site: X2H016Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Inorganic salts[(a)]		
$MgSO_4$[(b)]	*The 95th percentile of the data must be ≤ 45 mg/L.* *The 95th percentile of the data must be ≤ 37 mg/L.*	*The 95th percentile of the data must be 40 - 45 mg/L.* *The 95th percentile of the data must be 30 - 37 mg/L.*
Na_2SO_4	*The 95th percentile of the data must be ≤ 20 mg/L.*	*The 95th percentile of the data must be 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 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 46 - 57 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 351 mg/L.*
Physical variables		
Electrical Conductivity[(c)]	*The 95th percentile of the data must be ≤ 85 mS/m.* *The 95th percentile of the data must be ≤ 70 mS/m.*	*The 95th percentile of the data must be 70 - 85 mS/m.* *The 95th percentile of the data must be 55 - 70 mS/m.*
pH	*The 5th percentile of the data must be 5.9 - 6.5, and the 95th percentile 8.0 - 8.8.*	*The 5th percentile of the data must be < 6.1 and > 6.3, and the 95th percentile must be < 8.2 and > 8.6.*
Temperature[(d]	*Small to moderate deviation from the natural temperature range. Some highly temperature sensitive species in lower abundances and frequency of occurrence than expected for reference.*	*Vary by more than 2°C, i.e. a large change to the temperature regime occurs often. Most moderately temperature sensitive species would be in lower abundances and frequency of occurrence than expected for reference. Biological assessments therefore recommended and initiate baseline monitoring for this variable.*

River: Crocodile Monitoring site: X2H016Q01		PES and TEC: C EC Sc C62, C82: B
Water quality metrics	**EcoSpecs**	**TPC**
Dissolved oxygen(d	*The 5th percentile of the data must be ≥ 7 mg/L.*	*The 5th percentile of the data must be 7.2 - 7 mg/L. Initiate baseline monitoring for this variable.*
Turbidity(d	*Vary by a small amount from the natural turbidity range; minor silting of instream habitats acceptable.*	*Initiate baseline monitoring for this variable.*
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 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 ≤ 0.075 mg/L.*	*The 50th percentile of the data must be 0.1 - 0.125 mg/L.* *The 50th percentile of the data must be 0.06 - 0.075 mg/L.*
Response variables		
Chl-a phytoplankton(d)	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the CEV as stated in DWAF (1996c).(e)*	*An impact is expected if the 95th percentile of the data exceeds the CEV as stated in DWAF (1996c).*

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity is exceeded or salt pollution expected.
(b) $MgSO_4$ concentration was 52 mg/L, i.e. an F category. The minimum category accepted would be a D category of 37 - 45 mg/L.
(c) EcoSpec for the PES generated. Although the PES value was 57.75 mS/m, boundaries for the relevant category are 55.1 - ≤ 85 mg/L. As the upper boundary was considered too high to maintain the present state for salts, a lower boundary was used.
(d) No data were available for this assessment. All EcoSpecs and TPCs need verification as based on expert judgement.
(e) Although category boundaries exist in the Water quality Reserve manual (DWAF, 2008b) for a number of toxicants (e.g. Cd, found at this site), adherence to the CEV (DWAF, 1996a) is recommended for the present state. Data collection and testing will need to be undertaken to assess the suitable of these objectives.

23.3.3 Habitat and biota RQOs (EcoSpecs)

23.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish at EWR C5 and C6 in this MRU was indicated as a C (DWAF, 2010a). It is estimated that the ecological status of the fish at EWR C6 may deteriorate slightly to a C/D under the recommended flow scenario (Sc C3). No further deterioration should be allowed. The fish species richness of the reach should be maintained under this scenario but reduced FROC (distribution within a reach) is expected for some species (primarily related to decreased wet season flows and deterioration in geomorphology and water quality). A very high indigenous fish species richness of approximately 35 species is expected in this MRU. Various fish species that are intolerant to alteration or with a high preference for specific habitat features are present in this MRU and these species provide valuable indicators that should be used to monitor potential change. The primary indicator fish species for this reach include the rheophilic shortspine suckermouth (CPRE) and large semi-rheophilic largescale yellowfish (BMAR). These species are especially good indicators of flow modification (fast flowing habitats), rocky substrate condition and flow related water quality. Fish in this MRU are especially vulnerable to flow modification (reduced or increased flows as a result of flow modification, alteration of flood regime) and water quality deterioration (agricultural and urban development).*

Numerical: *EcoSpecs and TPCs for EWR C5 and C6 are provided in Table 23.7 and Table 23.8 respectively.*

Table 23.7 EWR C5: Fish EcoSpecs and TPCs (PES, TEC and Sc C3: C; Sc C62 and C82: B/C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc C62 and C82
Ecological status (PES)	*All indigenous spp.*	*Baseline FRAI[3] score of 66.1% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially CPAR, CPRE, BMAR, OPER, MMAC and PCAT OR FRAI scores decreasing below 63% (low C EC).*	*Deterioration in any habitat components.*	*A slight improvement is expected towards a category B/C.*
Species richness	*All indigenous spp.*	*Eight of an expected 35 indigenous fish species were sampled during the baseline (EWR) survey at the EWR site.*	*Less than ten fish species sampled using electrofishing during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*	*No change in species richness, although improvement in FROC of most species expected.*
Relative abundance.	*N/A.*		*Relative abundance of less than 1.5 ind/min sampled at the site (during optimal sampling conditions).*	*N/A.*	*Improvement in relkative abundance of most species expected.*
Alien fish species	*Any alien/intro-duced spp.*	*One alien fish species (CCAR) sampled at site during baseline (EWR) survey at relative abundance of 0.02 ind/min electrofishing.*	*Presence of more than 1 (CCAR) alien/introduced fish species at site during any survey, AND/OR an increase in relative abundance of CCAR becoming > 0.02 ind/min electrofishing.*	*N/A.*	*No notable change expected.*
FD habitats	*CPAR* **BMAR**	*During the baseline survey CPAR was not sampled, but it is expected to be present at site. BMAR was present during baseline EWR survey at relative abundance of 0.93 ind/min electrofishing.*	*CPAR present less than 50% of time (not sampled for more than 2 consecutive surveys) and BMAR absent during any survey AND/OR decrease in relative abundance below 0.5 ind/min for BMAR.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*	*A slight increase in abundance and FROC expected due to improved flows and water quality.*
FS habitats	*CPAR LCYL*	*During the baseline survey CPAR and LCYL were not sampled, but it is expected to be present at site.*	*CPAR and LCYL present less than 50% of time (not sampled for more than 2 consecutive surveys).*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on (to be quantified by RHAM; DWA, 2009b).*	*A slight increase in abundance and FROC expected due to improved flows and water quality.*
Substrate					

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc C62 and C82
Flow dependant spp. (flow alteration).	*OPER CPRE*	*During the baseline survey CPRE was not sampled, but it is expected to be present at site. OPER was present during baseline EWR survey at relative abundance of 0.03 ind/min electrofishing.*	*CPRE & OPER present less than 33% of time (not sampled for more than 3 consecutive surveys) AND/OR OPER present at relative abundance below 0.02 ind/min.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*	*A slight increase in abundance and FROC expected due to improved flows and water quality.*
Water quality intolerance					
SD habitats	*OMOS BMAR*	*OMOS and BMAR will be most appropriate indicators of SD habitats at the site. Both species were sampled during baseline survey, OMOS being present at 0.28 ind/min electrofishing, and BMAR at 0.93 ind/min electrofishing.*	*OMOS and BMAR absent during any survey AND/OR OMOS present at relative abundance < 0.15 ind/min and < 0.5 ind/min for BMAR.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*	*A slight increase in abundance and FROC of especially BMAR expected due to improved flows and water quality.*
Water column	*BMAR MBRE*	*During the baseline survey MBRE was not sampled, but it is expected to be present at site. BMAR was present during baseline EWR survey at relative abundance of 0.93 ind/min electrofishing.*	*MBRE present less than 50% of time (not sampled for more than 2 consecutive surveys) and BMAR absent during any survey AND/OR decrease in relative abundance below 0.5 ind/min for BMAR.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*	*A slight increase in abundance and FROC expected due to improved flows (BMAR) and water quality (MBRE).*
SS habitats	*BVIV BRAD*	*During the baseline survey BRAD was not sampled, but it is expected to be present at site. BVIV was present during baseline EWR survey at relative abundance of 0.4 ind/min electrofishing.*	*BRAD present less than 50% of time (not sampled for more than 2 consecutive surveys) and BVIV absent during any survey AND/OR decrease in relative abundance below 0.3 ind/min for BVIV.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*	*Improved flow regime and vegetative cover should improve conditions for these species.*
Overhanging vegetation	*BVIV BTRI*	*During the baseline survey BTRI was not sampled, but it is expected to be present at site. BVIV was present during baseline EWR survey at relative abundance of 0.4 ind/min electrofishing.*	*BTRI present less than 75% of time and BVIV absent during any survey AND/OR decrease in relative abundance below 0.3 ind/min for BVIV.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*	*Improved flow regime and vegetative cover should improve conditions for these species.*
Undercut banks	*MMAC PCAT*	*During the baseline survey MMAC and PCAT were not sampled, but it is expected to*	*MMAC and PCAT present less than 33% of time (not sampled for more than 3 consecutive surveys).*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*	*Improved flow regime will enhace undercut bank habitats and result in an*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc C62 and C82
		be present (at low abundance) at site.			*increased abundance and FROC of these species.*
Instream vegetation	*TREN BVIV*	*During the baseline survey TREN was not sampled, but it is expected to be present at site. BVIV was present during baseline EWR survey at relative abundance of 0.4 ind/min electrofishing.*	*TREN and BVIV absent during any survey AND/OR decrease in relative abundance below 0.3 ind/min for BVIV.*	*Significant change in instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*	*Improved flow regime and vegetative cover should improve conditions for these species.*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while various other species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	*No notable change in migratyory success expected (non-flow related impacts, barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

Table 23.8 EWR C6: Fish EcoSpecs and TPCs (PES: C; TEC and Sc C3: C/D; Sc C61 and C81: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C62 and C82
Ecological status	*All indigenous spp.*	*Baseline FRAI[3] score of 67.3% (C PES) calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially CPAR, LCON, BMAR, OR FRAI scores decreasing below 63% (low C EC).*	*Deterioration in any habitat components.*	*A slight deterioration into a category C/D expected.*	*An improvement towards a category B expected.*
Species richness	*All indigenous spp.*	*Four of the 34 expected indigenous fish species were sampled during the baseline (EWR) survey. Sampling conditions were not optimal due to high flows and crocodiles, and it can be expected that more species (approx. 21) should be present at the*	*Less than ten fish species sampled using electrofishing during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*	*No change in species richness expected, possible decrease in abundance and FROC of intolerant species may occur.*	*No change in species richness expected, possible increase in abundance and FROC of intolerant species may occur.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C62 and C82
		site.				
Relative abundance.	*N/A.*	*During previous surveys (not baseline EWR survey) conducted under optimal sampling conditions, fish were sampled at > 10 ind/min.*	*Relative abundance of less than 7 ind/min sampled at the site (during optimal sampling conditions).*		*Slight decrease in relative abundance expected (especially intolerant species).*	*Slight increase in relative abundance expected (especially intolerant species).*
Alien fish species	*Any alien/intro-duced spp.*	*No alien species previously sampled at site. Previous observations of HMOL in lower section of Reach.*	*Presence of any alien fish species during any survey or increased FROC and abundance of HMOL in reach.*	*N/A.*	*No notable change expected.*	*No notable change expected.*
FD Habitats	**CPAR BMAR** *(LCON)*	*CPAR and BMAR should always be present at the site under baseline conditions (based on available data for site: CPAR sampled 67% of time and BMAR 100% of time).*	*CPAR present less than 50% of time (not sampled for more than two consecutive surveys) and BMAR absent during any survey.*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*	*Decreased habitat suitability (decxreased wet season flows, substrate quality and water quality) may result in a decrease in abundance and FROC of these spp.*	*A slight increase in abundance and FROC may be expected.*
FS habitats	*CPAR LCYL (LCON)*	*CPAR and LCYL should always be present at the site under baseline conditions (based on available data for site: CPAR and LCYL sampled 67% of time).*	*CPAR and LCYL present less than 50% of time (not sampled for more than two consecutive surveys).*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*	*Habitat suitability (decreased wet season flows, substrate quality and water quality) may result in a decrease in abundance and FROC of these spp.*	*A slight increase in abundance and FROC may be expected.*
Substrate				*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*		
Flow dependant spp. (flow alteration)	*LMOL BMAR (LCON)*	*LMOL and BMAR should always be present at the site under baseline conditions (based on available data for site:*	*LMOL and BMAR absent during any survey.*		*Slight decrease in abundance and FROC expected.*	*Slight increase in abundance and FROC expected due to improved flows in wet season.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C62 and C82
		LMOL sampled 33% of time and BMAR 100% of time).				
Water quality intolerance	*LMOL CPAR*	*LMOL and CPAR should always be present at the site under baseline conditions (based on available data for site: LMOL sampled 33% of time and CPAR 67% of time).*	*LMOL and CPAR absent during any survey.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*	*Slight decrease in abundance and FROC expected due to water quality deterioration.*	*Slight increase in abundance and FROC expected due to improved water quality.*
SD habitats	*TREN OMOS (LCON)*	*TREN and OMOS should always be present at the site under baseline conditions (based on available data for site: TREN sampled 100% of time and OMOS 67% of time).*	*TREN and OMOS absent during any survey.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*	*Very slight deterioration in abundance and FROC may occur.*	*Slight deterioration in abundance and FROC may occur.*
Water column	*HVIT BIMB*	*HVIT and BIMB should be present at the site in deep pools (based on available data for site both species sampled 33% of time).*	*HVIT and BIMB present less than 33% of time (not sampled for more than two consecutive surveys).*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*	*Slight deterioration in abundance and fROC expected.*	*Slight improvement in these species abundance and FROC expected.*
SS habitats	*BVIV GGIU*	*BVIV and GGIU should always be present at the site under baseline conditions (based on available data for site: BVIV sampled 67% of time and GGIU 33% of time).*	*BVIV present < 100% of time and GGIU present less than 50% of time (not sampled for more than two consecutive surveys).*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*	*Potential slight decrease in abundance/FROC expected.*	*Potential slight increase in abundance/FROC expected.*
Overhanging vegetation	*BVIV TREN*	*BVIV and TREN should always be present at the site under baseline conditions (based on available data for site: BVIV sampled 67% of*	*BVIV and TREN absent during any survey.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*	*Potential slight decrease in abundance/FROC expected.*	*Potential slight increase in abundance/FROC expected.*
Instream	*BVIV*			*Significant change in*		

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in EcoSpecs under Sc C3	Estimated change in EcoSpecs under Sc C62 and C82
vegetation	*TREN*	*time and TREN 100% of time).*		*instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*		
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while various other species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	*No notable change in migratyory success expected (non-flow related impacts, barriers).*	*No notable change in migratyory success expected (non-flow related impacts, barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

23.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR C5 and C6 is a Category C for the PES and a Category B for the REC while TECs for both these sites are the same as the PES. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a large, wide Lowveld river associated with perennial flows; a large slow-flowing river with a sandy substrate (alluvial), and a band of tall riparian trees and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools with favourable marginal vegetation overhanging the stream banks and islands. Patches of SIC occur below in-stream controls, these controls can be extensive bedrock areas in the lower Crocodile River.*

Numerical: *Indicator taxa for EWR C5 and EWR C6 are provided in Table 23.9 and Table 23.11 respectively while EcoSpecs and TPCs for EWR C5 are provided in Table 23.10 and in Table 23.12 for EWR C6.*

Table 23.9 EWR C5: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Libellulidae*	*0.3 - 0.6*	*Cobbles*	*Low*
2	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
3	*Atyidae*	*N/A.*	*Vegetation*	*Moderate*
4	*Coenagrionidae*	*0.3 - 0.6*	*Vegetation*	*Low*

Table 23.10 EWR C5: Macro-invertebrate EcoSpecs and TPCs (PES, TEC and Sc C3: C; Sc Sc C62 and C82: B)

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62 and C82
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 110; ASPT value: > 5.	*SASS5 scores below 120 and ASPT below 5.1.*	*The SASS5 scores and ASPT values will improve.*
Ensure that the MIRAI score remains within the range of a C category (62% - 78%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 64% or less.*	*The MIRAI score will improve to a B Category (above 78%).*
Maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ Libellulidae: Abundance A. ▪ Elmidae: Abundance A.	*Any one of these taxa missing in two consecutive surveys.*	*The following indicator species should be added to the Ecospec: ▪ Leptophlebidae. ▪ Hydropsychidae.*
Maintain sufficient quantity and quality of inundated vegetation to support the following vegetation dwelling taxa: ▪ Atyidae. ▪ Coenagrionidae.	*Any one of these taxa missing in two consecutive surveys.*	*The following indicator species should be added to the Ecospec: ▪ Pyralidae.*
To maintain suitable water quality, shading, temperature and habitat conditions for the following five key taxa: ▪ Trichorythidae. ▪ Elmidae.	*Presence of less than four of the five key taxa listed in any survey.*	*The following indicator species should be added to the Ecospec: ▪ Trichorythidae. The absence of any of the five key taxa listed in any survey.*

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62 and C82
▪ *Libellulidae.* ▪ *Atyidae.* ▪ *Coenagrionidae.*		
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 >500 for two consecutive surveys.*	*To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.*

Table 23.11 EWR C6: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Trichorythidae*	*> 0.6*	*Cobbles*	*Moderate*
2	*Libellulidae*	*0.3 - 0.6*	*Cobbles*	*Low*
3	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
4	*Coenagrionidae*	*0.3 - 0.6*	*Vegetation*	*Low*

Table 23.12 EWR C6: Macro-invertebrate EcoSpecs and TPCs (PES, TEC and Sc C3: C; Sc C62 and C82: B)

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62 and C82
Ensure that the SASS5 scores and ASPT values occur in the following range: *SASS5 score: > 120; ASPT value: > 4.8.*	*SASS5 scores below 125 and ASPT below 4.8.*	*The SASS5 scores and ASPT values will improve.*
Ensure that the MIRAI score remains within the range of a C category (62% – 78%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 64% or less.*	*The MIRAI score will improve to a B Category (above 78%).*
Maintain suitable flow velocity(maximum > 0.6 m/s) and clean, unembedded surface area (cobbles) to support the Trichorythidae in the VFCS (Very fast flow over coarse sediment) biotope:	*Trichorythidae missing in any two consecutive surveys.*	*The following indicator species should be added to the EcoSpec:* ▪ *Leptophlebidae.* ▪ *Hydropsychidae.*
To maintain suitable flow velocity (0.3 - 0.6 m/s) and clean, unembedded surface area (cobbles) to support the following flow-dependent taxa in the FFCS biotope: ▪ *Libellulidae: Abundance A.* ▪ *Elmidae: Abundance A.*	*Any one of these taxa missing in two consecutive surveys.*	*The following indicator species should be added to the EcoSpec:* ▪ *Heptagenidae.*
To maintain sufficient quantity and quality of inundated vegetation to support the Coenagrionidae.	*Coenagrionidae missing in two consecutive surveys.*	*The following indicator species should be added to the EcoSpec:* ▪ *Atyidae.*
To maintain suitable water quality, shading, temperature and habitat conditions for the following four key taxa: ▪ *Trichorythidae.* ▪ *Elmidae.* ▪ *Libellulidae.* ▪ *Coenagrionidae.*	*Presence of less than three of the six key taxa listed in any survey.*	*The following indicator species should be added to the EcoSpec:* ▪ *Heptagenidae.* ▪ *Leptophlebidae.* ▪ *Hydropsychidae.*

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc C62 and C82
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 >500 for two consecutive surveys.*	*To ensure that no group consistently dominates the fauna, defined as D abundance (>1000) over more than two consecutive surveys.*

23.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR C5 and C6 (as at October 2007) for riparian vegetation was a Category C (76.3%) and (76.6%) respectively. Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR C5 and EWR C6 are provided in Table 23.13 and Table 23.14 respectively. There was medium confidence in the EcoSpecs and TPCs since only VEGRAI (DWA, 2010a) data were available for EWR 5 while VEGRAI and some RHAM data was available for EWR C6 resulting in higher confidence.*

Table 23.13 EWR C5: Riparian vegetation EcoSpecs and TPCs (PES, TEC, Sc C3 and C62: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 40% (in summer).*	*A decrease in sedge, grass and dicotyledonous forb cover below 30%.*
	VEGRAI data average 40 - 60% cover.	
Phragmites (reed) cover	*Maintain reed cover above 10%.*	*A decrease in reed cover below 10%.*
	VEGRAI data average of 20 - 40% on all zones. Alien invasion is a major impact on the PES at this site.	
Lower zone		
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 10% or lower.*	*An increase in terrestrial woody species cover >10%.*
	More than 10% cover by woody terrestrial species likely to reduce the EC to a lower category.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 5 and 60%.*	*A decrease in riparian woody species cover below 5% OR above 60%.*
	VEGRAI data average of <10%, this is within the lower range due to high exotic species cover.	
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 10% or lower.*	*An increase in perennial alien species cover >50%.*
	VEGRAI data average of 20 - 40% in the marginal zone, but comprised of annuals. Alien invasion low in lower and upper zones (<10%).	
Phragmites (reed) cover	*Maintain reed cover between 10% and 90%.*	*An increase in reed cover above 90% or a decrease below 10%.*
	VEGRAI data show value around 20%.	
Upper zone		
Alien invasion (perennial alien	*Maintain cover (%) of perennial alien species at 10% or lower.*	*An increase in perennial alien species cover >50%.*

Assessed Metric	EcoSpec	TPC
species)	*VEGRAI data average of 20 - 40% in the marginal zone, but comprised of annuals. Alien invasion low in lower and upper zones (<10%).*	
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 30% or lower.*	*An increase in terrestrial woody species cover >30%.*
	More than 30% cover by woody terrestrial species likely to reduce the EC to a lower category.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 20 and 70%.*	*A decrease in riparian woody species cover below 20% OR above 70%.*
	VEGRAI data average of 10 - 20%, this is within the lower range due to high exotic species cover.	
Phragmites (reed) cover	*Maintain reed cover below 50%.*	*An increase in reed cover above 50%.*
	VEGRAI data show value around 30%.	

Table 23.14 EWR C6: Riparian vegetation EcoSpecs and TPCs (PES: C; TEC, Sc C3, C62 and C82: B)

Assessed Metric	EcoSpec	TPC
Marginal zone (PES – C)		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 30% (in summer).*	*A decrease in sedge, grass and dicotyledonous forb cover below 30%.*
	RHAM data showed an average cover of 16% overall, and 49% on the marginal zone.	
Phragmites (reed) cover	*Maintain reed cover above 10%.*	*A decrease in reed cover below 10%.*
	RHAM data showed an average cover of 20% overall, and 13% on the marginal zone.	
Marginal zone (Target – B)		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover above 40% (in summer).*	*A decrease in sedge, grass and dicotyledonous forb cover below 40%.*
	RHAM data showed an average cover of 16% overall, and 49% on the marginal zone.	
Phragmites (reed) cover	*Maintain reed cover above 20%.*	*A decrease in reed cover below 20%.*
	RHAM data showed an average cover of 20% overall, and 13% on the marginal zone.	
Lower zone (PES – C)		
Phragmites (reed) cover	*Maintain reed cover between 10% and 90%.*	*An increase in reed cover above 90% or a decrease below 10%.*
	RHAM data showed an average cover of 20% overall, and 20% on the lower zone.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 5 and 60%.*	*A decrease in riparian woody species cover below 5% OR above 60%.*
	VEGRAI data showed cover of 10 - 20% and RHAM data showed cover at 0%. Expected to be naturally low and patchy, but with higher species richness than the marginal zone (Nuxia oppositifolio, Flugea virosa, Acacia robusta, Breonadia salicina, and Ficus caprefolia).	
Lower zone (Target – B)		
Phragmites (reed) cover	*Maintain reed cover between 20% and 80%.*	*An increase in reed cover above 80% or a decrease below 20%.*
	RHAM data showed an average cover of 20% overall, and 20% on the lower zone.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 10 and 50%.*	*A decrease in riparian woody species cover below 10% OR above 50%.*
	VEGRAI data showed cover of 10 - 20% and RHAM data showed cover at 0%. Expected to be naturally low and patchy, but with higher species richness than	

Assessed Metric	EcoSpec	TPC
	the marginal zone (Nuxia oppositifolio, Flugea virosa, Acacia robusta, Breonadia salicina, and Ficus caprefolia).	
Riparian zone (PES – C)		
Alien invasion (perennial alien species)	*Maintain the absence of perennial alien species.*	*An increase in perennial alien species cover >10%.*
	Currently alien species cover <10% of the riparian zone, all species are however non-perennial. No perennial alien species were observed. Both RHAM and VEGRAI data support observation (high confidence).	
Riparian zone (Target – B)		
Alien invasion (perennial alien species)	*Maintain the absence of perennial alien species.*	*An increase in perennial alien species cover >5%.*
	Currently alien species cover <10% of the riparian zone, all species are however non-perennial. No perennial alien species were observed. Both RHAM and VEGRAI data support observation (high confidence).	
Upper zone (PES – C)		
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 10% or lower.*	*An increase in perennial alien species cover >10%.*
	VEGRAI data average of 20 - 40% in the marginal zone, but comprised of annuals. Alien invasion low in lower and upper zones (<10%).	
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 30% or lower.*	*An increase in terrestrial woody species cover >30%.*
	More than 30% cover by woody terrestrial species likely to reduce the EC to a lower category.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 20 and 70%.*	*A decrease in riparian woody species cover below 20% OR above 70%.*
	VEGRAI data average of 10 - 20%, this is within the lower range due to high alien species cover.	
Phragmites (reed) cover	*Maintain reed cover below 50%.*	*An increase in reed cover above 50%.*
	No data available.	
Upper zone (Target – B)		
Alien invasion (perennial alien species)	*Maintain cover (%) of perennial alien species at 5% or lower.*	*An increase in perennial alien species cover >5%.*
	VEGRAI data average of 20 - 40% in the marginal zone, but comprised of annuals. Alien invasion low in lower and upper zones (<10%).	
Terrestrialisation	*Maintain cover (%) of terrestrial woody species at 15% or lower.*	*An increase in terrestrial woody species cover >15%.*
	More than 30% cover by woody terrestrial species likely to reduce the EC to a lower category.	
Indigenous riparian woody cover	*Maintain cover (%) of riparian woody species between 30 and 60%.*	*A decrease in riparian woody species cover below 30% OR above 60%.*
	VEGRAI data average of 10 - 20%, this is within the lower range due to high alien species cover.	
Phragmites (reed) cover	*Maintain reed cover below 40%.*	*An increase in reed cover above 40%.*
	No data available.	

24 IUA X2-12 AND 13: RESOURCE QUALITY OBJECTIVES

24.1 IUA OVERVIEW AND DESCRIPTION

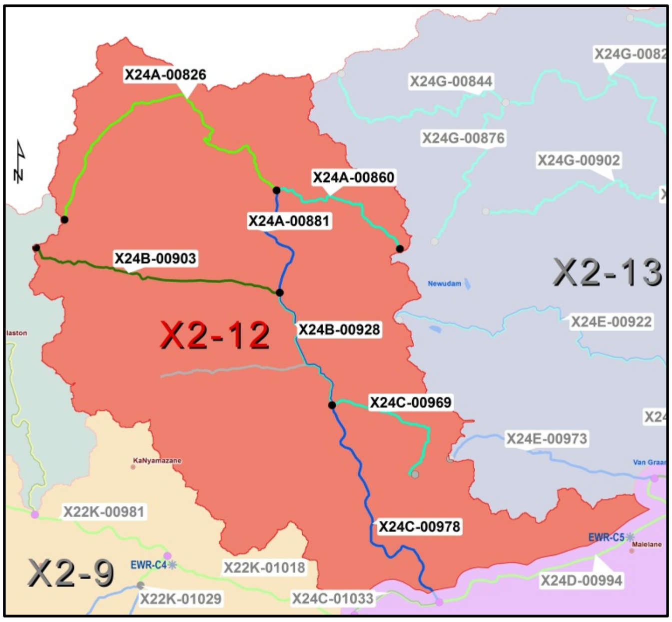
IUA X2-12 consists of the Nsikasi River catchment, a tributary of the Crocodile River. There are no significant dams in this IUA although there are few small farm dams. The landscape is undulating and landuse consist mostly of wilderness area (within the KNP) but in the west there are sprawling rural villages and more formal housing developments. There remainder of the area is used for grazing. Water use in the area is for domestic purposes but this is supplied mostly from the Crocodile River. There is limited supply from run-of-river out of the Nsikasi River and also from groundwater.

Most of the Nsikazi catchment is situated in the wilderness area of the KNP, with very little impacts apart from firebreak roads, resulting in a PES between A and B. The B PES results from the moderate influence in the form of upstream flow modifications (small dams). The two streams originating from the west outside of the Park borders (Nsikazi origin and Gutshwa) are mostly influenced by non-flow rural impacts such as agricultural fields, vegetation removal, overgrazing and trampling.

IUA X2-13 is made up of the rivers within the KNP and are natural or near natural.

IUA X2-12 and 2-13 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X2-12 – NSIKASI RIVER

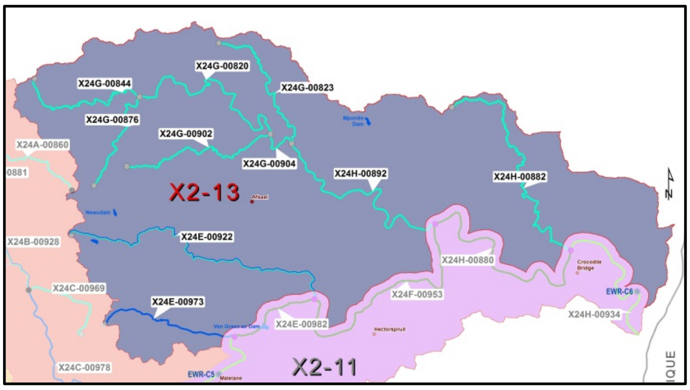


PRIORITY RATINGS

RUs	SQ number	River	PES	TEC	PR
RU C18	*X24A-00826*	*Nsikazi*	C	C	2
RU C19	*X24B-00903*	*Gutshwa*	D	D	3WQ

*The RQOs are provided below for a **Water Resource Class II** for IUA X2-12 and **Water Resource Class I** for IUA X2-13 (DWS, 2014a) and the catchment configuration as illustrated above.*

IUA X2-13 – NORTHERN TRIBUTARIES OF THE CROCODILE RIVER IN THE KNP



PRIORITY RATINGS

RUs	SQ number	River	PES	REC	PR
RU C20	*X24A-00860*	*Sithungwane*	A	A	1a & 1b
	X24A-00881	*Nsikazi*	B	B	
	X24B-00928	*Nsikazi*	A/B	A/B	
	X24C-00969	*Mnyeleni*	A	A	
	X24C-00978	*Nsikazi*	B	B	
	X24E-00973	*Matjulu*	B	B	
	X24E-00922	*Mlambeni*	A/B	A/B	
	X24G-00902	*Mitomeni*	A	A	
	X24G-00876	*Komapiti*	A	A	
	X24G-00844	*Mbyamiti*	A	A	
	X24G-00823	*Muhlambamadubo*	A	A	
	X24G-00820	*Mbyamiti*	A	A	
	X24G-00904	*Mbyamiti*	A	A	
	X24H-00882	*Vurhami*	A	A	
	X24H-00892	*Mbyamiti*	A	A	

24.2 RQOs FOR RU C18: MODERATE PRIORITY – 2 (X24A-00826)

24.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 24.1 RU C18: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X24A-00826										
C	*1.97*	*1.91*	*0.476*	*24.1*	*0.67*	*33.9*	*0.004*	*0.009*	*0.004*	*0.011*

24.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *WWTW.*
Water quality issue: *Elevated nutrients and salts.*

Narrative and numerical details for RU C18 are provided in Table 24.2.

Table 24.2 RU C18: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 0.125 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).*
Meet faecal coliform and E.coli targets for	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF,*

Narrative RQO	Numerical RQO
recreational (full contact) use.	*1996a).*

24.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 24.3.

Table 24.3 RU C18: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (trees and shrubs) and grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Five endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (Ilex mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 120 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be nine species under PES in the various reaches of this MRU. Flows should be adequate to ensure suitable habitats for indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish.*	*Maintain indigenous species richness (BMAR, BPAU, BTRI, BUNI, BVIV, CGAR, OMOS, PPHI and TREN) of nine species within this RU. Maintain current habitat diversity and conditions to support the requirements of all these species.*
Primary indicator species: BMAR (flow and flow related water quality, substrate, migration)		*Maintain suitable flows (all seasons) to sustain the rheophilic species and adequate flow and depth during wet season for large semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be maintained to facilitate migration (especially wet season).*
Secondary indicators: *Water quality: BTRI, BVIV* *Vegetation: OMOS, PPHI, TREN* *Migration: CGAR*		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish*

Indicators	Narrative RQO	Numerical RQO
		movement.
MACRO-INVERTEBRATES		
Libellulidae	*Flows should be adequate to ensure suitable habitats for this moderate flow dependant taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

24.3 RQOS FOR RU C19: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X24B-00903)

24.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 24.4 RU C19: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	70%	90%	70%
X24B-00903										
D	*25.41*	*24.8*	*4.113*	*16.2*	*6.206*	*24.4*	*0.05*	*0.09*	*0.116*	*0.136*

24.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. Results of the water quality assessment for EWR C5 conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a) were considered.*
Model: *N/A.*
Users: *Extensive urban and rural impacts from the Kabokweni and Malekutu towns.*
Water quality issue: *Nutrients, salts, turbidity, toxics.*

Narrative and numerical details for RU C19 are provided in Table 24.5.

Table 24.5 RU C19: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 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).*
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.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems:*

Narrative RQO	Numerical RQO
	driver).

24.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 24.6.

Table 24.6 RU C19: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (trees and shrubs) and grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Four endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*One listed riparian species should remain within the RU (Ilex mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 65 riparian plant taxa within the RU.*

24.4 RQOS FOR RU C20: LOW PRIORITY – 1B

24.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 24.7 RU C20: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X24A-00881										
B	*11.68*	*11.32*	*3.44*	*29.5*	*4.747*	*40.6*	*0.027*	*0.056*	*0.034*	*0.077*
X24B-00928										
A/B	*42.39*	*41.38*	*13.459*	*31.8*	*18.647*	*44*	*0.236*	*0.351*	*0.261*	*0.319*
X24C-00978										
B	*52.25*	*41.97*	*16.062*	*30.7*	*21.15*	*40.5*	*0.05*	*0.194*	*0.318*	*0.401*

25 IUA X3-1 (AND PART OF IUA X3-2): RESOURCE QUALITY OBJECTIVES

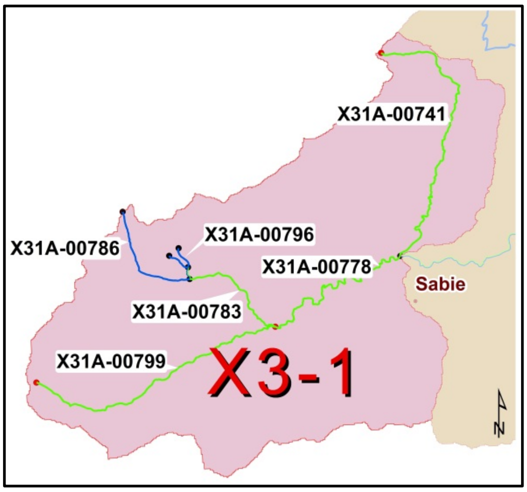
25.1 IUA OVERVIEW AND DESCRIPTION

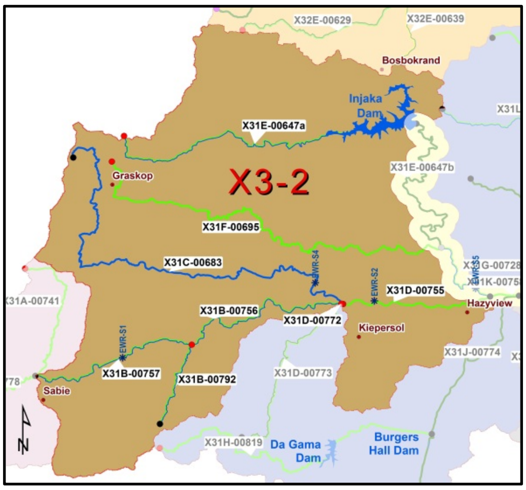
This IUA consists of the headwaters of the Sabie River down to the confluence with the Klein Sabie River. There are no significant dams in the IUA. The Sabie River rises on the escarpment and drops off steeply through mountainous terrain as it flows through this IUA. Landuse in this IUA is mostly forestry with some wilderness areas and urban areas. Water use in the IUA is limited to the urban use of Sabie. There is very little irrigation in this area.

The rivers in this zone (X31A) range between slightly modified (B to B/C PES) to moderately modified (C PES) for the Sabie main stem and Klein Sabie. The primary impact in this zone is non-flow related associated with forestry, while some water quality deterioration is also evident in the lower Sabie reach due to urban runoff and sawmill industries. A number of farm smallholdings were noted as are tourism/recreational features (lodges). The upper part of the Sabie River in IUA X3-2 has Sabie town located on the headwaters and then extends through a mosaic of plantation forestry and natural vegetation.

IUA X3-1 and X3-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-1 - SABIE HEADWATERS AND TRIBS AND SABIE RIVER IN IUA X3-2





PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU S2	*X31A-00741*	*Klein Sabie*	C	B/C	2
MRU Sabie A	*X31A-00778**	*Sabie*			3
	*X31A-00799**	*Sabie*			
	*X31B-00756**	*Sabie*			
	X31B-00757 EWR S1	*Sabie*	B/C	B	
	X31D-00755 EWR S2	*Sabie*	C	B	
	X31D-00772[#]	*Sabie*			
RU S1	*X31A-00783*		C	C	2
	X31A-00786		B	B	
	X31A-00794		B	B	
	X31A-00796		B	B	
	X31A-00803		B/C	B/C	

** Where SQ does not have a EC the EC is different from the EWR S1. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this RU.*
 # As above but applies to EWR S2.

The RQOs are provided below for a ***Water Resource Class I*** *for IUA X3-1 and X3-2 (DWS, 2014a) and the catchment configuration as illustrated above.*

25.2 RQOs FOR RU S2: MODERATE PRIORITY - 2 (X23A-00741)

X32A-00741 situated in RU S2 requires improvement to achieve the TEC. The actions required are mostly non flow-related and include:

- *Significant improvement of the riparian zone (in forestry area).*
- *Reduced sediment (erosion control in forestry area).*
- *Improved water quality in lower reaches (Sabie formal and informal settlements).*

These improvements are seen to be difficult to implement with regards to the settlements, but the forestry practices can be improved. As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

25.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 25.1 RU S1: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31A-00741										
B/C[1]	14.62	11.79	2.469	16.9	3.777	25.8	0.046	0.05	0.046	0.083

1 The EWR rule is provided for a C as the improvements to a B/C are based on non flow-related measures.

25.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Some impacts from Sabie town in the lower reaches.*
Water quality issue: *Nutrients.*

Narrative and numerical details for RU C1 are provided in Table 25.2.

Table 25.2 RU S1: 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 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*

25.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 25.3.

Table 25.3 RU S1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (forest/high density savanna) and non-woody (grassland).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain large or decrease.*	*To improve to B/C 50% of existing perennial aliens within the riparian zone should be removed (this includes plantation species used in forestry) .*
Riparian zone continuity	*Riparian zone continuity should remain largely modified, or improve*	*To improve to B/C encroachment of forestry within and into the riparian zone should be reduced by 40%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Five endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa; I. mitis var. mitis)*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 60 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be seven species under the PES. Flows should be adequate to ensure suitable habitats for primary (flow dependant) indicator species (CANO/VNEL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (AMOS, BANO[1], BBRI, CANO, PPHI, TSPA and VNEL) of seven species within this RU and prevent further spread or increase in diversity and abundance of predatory alien species (especially OMYK). Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: CANO/VNEL (flow and flow related water quality, substrate condition, migration)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicators: Flow: BARG Water quality: BBRI, BARG Substrate: AMOS Vegetation: BBRI, PPHI, TSPA Migration: AMOS		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction of the FROC of these species in the reaches. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*

Indicators	Narrative RQO	Numerical RQO
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

25.3 RQOs FOR MRU SABIE A: HIGH PRIORITY – 3 (EWR S1: X31B-00757 AND EWR S2: X31D-00755; INCLUDING X31A-00778, 00799, X31B-00756, 00772)

The TECs is provided for EWR S1 and EWR S2 below. Note that these sites represent the Sabie River in IUA X3-1 and IUA X3-2. Scenario S6 was proposed as the preferred scenario and represents the case where a balance is achieved between the need to supply growing water requirements for socio-economic activities while still providing protection of the ecology (refer to section 1.6.3). The scenario only impacts on EWR S3 (Sabie River) and EWR S5 (Marite River). At all the other EWR sites, the status quo is therefore maintained (DWS, 2014a).

According to DWS (2014) various nodes in the Sabie River System require improvements based on non flow-related/anthropogenic issues which have to be addressed. Where it is deemed that the REC is attainable, it has been included in the Sc S6 configuration.

EWR S1 requires improvement to achieve the TEC. The actions required are mostly non flow-related and include:

- *Picnic site must be closed and rehabilitated and alien vegetation species removed.*
- *Reduced sediment (erosion control in forestry area).*
- *Improved water quality in lower reaches (Sabie formal and informal settlements).*

EWR S2 requires improvement to achieve the TEC. The actions required are mostly non flow-related and include:

- *Removal of alien vegetation species and cease moving in the riparian zone.*
- *Reduced recreational disturbance.*
- *Improved nutrient status.*

As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

Table 25.4 TECs for EWR S1 and EWR S2

EWR S1		
Component	**PES**	**REC and Immediately applicable**
Physico chemical	A/B	A/B
Geomorphology	B	B
Fish	B/C	B
Invertebrates	B	A/B
Riparian vegetation	B/C	B
EcoStatus	B/C	B

EWR S2		
Component	**PES**	**REC and Immediately applicable**
Physico chemical	B	B
Geomorphology	B	B
Fish	B/C	B
Invertebrates	B/C	B
Riparian vegetation	C	B
EcoStatus	C	B

25.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 25.5 MRU SABIE A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X31B-00757 (EWR S1)											
B/C	B[1]	132	102.8	17	12.88	70.32	53.27	0.204	0.383	0.432	0.889
X31D-00755 (EWR S2)											
C	B[1]	261.7	176.7	29.16	11.14	94.58	36.14	0.373	0.576	0.765	1.391

1 The EWR rule is provided for a B/C and a C as the improvements to a B are based on non flow-related measures.

25.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Urban impacts from Sabie town and upper reaches of Hazyview, including Hazyview WWTW as well as extensive irrigation.*
Water quality issue: *Nutrients, salts, toxics.*
Narrative and Numerical: *Details for MRU Sabie A are provided in Tables 25.6, 25.7 (EWR S1) and 25.8 (EWR S2). Data used for water quality assessments should be collected from X3H001Q01 for EWR S1 and X3H006Q01 for EWR S2.*

Table 25.6 MRU SABIE A: 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 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 (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).*

Narrative RQO	Numerical RQO
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

** Note that this improvement in nutrients is required to support the improvement required for fish and invertebrate improvement. Improvement is not necessarily required for the overall water quality category.*

Table 25.7 EWR S1: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: Sabie		**PES: A/B EC**
Monitoring site: X3H001Q01		
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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature(b)	*No deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen(b)	*The 5th percentile of the data must be ≥ 8.0 mg/L.*	*The 5th percentile of the data must be 8.2 - 8 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.*	*Initiate baseline monitoring for this variable.*
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 0.55 - 0.7 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 0.02 - 0.025 mg/L.*
Response variables		
Chl-a phytoplankton(b)	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF*

River: Sabie Monitoring site: X3H001Q01		PES: A/B EC
Water quality metrics	**EcoSpecs**	**TPC**
		(2008b).

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

Table 25.8 EWR S2: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Sabie Monitoring site: X3H006Q01		PES: B 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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 118 mg/L (A/B category).*	*The 95th percentile of the data must be 95 - 118 mg/L.*
$CaSO_4$	*The 95th percentile of the data must be ≤ 351 mg/L.*	*The 95th percentile of the data must be 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be <6.7 and >7.8.*
Temperature[(b)]	*No deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7.5 mg/L.*	*The 5th percentile of the data must be 7.8 - 7.5 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.*	*Initiate baseline monitoring for this variable.*
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 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 ≤ 0.015 mg/L.*	*The 50th percentile of the data must be 0.02 - 0.025 mg/L.* *The 50th percentile of the data must be 0.012 - 0.015 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 52.5 mg/m^2 [(c)].*	*The 50th percentile of the data must be 42 - 52 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A Category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF*

River: Sabie Monitoring site: X3H006Q01	PES: B EC	
Water quality metrics	**EcoSpecs**	**TPC**
		(2008b).

(a) To be generated using Tool for TEACHA (if available) when the TPC for Electrical Conductivity 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.

(c) Periphyton (32.97 mg/m^2) is actually in a C/D Category (C = 12 - 21 and D = 21 - 84 mg/m^2, DWAF; 2008b), so have defined the upper boundary of a C/D as the EcoSpec for the REC.

25.3.3 Habitat and biota RQOs (EcoSpecs)

25.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based on fish for both EWR sites within this MRU was indicated as a B/C (DWAF, 2010a) and it should be aimed to maintain this EC in future. The indigenous fish species richness ranged from moderate (eight species) in the upper reaches (EWR S1) to low with five species in the lower reaches (EWR S2). Improvement in non-flow related impacts may result in slight overall improvement in the fish assemblage (reduced sedimentation of rocky substrate, improved indigenous vegetative habitats). Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this unit include the pennant-tail suckermouth (CANO) and Inkomati chiselmouth (VNEL). Both these species are rheophilics and are good indicators of flow modification (fast flowing habitats), rocky substrate condition and water quality. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU are especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for EWR S1 and EWR S2 are provided in Table 25.9 and 25.30 respectively.*

Table 25.9 EWR S1: Fish EcoSpecs and TPCs (PES: B; TEC: B/C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI[3] score of 78.3% (B/C) calculated for reach (DWA, 2010a).*	*FRAI scores decreasing below 75% (high C) OR any decreased FROC2 in reach of especially AURA, CANO and VNEL.*	*Any deterioration in habitat that results in decrease in FROC of species.*
Species richness	*All indigenous spp.*	*Three of an expected seven naturally occurring indigenous fish species were sampled baseline (EWR) surveys. Eight species expected in this SQ reach under the PES.*	*Less than 3 naturally occurring indigenous fish species sampled during a survey when habitat can be sampled efficiently at EWR site.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During the baseline (EWR) surveys fish were sampled at 2.8 ind/min.*	*Relative abundance of less than 1.5 ind/min sampled at the site (during optimal sampling conditions).*	*N/A.*
Alien fish species.	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
FD Habitats	*VNEL CANO*	*During the baseline survey VNEL was present at site at relative abundance of 2 ind/min electrofishing, while CANO was present at 0.76 ind/min.*	*VNEL and CANO absent from site during any survey OR present at relative abundance < 1 ind/min for VNEL and < 0.4 ind/min for CANO.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*
FS habitats				
Substrate				
Flow dependant spp. (flow alteration)	*CANO VNEL (AURA and BBRI if sampled in future at site)*			
Water quality intolerance				
SD habitats	*AMOS (BANO, BBRI).*	*AMOS only SD indicator sampled at EWR site during baseline survey, present at relative abundance of 0.01 ind/min electrofishing.*	*AMOS only SD indicator sampled at site and not a reliable indicator species as they are generally coincidentally sampled (TPCs for BANO and BBRI can be defined in future if they are sampled at site).*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
SS habitats	*BANO BBRI TSPA*	*BANO, BBRI and TSPA only SS and overhanging vegetation indicator species expected at site. None of these species were present during baseline (EWR) survey.*	*TPCs for BANO, BBRI and TSPA can be defined in future if they are sampled at the EWR site.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009).*
Overhanging vegetation				*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*AMOS (BBRI)*	*AMOS only undercut bank indicator sampled at EWR site during baseline survey, present at relative abundance of 0.01 ind/min electrofishing.*	*AMOS only SD indicator sampled at site and not a reliable indicator species as they are generally coincidentally sampled. (TPCs for BBRI can be defined in future if they are sampled at site).*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TSPA BANO[5]*	*BANO and TSPA only instream vegetation indicator species expected at site. None of these species were present during baseline (EWR) survey.*	*TPCs for BANO and TSPA can be defined in future if they are sampled at the EWR site.*	*Significant change in Instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS VNEL*	*AMOS is a catadromous species while various other species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

5 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

Table 25.10 EWR S2: Fish EcoSpecs and TPCs (PES: B/C and TEC: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline (PES) FRAI[3] score of 78.6% (B/C) calculated for reach.*	*Any decreased FROC[2] in reach of especially CANO, VNEL, BEUT and PER OR FRAI scores decreasing below 75% (high C EC).*	*Any deterioration in habitat that results in decrease in FROC of species.*
Species richness	*All indigenous spp.*	*14 of the 22 expected indigenous fish species were sampled during the baseline (EWR) survey (25 species estimated to occur in reach under PES).*	*Less than 12 fish species sampled using electrofishing during a survey at EWR site when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During the baseline (EWR-PES) surveys fish were sampled at 4.3 ind/min.*	*Relative abundance of less than 2.5 ind/min sampled at the site (during optimal sampling conditions).*	*N/A.*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*
FD Habitats	*VNEL BEUT*	*During the baseline survey VNEL was present at site at relative abundance of 0.43 ind/min electrofishing, while BEUT was present at 0.57 ind/min (electrofishing).*	*VNEL and BEUT absent from site during any survey OR present at relative abundance < 0.25 ind/min for VNEL and < 0.3 ind/min for BEUT.*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*
FS habitats	**VNEL CANO**	*During the baseline survey VNEL was present at site at relative abundance of 0.43 ind/min while CANO was present at 1.82 ind/min (electrofishing).*	*VNEL and CANO absent from site during any survey OR present at relative abundance < 0.25 ind/min for VNEL and < 1.2 ind/min for CANO.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*
Substrate	*BPOL VNEL*	*During the baseline survey VNEL was present at site at relative abundance of 0.43 ind/min while BPOL was present at 0.15 ind/min (electrofishing).*	*VNEL absent from site during any survey and BPOL absent during 2 consecutive surveys OR present at relative abundance < 0.25 ind/min for VNEL and < 0.08 ind/min for BPOL.*	*Reduced suitability (abundance and quality) of substrate habitats (increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, etc.) (to be quantified with RHAM).*
Flow dependant spp. (flow alteration)	*OPER CANO*	*During the baseline survey OPER was present at site at relative abundance of 0.12 ind/min while CANO was present at 1.82 ind/min*	*OPER and CANO absent from site during any survey OR present at relative abundance < 0.05 ind/min for OPER and < 1.2 ind/min for*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		(electrofishing).	*CANO.*	
Water quality intolerance	*BEUT CANO*	*During the baseline survey BEUT was present at site at relative abundance of 0.57 ind/min while CANO was present at 1.82 ind/min (electrofishing).*	*BEUT and CANO absent from site during any survey OR present at relative abundance < 0.3 ind/min for BEUT and < 1.2 ind/min for CANO.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*BMAR BPOL*	*During the baseline survey BMAR was present at site at relative abundance of 0.42 ind/min while BPOL was present at 0.15 ind/min (electrofishing).*	*BMAR absent from site during any survey and BPOL absent during 2 consecutive surveys OR present at relative abundance < 0.25 ind/min for BMAR and < 0.08 ind/min for BPOL.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*OPER BMAR*	*During the baseline survey BMAR was present at site at relative abundance of 0.42 ind/min while BPOL was present at 0.15 ind/min (electrofishing).*	*BMAR absent from site during any survey and BPOL absent during 2 consecutive surveys OR present at relative abundance < 0.25 ind/min for BMAR and < 0.08 ind/min for BPOL.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*MACU PPHI*	*MACU and PPHI are the best indicator species of SS at the site (as observed during baseline surveys). During the baseline survey MACU was present at site at relative abundance of 0.05 ind/min while PPHI was present at 0.25 ind/min (electrofishing).*	*PPHI absent from site during any survey and MACU absent during 2 consecutive surveys OR present PPHI present at relative abundance < 0.15 ind/min.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BEUT PPHII*	*During the baseline survey BEUT was present at site at relative abundance of 0.57 ind/min while PPHI was present at 0.25 ind/min (electrofishing).*	*BEUT and PPHI absent from site during any survey OR present at relative abundance < 0.3 ind/min for BEUT and < 1.5 ind/min for PPHI.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009).*
Undercut banks				*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TSPA*	*The only species with high indicator value for instream vegetation is TSPA. During the baseline survey TSPA was present at site at relative abundance of 0.07 ind/min.*	*TSPA absent during 2 consecutive surveys or present with relative abundance < 0.03 ind/min.*	*Significant change in Instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*These indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

25.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S1 is a Category B for the PES and a Category A/B for the REC while the EC for the macro-invertebrates at EWR S2 is a Category B/C for the PES and a Category B for the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a small mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal and riparian vegetation overhanging the stream banks. The REC and TEC improves the macro-invertebrate EC from a B to an A/B at EWR1, and from a B/C to a B at EWR2.*

Numerical: *Indicator taxa for EWR S1 and S2 are provided in Table 25.11 and EcoSpecs and TPCs are provided for EWR S1 (Table 25.12) and EWR S2 (Table 25.13).*

Table 25.11 EWR S1 and EWR S2: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
3	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Table 25.12 EWR S1: Macro-invertebrate EcoSpecs and TPCs (PES: B; TEC: A/B)

EcoSpecs	TPCs	Estimated change in Ecospecs for TEC
Ensure that the MIRAI score remains within the range of a B category (80% – 89%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 80% or less.*	*Ensure that the MIRAI score remains above the B Category (>89%).*
Presence of at least three of the following taxa: Perlidae, Heptageniidae, Athericidae, Baetidae > 2spp.	*One or more of the following taxa present as individuals only, or absent: Perlidae, Heptageniidae, Athericidae, Baetidae > 2 spp.*	*Additional key taxa for the improved situation: Oligoneuridae, Prosopistomatidae.*
No macro-invertebrate family consistently dominating the fauna defined as C abundance (> 100) over two consecutive surveys.	*Any one or more taxa occurring in an abundance of > 100 individuals over two consecutive surveys.*	*No macro-invertebrate family consistently dominating the fauna defined as C abundance (> 100) over two consecutive surveys.*

Table 25.13 EWR S2: Macro-invertebrate EcoSpecs and TPCs (PES: B/C; TEC: B)

EcoSpecs	TPCs	Estimated change in Ecospecs for TEC
Ensure that the SASS5 scores and ASPT values occur in the following range: *SASS5 score: > 160; ASPT value: > 6.8.*	*SASS5 scores below 160 and ASPT below 7.*	*Ensure that the SASS5 scores are > 170.*
To ensure that the MIRAI score remains within the range of a B/C category (77.4% - 82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 80% or less.*	*Ensure that the MIRAI score remains above the B Category (>82%).*
The presence of the following taxa at A or greater abundances:	*One or more of the following taxa present as individuals*	*Additional key taxa for the improved situation:*

EcoSpecs	TPCs	Estimated change in Ecospecs for TEC
Perlidae, Heptageniidae, Elmidae, Baetidae > 2 spp.	*only, or absent altogether: Perlidae, Heptageniidae, and Elmidae. Less than 2 spp of Baetidae.*	▪ *Trichorythidae.* ▪ *Libellulidae.*
Ensure that no group consistently dominates the fauna, defined as C abundance (> 100) over more than two consecutive surveys.	*The presence of any taxon occurring in an abundance of > 100 individuals for two consecutive surveys.*	*No macro-invertebrate family consistently dominating the fauna defined as C abundance (> 100) over two consecutive surveys.*

25.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S1 and S2 (as at October 2007) for riparian vegetation was a Category B/C (80.1%) and C (74.3%) respectively. Vegetation cover (woody and non-woody) has to be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species have to be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S1 and EWR S2 are provided in Table 25.14 and Table 25.15 respectively. There was high confidence in the EcoSpecs and TPCs at EWR S1 since RHAM (DWA, 2009b) and VEGRAI (Kleynhans et al., 2007) data were available while only VEGRAI data was available for EWR S2 resulting in lower confidence.*

Table 25.14 EWR S1: Riparian vegetation EcoSpecs and TPCs (PES: B/C; TEC: B)

Assessed Metric	EcoSpec	TPC
Marginal zone (B/C)		
Indigenous riparian woody cover	*Riparian woody species cover between 30% and 60%.*	*An increase in riparian woody species cover above 60% OR a decrease below 30%.*
	RHAM data average of 30% cover; VEGRAI data range between 20 - 40%.	
Phragmites (reed) cover	*Reed cover between 30% and 40%.*	*An increase in reed cover above 40%.*
	RHAM data recorded no reeds.	
Marginal zone (B)		
Indigenous riparian woody cover	*Riparian woody species cover between 30% and 70%.*	*An increase in riparian woody species cover above 70% OR a decrease below 30%.*
	RHAM data average of 30% cover; VEGRAI data range between 20 - 40%.	
Phragmites (reed) cover	*Reed cover between 20% and 30%.*	*An increase in reed cover above 30%.*
	RHAM data recorded no reeds.	
Riparian zone (B/C)		
Alien invasion (perennial alien species)	*Alien species cover between 10 - 15%.*	*An increase in alien species cover above 15%.*
	VEGRAI data recorded <10% (marginal zone), 20% (lower zone), 10 - 20% (upper zone). RHAM data recorded an absence of perennial alien species in the marginal zone and an average of 16% on the lower zone.	
Riparian zone (B)		
Alien invasion (perennial alien species)	*Maintain alien species cover <10%.*	*An increase in alien species cover above 10%.*
	VEGRAI data recorded <10% (marginal zone), 20% (lower zone), 10 - 20% (upper zone). RHAM data recorded an absence of perennial alien species in the marginal zone and an average of 16% on the lower zone.	

Assessed Metric	EcoSpec	TPC
Lower zone (B/C)		
Indigenous riparian woody cover	*Riparian woody species cover between 30% and 60%.*	*An increase in riparian woody species cover above 60% OR a decrease below 30%.*
	RHAM data average of 7% cover; VEGRAI data range between 40 - 60%.	
Phragmites (reed) cover	*Reed cover between 20% and 30%.*	*An increase in reed cover above 30%.*
	RHAM data recorded no reeds.	
Lower zone (B)		
Indigenous riparian woody cover	*Riparian woody species cover between 30% and 70%.*	*An increase in riparian woody species cover above 70% OR a decrease below 30%.*
	RHAM data average of 7% cover; VEGRAI data range between 40 - 60%.	
Phragmites (reed) cover	*Reed cover between 15% and 25%.*	*An increase in reed cover above 25%.*
	RHAM data recorded no reeds.	
Upper zone (B/C)		
Indigenous riparian woody cover	*Riparian woody species cover between 30% and 60%.*	*An increase in riparian woody species cover above 60% OR a decrease below 30%.*
	VEGRAI data range between 40 - 60%.	
Phragmites (reed) cover	*Reed cover between 20% and 30%.*	*An increase in reed cover above 30%.*
	RHAM data recorded no reeds.	
Upper zone (B)		
Indigenous riparian woody cover	*Riparian woody species cover between 40% and 80%.*	*An increase in riparian woody species cover above 80% OR a decrease below 40%.*
	VEGRAI data range between 40 - 60%.	
Phragmites (reed) cover	*Reed cover between 10% and 20%.*	*An increase in reed cover above 20%.*
	RHAM data recorded no reeds.	

Table 25.15 EWR S2: Riparian vegetation EcoSpecs and TPCs (PES: C; TEC: B)

Assessed Metric	EcoSpec	TPC
Marginal zone (C)		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Non-woody cover between 50 and 60%.*	*An increase in non-woody cover above 60%.*
	VEGRAI data range between 40 - 60%.	
Marginal zone (B)		
Non-woody Indigenous cover (grasses, sedges and dicotyledonous forbs)	*Non-woody cover between 30 and 40%.*	*An increase in non-woody cover above 40%.*
	VEGRAI data range between 40 - 60%.	
Riparian zone (C)		
Alien invasion (perennial alien species)	*Alien species cover between 10 - 15%.*	*An increase in alien species cover above 15%.*
	VEGRAI data recorded 10 - 20% (marginal zone, but mostly annuals), 10 - 20% (lower zone), and <10% (upper zone).	
Indigenous riparian woody cover	*Riparian woody species cover between 20% and 70%.*	*An increase in riparian woody species cover above 70% OR a decrease below 20%.*
	VEGRAI data range between 40 - 60%.	
Riparian zone (B)		

Assessed Metric	EcoSpec	TPC
Alien invasion (perennial alien species)	*Alien species cover <10%.*	*An increase in alien species cover above 10%.*
	VEGRAI data recorded 10 - 20% (marginal zone, but mostly annuals), 10 - 20% (lower zone), and <10% (upper zone).	
Indigenous riparian woody cover	*Riparian woody species cover between 40% and 90%.*	*An increase in riparian woody species cover above 90% OR a decrease below 40%.*
	VEGRAI data range between 40 - 60%.	

25.4 RQOs FOR RU S1: MODERATE PRIORITY - 2 (X31A-00783, 00786, 00794, 00796, 00803)

25.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 25.16 RU S1: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31A-00783										
C	*12.12*	*9.48*	*3.167*	*26.1*	*4.094*	*33.8*	*0.034*	*0.049*	*0.065*	*0.098*
X31A-00786										
B	*4.65*	*3.64*	*1.816*	*39*	*2.222*	*47.7*	*0.026*	*0.029*	*0.039*	*0.051*
X31A-00794										
B	*Small SQ catchment areas (less than 3 km^2) and hence no hydrology modelled (small flows and inaccurate at this resolution).*									
X31A-00796										
B	*Small SQ catchment areas (less than 3 km^2) and hence no hydrology modelled (small flows and inaccurate at this resolution).*									
X31A-00803										
B	*Small SQ catchment areas (less than 3 km^2) and hence no hydrology modelled (small flows and inaccurate at this resolution).*									

25.4.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 25.17.

Table 25.17 RU S1: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (forest/high density savanna).*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain large or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	

Indicators	Narrative RQO	Numerical RQO
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Five endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa, I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 55 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be very low (one species namely ANAT) in most of this RU with small sections housing higher richness (seven species) under the PES. Flows should be adequate to ensure suitable habitats for primary indicator species (ANAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (AMOS, ANAT, BANO[1], CANO, PPHI, TSPA and VNEL) of seven species within this RU and prevent further spread or increase in diversity and abundance of predatory alien species (especially OMYK). Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: ANAT (flow and flow related water quality, substrate condition, migration)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicators: Flow, water quality and substrate: CANO, VNEL Vegetation: PPHI, TSPA Migration: AMOS, VNEL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction IN the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*To maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate*

Indicators	Narrative RQO	Numerical RQO
		water quality in the SIC biotope (15 cm depth).
Pyralidae	*MV habitat and water quality should be adequate to accommodate this key taxon.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

26 IUA X3-2: RESOURCE QUALITY OBJECTIVES

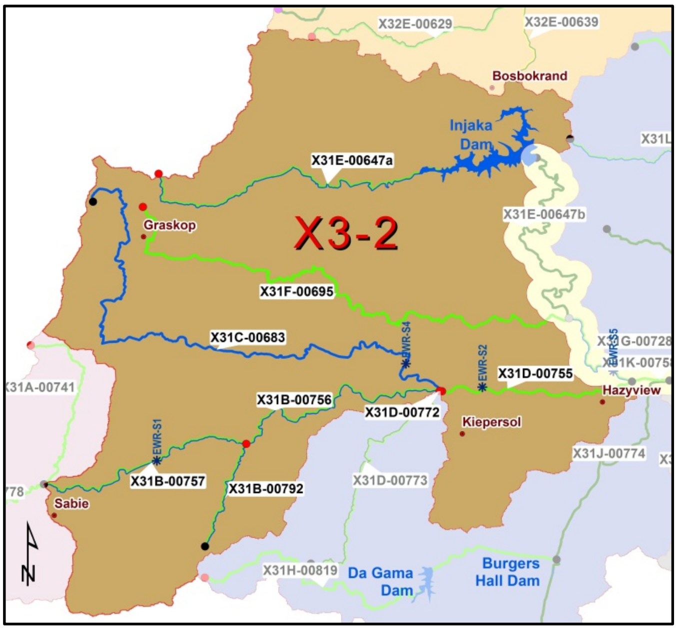
26.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the upper reaches of the Marite River down to the Inyaka Dam, the Mac-Mac and the Motitsi rivers (the main Sabie River having been covered by IUA X3-1). The terrain is mostly steep and mountainous. This IUA includes the Inyaka Dam, by far the largest dam in the Sabie catchment, as well as Maritsane Dam located upstream of the Inyaka Dam. Land use in the IUA consists mostly of forestry although there are significant wilderness areas, as well as areas under irrigation and urban/rural development. The towns of Graskop, Hazeyview and parts of Bushbuckridge are located in this IUA. Water use in the IUA consists of irrigation, domestic use and transfers out of the Inyaka Dam to the Sand River catchment (IUA X3-7). The RU S4 includes the Sabani River of IUA X3-4 which includes the Da Gama Dam and several farm dams.The Sabani River will therefore be discussed here.

The rivers in this zone range between slightly modified (B/C PES) for the Goudstroom (X31B-00792), Mac-Mac (X31C-00683) and the Marite River upstream of Inyaka Dam (X31E-00647a) and moderately modified (C PES) for the Motitsi River (X31F-00695). The primary impact in this zone are non-flow related associated with forestry and agricultural fields, while some water quality deterioration is also evident in the some areas due to urban runoff (Graskop in the Motitsi) and sawmill industries.

IUA X3-2 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-2 - TRIBUTARIES IN X3-2 AND THE SABANI PRIORITY RATINGS (IUA X3-4) RIVER



RU	SQ	RIVER	PES	TEC	PR
RU S4	*X31B-00792*	*Goudstroom*	**B/C**	**B/C**	**2**
	X31D-00773	*Sabani*	**C/D**	**C/D**	
MRU Mac A	*X31C-00683 EWR S4*	*Mac-Mac*	**B**	**B**	**3**
RU S8	*X31E-00647a*	*Marite (US of dam)*	**B/C**	**B**	**3**
	X31F-00695	*Motitsi*	**C**	**B**	**2**

*The RQOs are provided below for a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

26.2 RQOs FOR RU S4: MODERATE PRIORITY - 2 (X31B-00792, X31D-00773)

26.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 26.1 RU S4: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31B-00772										
B/C[1]	12.21	9.79	3.786	31	4.754	38.9	0.035	0.058	0.075	0.111
X31D-00773										
C/D	19.23	7.61	3.134	16.3	3.745	19.5	0.03	0.063	0.068	0.105

1 The EWR rule is provided for a C as the improvements to a B are based on non flow-related measures.

26.2.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. Data from EWR S2 was evaluated for phosphate and salt levels.*
Model: *N/A.*
Users: *Old gold mining decant and irrigation return flows.*
Water quality issue: *Elevated nutrients, salts, suspended solids (turbidity); toxics (As, Cn).*

Narrative and numerical details for RU S4 are provided in Table 26.2.

Table 26.2 RU S4: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
Ensure that nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than 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 (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that As levels are within Ideal limits or A categories.	*95^{th} percentile of the data must be less than 0.020 mg/L As (aquatic ecosystems: driver).*
Ensure that (free) Cn levels are within Ideal limits or A categories.	*95^{th} percentile of the data must be less than 0.004 mg/L Cn (aquatic ecosystems: driver).*

26.2.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 26.3.

Table 26.3 RU S4: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woodland grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of forestry activities into the riparian zone and existing forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry encroachment into or within the riparian zone should be reduced by 25%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Five (5) endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (Balanites maughamii subsp. maughamii, Crinum macowanii and Cyathea capensis var. capensis)*
FISH		
Species richness	*Indigenous fish species richness estimated to be very low (one species namely ANAT) in most of this RU with small sections housing higher richness (seven species) under the PES. Flows should be adequate to ensure suitable habitats for primary indicator species (ANAT). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (AMOS, ANAT, BANO[1], CANO, PPHI, TSPA and VNEL) of seven species within this RU and prevent further spread or increase in diversity and abundance of predatory alien species (especially OMYK). Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: ANAT (flow and flow related water quality, substrate condition, migration)		*Maintain suitable flows (all seasons) to sustain these rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicators: Flow, water quality and substrate: CANO, VNEL *Vegetation: PPHI, TSPA* *Migration: AMOS, VNEL*		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction IN the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae	*Flows should be adequate to ensure suitable habitats for these flow*	*Maintain suitable conditions for these flow dependent taxa (high velocity: >*

Indicators	Narrative RQO	Numerical RQO
Philopotamidae	*dependant taxa.*	*0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*MV habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

26.3 RQOs FOR MRU MAC A: HIGH PRIORITY – 3 (EWR S4: X31C-00683)

The TECs is provided for EWR S4 below. Note that this site represents the Mac-Mac River in IUA X3-2. Although Sc S6 does not impact EWR S4, the site does however require improvement to achieve the TEC which entails improved water quality to improve the fish to a B EC. It is unknown how attainable as there is uncertainty regarding the source of the water quality issues. The necessity for improvement is acknowledged, but due to uncertainty whether this is achievable, the catchment configuration of an overall B was recommended (DWS, 2014a).

Table 26.4 TECs for EWR S4

Component	PES and Immediately applicable	REC
Physico chemical	**A/B**	**A**
Geomorphology	**A**	**A**
Fish	**B/C**	**B**
Invertebrates	**A/B**	**A/B**
Riparian vegetation	**A/B**	**A/B**
EcoStatus	**B**	**A/B**

26.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 26.5 MRU MAC A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X23G-01057 (EWR S4)											
B	**B**	*132*	*102.8*	*17*	*12.88*	*70.32*	*53.27*	*0.204*	*0.383*	*0.432*	*0.889*

26.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Forestry and related activities, e.g. Venus saw mill.*
Water quality issue: *Suspended solids.*
Narrative and Numerical: *Details for MRU Mac A are provided in Tables 26.6 and 26.7 (EWR S4). Data used for water quality assessments should be collected from X3H003Q01.*

Table 26.6 MRU MAC A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 26.7 EWR S4: Water quality EcoSpecs and TPCs (PES and TEC: A/B)

River: Mac Mac		**PES: A/B EC**
Monitoring site: X3H003Q01		
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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature[(b)]	*No deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 8.0 mg/L.*	*The 5th percentile of the data must be 8.2 - 8 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.*	*Initiate baseline monitoring for this variable.*
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 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 0.001 - 0.015 mg/L.*

River: Mac Mac		**PES: A/B EC**
Monitoring site: X3H003Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 67 - 84 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

26.3.3 Habitat and biota RQOs (EcoSpecs)

26.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this unit was indicated as a B/C (DWAF, 2010a) and it should be aimed to maintain this EC in future. The overall indigenous fish species richness of this reach is estimated to be 20 under present conditions. Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this MRU include the pennant-tail suckermouth (CANO) and Inkomati chiselmouth (VNEL). Both these species are rheophilics and are good indicators of flow modification (fast flowing habitats), rocky substrate condition and water quality. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU are especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for EWR S4 are provided in Table 26.8.*

Table 26.8 EWR S4: Fish EcoSpecs and TPCs (PES and TEC: B/C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI[3] score of 80.4% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially CANO, VNEL, BEUT OR FRAI scores decreasing below 77.4% (high C EC).*	*Any deterioration in habitat that results in decrease in FROC of species.*
Species richness	*All indigenous spp.*	*Five of the 12 expected indigenous fish species were sampled during the baseline (EWR) survey. (Twenty species expected in reach under the PES).*	*Less than five fish species sampled using electrofishing during a survey at EWR site when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During recent surveys fish were sampled at 3.1 ind/min.*	*Relative abundance of less than 1.6 ind/min sampled at the site (during same season as baseline data).*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*
FD Habitats	*VNEL BEUT*	*During the baseline survey VNEL was present at site at relative abundance of 1.58 ind/min electrofishing, while BEUT was present at 0.25 ind/min (electrofishing).*	*VNEL and BEUT absent from site during any survey OR present at relative abundance < 1 ind/min for VNEL and < 0.1 ind/min for BEUT.*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows) (to be quantified by RHAM; DWA, 2009b).*
FS habitats	**VNEL CANO**	*During the baseline survey VNEL was present at site at relative abundance of 1.58 ind/min electrofishing, while CANO was present at 0.81 ind/min (electrofishing).*	*VNEL and CANO absent from site during any survey OR present at relative abundance < 1 ind/min for VNEL and < 0.4 ind/min for CANO.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows), Reduced suitability (abundance & quality) of substrate habitats (increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, etc.) (to be quantified by RHAM; DWA, 2009b).*
Substrate				
Flow dependant spp. (flow alteration).	*CANO BEUT (OPER)*	*During the baseline survey CANO was present at site at relative abundance of 0.81 ind/min electrofishing, while BEUT was present at 0.25 ind/min (electrofishing).*	*CANO and BEUT absent from site during any survey OR present at relative abundance < 0.4 ind/min for CANO and < 0.1 ind/min for BEUT.*	
Water quality intolerance	*BEUT CANO*			*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*OPER*	*OPER was only indicator of SD habitats sampled during baseline conditions and it was present in very low abundance (0.02 ind/min).*	*Due to low abundance of OPER at site, it may not be a valid indicator and will require verification. Preliminary TPC: Absence of OPER for 2 consecutive surveys.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*OPER*	*OPER was only indicator of water column sampled during baseline conditions and it was present in very low abundance (0.02 ind/min).*	*Due to low abundance of OPER at site, it may not be a valid indicator and will require verification. Preliminary TPC: Absence of OPER for 2 consecutive surveys.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*BBRI PPHI*	*BBRI and PPHI are the best indicators of SS habitats at site, but they were not sampled during baseline EWR survey.*	*Due to absence of any SS habitat indicators at site during baseline survey, no TPC can be set at present. Should*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			these species be sampled in future, TPCs could be defined.	*sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BEUT*	*During the baseline survey BEUT was present at 0.25 ind/min (electrofishing).*	*BEUT absent from site during any survey OR present at relative abundance < 0.1 ind/min.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks				*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TSPA*	*TSPA is the best indicator of instream vegetation habitats at site, but it was not sampled during baseline EWR survey.*	*Due to absence of an instream vegetation habitat indicator at site during baseline survey, no TPC can be set at present. Should these species be sampled in future, TPCs could be defined.*	*Significant change in Instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous[1] species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

26.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S4 is a Category A/B for the PES and the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a small mountain river assemblage associated with perennial flows. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal and riparian vegetation overhanging the stream banks.*

Numerical: *Indicator taxa for EWR S4 are provided in Table 26.9 and EcoSpecs and TPCs in Table 26.10.*

Table 26.9 EWR S4: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Pyralidae*	*0.3 - 0.6*	*Vegetation*	*High*

Table 26.10 EWR S4: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: A/B)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 190; ASPT value: > 6.	*SASS5 scores below 190 and ASPT below 6.*
Ensure that the MIRAI score remains within the range of a B category (> 82.0-87.4%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 83% or less.*
Presence of at least 7 of the following 9 high-scoring taxa: Perlidae, Heptageniidae Baetidae > 2 spp., Helodidae, Athericidae, Philopotamidae, Chlorocyphidae, and Pyralidae.	*Two or more of the following taxa present only as individuals, or absent altogether (for 2 consecutive samples): Perlidae, Heptageniidae, Helodidae, Athericidae, Chlorocyphidae, Pyralidae, and Philopotamidae. Less than 2 spp. of Baetidae.*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa may occur at B abundance (e.g. Simuliidae). No group to dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*

26.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S4 (as at October 2007) for riparian vegetation was a Category A/B (89.9%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S4 are provided in Table 26.11. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 26.11 EWR S4: Riparian vegetation EcoSpecs and TPCs (PES and TEC: A/B)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Terrestrialisation	*The absence of woody kloof species.*	*A presence of woody kloof species.*
	RHAM data average of 30% cover; VEGRAI data range between 20 - 40%.	
Indigenous Riparian Woody Cover	*Indigenous riparian woody cover between 20 and 60%.*	*A decrease in riparian woody species cover below 20%.*
	RHAM data average of 7% cover; VEGRAI data range between 40 - 60%.	
Non-woody Indigenous Cover (grasses, sedges and dicotyledonous forbs)	*Non-woody cover between 30 and 60%.*	*An increase in non-woody cover above 70%.*
	RHAM data recorded no reeds.	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 1 and 5%.*	*An increase in alien species cover above 5%.*
	VEGRAI data recorded <10% (marginal zone), 20% (lower zone), 10 - 20% (upper zone). RHAM data recorded an absence of perennial alien species in the marginal zone and an average of 16% on the lower zone.	
Phragmites (reed)	*The absence of reeds.*	*The presence of reeds.*

Assessed Metric	EcoSpec	TPC
cover	RHAM data recorded no reeds.	
Lower zone		
Indigenous riparian woody cover	Indigenous riparian woody cover between 60 and 80%.	A decrease in riparian woody species cover below 60%.
	VEGRAI data range between 40 - 60%.	
	RHAM data recorded no reeds.	

26.4 RQOs FOR RU S8: MODERATE PRIORITY - 2 (X31E-00647A, X31F-00695)

Both these SQs situated in RU S8 require improvement to achieve the TEC. The actions required are mostly non flow-related and include:

- *X31A-00647 and X31F-00695: An improved riparian zone.*

As none of the scenarios are relevant to this site, the improvement is valid irrespective of the recommended scenario (DWS, 2014a).

26.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 26.12 RU S8: 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%
X31E-00647a										
B[1]	79.88	62.79	23.286	29.2	30.89	38.7	0.231	0.336	0.493	0.71
X31F-00695										
B[1]	43.91	35.84	11.265	25.6	15.461	35.2	0.101	0.159	0.172	0.206

1 The EWR rule is provided for a B/C and a C as the improvements to a B are based on non flow-related measures.

26.4.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Mining and urban impacts from Graskop town.*
Water quality issue: *Nutrients, salts, toxics, turbidity.*

Narrative and numerical details for RU S8 are provided in Table 26.13.

Table 26.13 RU S8: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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 (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*

Narrative RQO	Numerical RQO
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 or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure that nutrient levels are within Acceptable limits.	*50^{th} percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*

26.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 26.14.

Table 26.14 RU S8: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (forest/high density savanna) but with patches of grassland common.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 40% of existing perennial aliens within the riparian zone should be removed.*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*To improve forestry and agricultural encroachment into or within the riparian zone should be reduced by 25%.*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry and agricultural encroachment into or within the riparian zone should be reduced by 25%.*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Twelve endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (Cyathea capensis var. capensis; Erica rivularis and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness.*	*Maintain the presence of at least 55 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 24 under the PES. Flows should be adequate to ensure suitable habitats for primary indicator species (CANO/VNEL). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (AMOS, ANAT, AURA, BANO, BARG, BBRI, BEUT, BIMB, BMAR, BPOL, BTRI, BUNI, CANO, CGAR, CSWI, LCYL, LMOL, MACU, MMAC, OPER, PCAT, PPHI, TSPA and VNEL) of estimated 24 species within this RU and prevent invasion or spread of alien fish species. Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: CANO/VNEL		*Maintain suitable flows (all seasons) to sustain these rheophilic species.*

Indicators	Narrative RQO	Numerical RQO
(water quality, vegetation, substrate condition, migration)		*Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicators: Flow: ANAT, AURA, BARG, BEUT, BMAR, BPOL, OPER Water quality: BEUT, BARG, OPER, PCAT Substrate: ANAT, AURA Vegetation: BANO[1], BBRI, PPHI, TSPA Migration: AMOS, BMAR		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction in the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*Maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae Hydraenidae	*MV habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

26.4.4 Wetland RQOs

Wetland RQOs are provided in Table 26.15.

Table 26.15 RU S8: Wetland RQOs

SQ	TEC	Wetland RQO
X31F-00695	**C**	*Maintain TEC and Moderate EIS.* *Cessation of forestry encroachment on channelled valley bottom wetlands.*

27 IUA X3-3: RESOURCE QUALITY OBJECTIVES

27.1 IUA OVERVIEW AND DESCRIPTION

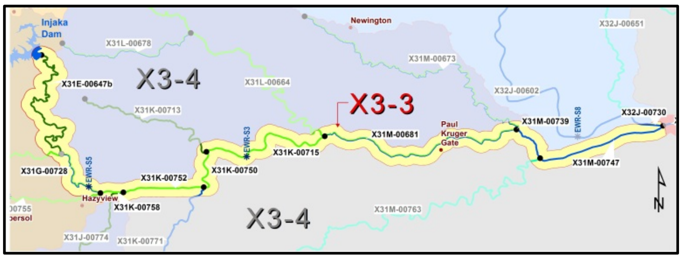
This IUA consists of the main stem of the Marite and Sabie Rivers from the Inyaka Dam to the confluence with the Sand River. There are no dams on the river although there is a significant weir at Hoxane where water is abstracted for domestic use. The terrain is relatively flat and landuse consists of irrigation and grazing.

Water use in this IUA is mostly domestic use. There are large abstractions from the Hoxane weir for domestic use on both sides of the river. There is also a significant amount of irrigation use.

The river reaches in the upper section of this zone (Marite Downstream of Inyaka Dam and upper Sabie section) is moderately to largely modified (PES C to C/D), but improving further downstream (main Sabie River) closer to the nature conservation areas (especially on right bank). The primary impacts in the upper reaches of this zone are flow-related due to the Inyaka Dam (Marite River) regulation as well as abstraction for irrigation. The middle and lower section of this zone is impacted more by non-flow related activities (agriculture, rural settlements) and to some extent water quality deterioration (increased nutrients, Hazyview town runoff).

IUA X3-3 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-3 - MARITE AND SABIE RIVERS DS OF INYAKA DAM TO THE SAND CONFLUENCE



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Mar A	*X31G-00728 EWR S5*	*Marite*	B/C	B/C	3
	*X31E-00647b**	*Marite (DS of Dam)*			
Sabie B	*X31K-00715 EWR S3**	*Sabie*	A/B	A/B	3
	X31K-00750#	*Sabie*			
	X31K-00752#	*Sabie*			
	X31K-00758#	*Sabie*			
	X31M-00681#	*Sabie*			
	X31M-00747#	*Sabie*			
	X31M-00739#	*Sabie*			

** Where SQ does not have a EC the EC is different from the EWR site. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this RU.*

*The RQOs are provided below for a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

27.2 RQOs FOR MRU MARITE A: HIGH PRIORITY – 3 (EWR S5: X31G-00728; INCLUDING X31E-00647B)

The TECs is provided for EWR S5 below. Note that EWR S5 represents the Marite River downstream of Inyaka Dam.

Table 27.1 TECs for EWR S5

Component	PES	REC	Immediately applicable
Physico chemical	B	B	B
Geomorphology	C	C	C
Fish	B/C	B	B/C
Invertebrates	B/C	B	B/C
Riparian vegetation	B/C	B	B/C
EcoStatus	B/C	B	B/C

27.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 27.2 MRU MARITE A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X31G-00728 (EWR S5)											
B/C	B/C	*156.4*	*102.7*	*44.3*	*28.32*	*100*	*63.94*	*0.68*	*0.88*	*0.75*	*1*

27.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Impacts from extensive settlements and irrigation activities, including fertilizer use.*
Water quality issue: *Nutrients, salts, toxics.*
Narrative and Numerical: *Details for MRU Marite A are provided in Tables 27.3 and 27.4 (EWR S5). Data used for water quality assessments should be collected from X3H011Q01.*

Table 27.3 MRU MARITE A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
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 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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 27.4 EWR S5: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Marite		**PES: B EC**
Monitoring site: X3H011Q01		**Note that Sc S6 may result in improved water quality.**
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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature[(b)]	*No deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7.0 mg/L.*	*The 5th percentile of the data must be 7.2 - 7 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.*	*Initiate baseline monitoring for this variable.*
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 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 0.012 - 0.015 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 67 - 84 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

27.2.3 Habitat and biota RQOs (EcoSpecs)

27.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this unit was indicated as a B/C (DWAF, 2010a) and it should be aimed to maintain this ecological category in future. The overall* *indigenous fish species richness of this reach is high, estimated to be as high as 26 species under present conditions. Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this unit include the small rheophilic pennant-tail suckermouth (CANO) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien predatory fish species.*

Numerical: *EcoSpecs and TPCs for EWR S5 are provided in Table 27.5.*

Table 27.5 EWR S5: Fish EcoSpecs and TPCs (PES and TEC: B/C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI[3] score of 77.9% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially CANO, BEUT, OPER and BMAR OR FRAI scores decreasing below 70% (high C EC).*	*Any deterioration in habitat that results in decrease in FROC of species.*
Species richness	*All indigenous spp.*	*Fifteen of the 23 expected indigenous fish species were sampled during the baseline (EWR) survey (26 spp. estimated for SQ reach under PES)*	*Less than 11 fish species sampled using electrofishing during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During recent surveys fish were sampled at 4 ind/min.*	*Relative abundance of less than 3 ind/min sampled at the site (during same season as baseline data).*	
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*
FD Habitats	**CANO BMAR**	*During the baseline survey CANO was present at site at relative abundance of 1.36 ind/min electrofishing, while BMAR was present at 1 ind/min (electrofishing).*	*CANO and BMAR absent from site during any survey OR present at relative abundance 1 ind/min for CANO and < 0.6 ind/min for BMAR.*	*Reduced suitability (abundance and quality) of FD, FS habitats (i.e. decreased flows, increased zero flows). Reduced suitability (abundance and quality) of substrate habitats (increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates, etc.) (to be quantified by RHAM; DWA, 2009b).*
FS habitats				
Substrate				

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Flow dependant spp. (flow alteration)	*CANO AURA*	*During the baseline survey CANO was present at site at relative abundance of 1.36 ind/min electrofishing, while AURA was present at 0.15 ind/min (electrofishing).*	*CANO and AURA absent from site during any survey OR present at relative abundance 1 ind/min for CANO and < 0.05 ind/min for AURA.*	
Water quality intolerance	*CANO BEUT*	*During the baseline survey CANO was present at site at relative abundance of 1.36 ind/min electrofishing, while BEUT was present at 0.39 ind/min (electrofishing).*	*CANO and BEUT absent from site during any survey OR present at relative abundance < 1 ind/min for CANO and < 0.2 ind/min for BEUT.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*BMAR CGAR*	*During the baseline survey CGAR was present at site at relative abundance of 0.1 ind/min electrofishing, while BMAR was present at 1 ind/min (electrofishing).*	*CGAR and BMAR absent from site during any survey OR present at relative abundance 0.05 ind/min for CGAR and < 0.6ind/min for BMAR.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*BMAR OPER*	*BMAR and OPER are the best indicators of water column at site. During the baseline survey OPER was present at site at very low relative abundance of 0.02 ind/min electrofishing, while BMAR was present at 1 ind/min (electrofishing).*	*BMAR absent from site during any survey OR present at relative abundance < 0.6ind/min for BMAR* **OR** *OPER absent for 2 consecutive surveys.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*PPHI, TSPA*	*PPHI and TSPA are the best indicators of SS habitats at site. During the baseline survey both were sampled at very low relative abundance of 0.03 ind/min for PPHI and 0.02 ind/min TSPA (electrofishing).*	*PPHI and TSPA absent for 2 consecutive surveys.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation				*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*MMAC BEUT*	*During the baseline survey MMAC was present at site at relative abundance of 0.13 ind/min electrofishing, while BEUT was present at 0.39 ind/min (electrofishing).*	*MMAC and BEUT absent from site during any survey OR present at relative abundance < 0.05 ind/min for MMAC and < 0.2 ind/min for BEUT.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TSPA*	*TSPA is the best indicator of instream vegetation habitats at site. During the baseline survey it was*	*TSPA absent for two consecutive surveys.*	*Significant change in instream vegetation habitats (to be quantified by RHAM;*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		sampled at very low relative abundance of 0.02 ind/min (electrofishing).		*DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous[1] species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

27.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S5 is a Category B/C for the PES and a Category B for the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: medium-sized foothill river associated with perennial flows; U-shaped channel incised in a rocky substrate. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation (shrubs and riparian trees) overhanging the stream banks.*

Numerical: *Indicator taxa for EWR S5 are provided in Table 27.6 and EcoSpecs and TPCs in Table 27.7.*

Table 27.6 EWR S5: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*
5	*Pyralidae*	*0.3 - 0.6*	*Vegetation*	*High*

Table 27.7 EWR S5: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B/C)

EcoSpecs	TPCs
Ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 225; ASPT value: > 6.2.	*SASS5 scores below 230 and ASPT below 6.4.*
Ensure that the MIRAI score remains within the range of a B/C category (77.4% - 82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 80% or less.*
Presence of at least 7 of the following 9 high-scoring taxa: Perlidae, Heptageniidae Baetidae > 2 spp., Elmidae, Athericidae, Hydropsychidae > 2 spp., and Pyralidae.	*Two or more of the following taxa present only as individuals, or absent altogether (for 2 consecutive samples): Perlidae, Heptageniidae, Elmidae, Athericidae, and Pyralidae. Less than 2 spp. of Baetidae or Hydropsychidae.*
Balanced community structure, i.e. majority of macroinvertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae, Baetidae, Heptageniidae).	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*

EcoSpecs	TPCs
No group to dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.	

27.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S5 (as at October 2007) for riparian vegetation was a Category B/C (80.4%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S5 are provided in Table 27.8. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 27.8 EWR S5: Riparian vegetation EcoSpecs and TPCs (PES and TEC: A/B)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Terrestrialisation	*The absence of terrestrial woody species.*	*The presence of terrestrial woody species.*
	No terrestrial species recorded in the RHAM	
Phragmites (reed) cover	*Reed cover between 20 and 30%.*	*A decrease in reed cover below 30%.*
	RHAM data recorded cover of 90% (similarly, Ecospec, baseline and TPC applies to left bank only).	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 10 - 15%.*	*An increase in alien species cover above 15%.*
	VEGRAI and RHAM sites were placed differently, but data show <10% cover by alien perennial species on the marginal and upper zones. Lower zone data were <10% for RHAM site and 10 - 20% for the VEGRAI site.	
Lower zone		
Indigenous riparian woody cover	*Terrestrial woody cover between 1 and 5%.*	*An increase in terrestrial woody species cover >5%.*
	An average of 5% cover was recorded at the RHAM site.	
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs)	*Non-woody cover between 40% and 50%.*	*A decrease in sedge, grass and dicotyledonous forb cover below 40% OR an increase above 90%.*
	RHAM data show 0% on the right bank and an average of 44% on the left bank. EcoSpecs and TPCs apply to the left bank only since the right bank consists of solid exposed bedrock unlikely to ever be colonised.	
Phragmites (reed) cover	*Reed cover between 20 and 30%.*	*An increase in reed cover above 80% or a decrease below 20%.*
	RHAM recorded an average cover of 27% (similarly, EcoSpec, baseline and TPC applies to the left bank only).	
Upper zone		
Phragmites (reed) cover	*Reed cover below 20%.*	*An increase in reed cover above 40%.*
	No data to support TPC, RHAM transect should be extended to about 30m.	
Indigenous riparian woody cover	*Terrestrial woody cover between 15 and 20%.*	*An increase in terrestrial woody species cover >20%.*
	An average of 9% cover was recorded at the RHAM site.	

<table>
<tr><th>Assessed Metric</th><th>EcoSpec</th><th>TPC</th></tr>
<tr><td colspan="3">Lower and Upper zone</td></tr>
<tr><td rowspan="2">Indigenous riparian woody cover</td><td>Indigenous riparian woody cover between 70 and 80%.</td><td>A decrease in riparian woody cover below 30% OR an increase above 80%.</td></tr>
<tr><td colspan="2">RHAM data average of 65% was recorded. VEGRAI data range (on a different site) was between 20 and 60%.</td></tr>
<tr><td rowspan="2">Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs)</td><td>Non-woody cover between 40% and 50%.</td><td>A decrease in sedge, grass and dicotyledonous forb cover below 40% OR an increase above 90%.</td></tr>
<tr><td colspan="2">RHAM data show 0% on the right bank and an average of 44% on the left bank. EcoSpecs and TPCs apply to the left bank only since the right bank consists of solid exposed bedrock unlikely to ever be colonised.</td></tr>
</table>

27.3 RQOs FOR MRU SABIE B: HIGH PRIORITY – 3 (EWR S3: X31K-00647B; INCLUDING X31K-00750, 00752, 00758, X31M-00681, 00747, 00739)

The TECs are provided for EWR S3 below. Note that EWR S3 represents the Sabie River downstream of Inyaka Dam and will be impacted by Sc S71 which was the preferred scenario for the Sabie River System. However Sc 71 results in conditions similar to the PES and REC.

Table 27.9 TECs for EWR S3

Component	PES, REC, Immediately applicable
Physico chemical	**B**
Geomorphology	**B**
Fish	**B**
Invertebrates	**B**
Riparian vegetation	**A/B**
EcoStatus	**A/B**

27.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 27.10 MRU SABIE B: Flow RQOs

<table>
<tr><th rowspan="2">PES (EWR)</th><th rowspan="2">TEC</th><th rowspan="2">nMAR (MCM)</th><th rowspan="2">pMAR (MCM)</th><th rowspan="2">Low flows (MCM)</th><th rowspan="2">Low flows (%nMAR)</th><th rowspan="2">Total flows (MCM)</th><th rowspan="2">Total (%nMAR)</th><th colspan="2">Oct</th><th colspan="2">Mar</th></tr>
<tr><th>90%</th><th>60%</th><th>90%</th><th>60%</th></tr>
<tr><td colspan="12">X31K-00647B (EWR S3)</td></tr>
<tr><td>A/B</td><td>A/B</td><td>493.7</td><td>305.0</td><td>47.96</td><td>9.71</td><td>187.29</td><td>37.94</td><td>0.581</td><td>0.955</td><td>1.489</td><td>2.848</td></tr>
</table>

27.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*

Users: *Impacts from rural settlements and urban areas such as Hazyview. Manghwazi WWTW discharges result in elevated nutrients and the release of hazardous microbes into the river. Extensive irrigation return flows and Pabeni quarry.*

Water quality issue: *Nutrients, salts, toxics, turbidity/suspended solids.*

Narrative and Numerical: *Details for MRU Sabie B are provided in Tables 27.11 and 27.12 (EWR S3). Data used for water quality assessments should be collected from X3H013Q01.*

Table 27.11 MRU SABIE B: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
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 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 turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 27.12 EWR S3: Water quality EcoSpecs and TPCs (PES and TEC: B)

River: Sabie		**PES: B EC**
Monitoring site: X3H013Q01		
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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 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 24 - 30 mS/m.*
pH	*The 5th and 95th percentiles of the data must range from 6.5 to 8.0.*	*The 5th and 95th percentiles of the data must be < 6.7 and > 7.8.*
Temperature[(b)]	*No deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5th percentile of the data must be ≥ 7.5 mg/L.*	*The 5th percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Small to moderate changes to the catchment land-use resulting in minor*	*Initiate baseline monitoring for this variable.*

River: Sabie Monitoring site: X3H013Q01	PES: B EC	
Water quality metrics	**EcoSpecs**	**TPC**
	effects of silting of habitats, largely of a temporary nature, with very intermittent temporary unnaturally high sediment loads and high turbidities.	
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 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 0.012 - 0.015 mg/L.*
Response variables		
Chl-a phytoplankton(b)	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 17 - 21 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

27.3.3 Habitat and biota RQOs (EcoSpecs)

27.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this MRU was indicated as a B (DWAF, 2010a) and it should be aimed to maintain this EC in future. The overall indigenous fish species richness of this reach is high, estimated to be as high as 26 species under present conditions. Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this MRU include the small rheophilic pennant-tail suckermouth (CANO) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspect of the ecosystem. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien fish species.*

Numerical: *EcoSpecs and TPCs for EWR S3 are provided in Table 27.13.*

Table 27.13 EWR S3: Fish EcoSpecs and TPCs (PES and TEC: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI[3] score of 85.6% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially BMAR, CANO, BEUT, LMOL, OPER, MBRE, PPHI, BVIV and TREN OR FRAI scores decreasing below 79%*	*Any deterioration in habitat that results in decrease in FROC of species.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			(high C EC).	
Species richness	*All spp.*	*Fifteen of the 35 expected indigenous fish species were sampled during the baseline (EWR) survey (37 spp. estimated for SQ reach under PES)*	*Less than 13 fish species sampled using electrofishing during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During recent surveys fish were sampled at 4.5 ind/min.*	*Relative abundance of less than 3.5 ind/min sampled at the site (during same season as baseline data) when habitat can be sampled efficiently.*	*N/A*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*
FD Habitats	**BMAR CANO** *(BEUT)*	*BMAR and CANO are expected to always be present at the EWR site (conditions similar to baseline conditions). This is based on available data for the site: (192 CANO individuals sampled during EWR survey at 2.02 ind/min), and BMAR 100% present during historical surveys, and sampled at relative abundance of 0.74 ind/min under baseline conditions.*	*BMAR and CANO present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of < 0.5 ind/min for BMAR and < 1.5 ind/min for CANO.*	*Reduced suitability (abundance and quality) of FD habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*
FS habitats	*BMAR LMOL*	*BMAR and LMOL are expected to always be present at the site (conditions similar to baseline conditions). This is based on available data for the site: BMAR and LMOL 100% present during historical surveys, and both species sampled at a relative abundance of 0.7 ind/min under baseline conditions.*	*BMAR and LMOL present less than 100% of time (not sampled during any survey) AND/OR decrease in relative abundance of < 0.5 ind/min for both species.*	*Reduced suitability (abundance and quality) of FS habitats (i.e. decreased flows, increased zero flows), (to be quantified by RHAM; DWA, 2009b).*
Substrate				*Increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates ((to be quantified by RHAM; DWA, 2009b).*
Flow dependant spp. (flow alteration)	*OPER CANO*	*CANO is expected to always be present at the site (conditions similar to baseline conditions) and OPER sampled 60% of the historical surveys. 192 individuals CANO sampled during EWR survey (2.02 ind/min.), and OPER sampled at a relative abundance of*	*OPER present less than 50% of time (not sampled for more than 2 consecutive surveys) and CANO absent during any survey AND/OR decrease in relative abundance of < 1.5 ind/min. for CANO.*	

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		0.14 ind/min under baseline conditions.		
Water quality intolerance	*OPER BEUT*	*Both species were sampled during baseline survey: OPER sampled at a relative abundance of 0.14 ind/min (60% of historical surveys), and BEUT sampled at a relative abundance of 0.12 ind/min (40% of historical surveys).*	*OPER and BEUT present less than 50% of time (not sampled for more than 2 consecutive surveys).*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*BMAR TREN OMOS*	*OMOS and TREN will be most appropriate indicators of SD habitats at the site. Both species were sampled during historical surveys (80 - 100% of the time) and during the baseline survey, but at low numbers, OMOS being present at 0.04 ind/min electrofishing, and TREN at 0.01 ind/min electrofishing. BMAR have a lower indicator value (0.88), but is more abundant (0.74 ind/min electrofishing) and thus should be used in conjunction with TREN and OMOS.*	*BMAR absent during any survey (or with relative abundance < 0.5 ind/min.) AND/OR <u>both</u> TREN and OMOS absent during any survey.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*BMAR MBRE OPER*	*OPE and MBRE were sampled during baseline survey: OPER sampled at a relative abundance of 0.14 ind/min (60% of historical surveys), and MBRE sampled at a relative abundance of 0.01 ind/min (80% of historical surveys). BMAR have a lower indicator value (0.82), but is more abundant (0.74 ind/min electrofishing) and could be used in conjunction with MBRE and OPER.*	*Adult BMAR individuals (> 150 mm) absent during any survey AND/OR <u>both</u> MBRE and OPER absent during any survey.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats	*BVIV*	*BVIV was present during baseline EWR survey at relative abundance of 0.17 ind/min electrofishing.*	*BVIV absent during any survey <u>AND/OR</u> decrease in relative abundance below 0.1 ind/min for BVIV.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
				quantified by RHAM; DWA, 2009b).
Overhanging vegetation	*BVIV PPHI*	*Both species were sampled during baseline survey: BVIV is the best indicator of overhanging vegetation habitats (Indicator value = 0.98) and is expected to be present at site EWR3 100% of the time at > 0.17 ind/min electrofishing. Alternative overhanging vegetation indicators (SMER, TREN and BUNI) occur in very low numbers, thus PPHI have been selected as additional indicator. PPHI had a relative abundance of 0.25 ind/min during baseline survey and it occurred 60% of surveys conducted at site.*	*BVIV absent during any survey AND/OR decrease in relative abundance below 0.1 ind/min for BVIV. PPHI present less than 50% of time (not sampled for more than 2 consecutive surveys).*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*BEUT PPHI*	*Both species were sampled during the baseline survey at relatively high numbers. Despite lower numbers in historical sampling surveys, it is expected that both species should be present at site EWR3 100% of the time. During baseline survey BEUT at a relative abundance of 0.12 ind/min, and PPHI at 0.25 ind/min. electrofishing.*	*Both BEUT and PPHI absent during any survey <u>AND/OR</u> decrease in relative abundance below 0.07 ind/min for BEUT and < 0.15 ind/min for PPHI.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TREN BVIV*	*TREN and BVIV will be most appropriate indicators of Instream vegetation habitats at the site. Both species were sampled during the baseline survey and 100% of the time during historical surveys. However, TREN was sampled at low numbers (0.01 ind/min electrofishing). BVIV were sampled at 0.17 ind/min electrofishing.*	*BVIV absent during any survey <u>AND/OR</u> decrease in relative abundance below 0.1 ind/min for BVIV <u>AND/OR</u> TREN present less than 50% of time (not sampled for more than 2 consecutive surveys).*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous[1] species in terms of their migratory requirements, requiring movement between river*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
		reaches.		

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

27.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S3 is a Category B for the PES and a Category B for the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: medium-sized foothill river associated with perennial flows; U-shaped channel incised in a rocky substrate. The macro-invertebrate habitats in the river are dominated by good SIC with favourable marginal vegetation (reeds and riparian trees) overhanging the stream banks.*

Numerical: *Indicator taxa for EWR S3 are provided in Table 27.14 and EcoSpecs and TPCs in Table 27.15.*

Table 27.14 EWR S3: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
4	*Pyralidae*	*0.3 - 0.6*	*Vegetation*	*High*

Table 27.15 EWR S3: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B)

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 190; ASPT value: > 6.	*SASS5 scores below 200 and ASPT below 6.2.*
To ensure that the MIRAI score remains within the range of a B category (> 82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 82.01% or less.*
Presence of at least 7 of the following 9 high-scoring taxa: Perlidae, Heptageniidae, Baetidae > 2spp., Helodidae, Athericidae, Philopotamidae, Chlorocyphidae and Pyralidae.	*Two or more of the following taxa present only as individuals, or absent altogether: Perlidae, Heptageniidae, Helodidae, Athericidae, Chlorocyphidae, Pyralidae, and Philopotamidae. Less than 2 spp. of Baetidae.*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae). No group to consistently dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*

27.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S3 (as at October 2007) for riparian vegetation was a Category A/B (89.3%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S3 are provided in Table 27.16. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 27.16 EWR S3: Riparian vegetation EcoSpecs and TPCs (PES and TEC: A/B)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Terrestrialisation	*The absence of terrestrial woody species.*	*The presence of terrestrial woody species.*
	RHAM data recorded 1% cover in the marginal zone.	
Phragmites (reed) cover	*Reed cover between 20 and 40%.*	*An increase in reed cover above 80% OR a decrease below 20%.*
	VEGRAI data recorded <10% in the marginal zone, annuals.	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 1 - 5%.*	*An increase in alien species cover above 5%.*
	VEGRAI and RHAM sites were placed differently, but data show <10% cover by alien perennial species on the marginal and upper zones. Lower zone data were <10% for RHAM site and 10 - 20% for the VEGRAI site.	
Indigenous riparian woody cover	*Indigenous riparian woody cover between 20 and 40%.*	*A decrease in riparian woody species cover below 10% OR an increase above 40%.*
	VEGRAI data range from 10 to 40%. RHAM data recorded 18% cover in the marginal zone, 10% cover in the lower zone and 14 % cover in the upper zone.	
Non-woody indigenous cover (grasses, sedges and dicotyledonous forbs)	*Maintain grass, sedge and dicotyledonous forb cover between 30% and 90%.*	*A decrease in sedge, grass and dicotyledonous forb cover below 30% OR above 90%.*
	RHAM data recorded an average of 45% cover in the riparian zone.	
Lower zone		
Indigenous riparian woody cover	*The absence of terrestrial woody species.*	*An increase in terrestrial woody species cover above 5%.*
	RHAM data recorded 8% cover in the lower zone.	
Phragmites (reed) cover	*Reed cover between 20 and 40%.*	*An increase in reed cover above 80% OR a decrease below 20%.*
	VEGRAI data recorded <10% in the lower zone and the RHAM data recorded 3% cover in the lower zone.	
Upper zone		
Phragmites (reed) cover	*Reed cover between 1 and 20%.*	*An increase in reed cover above 30% OR a total loss of reed cover.*
	VEGRAI data recorded <10% in the upper zone and RHAM data recorded 1% cover in the upper zone.	
Indigenous riparian woody cover	*Terrestrial woody cover between 10 and 20%.*	*An increase in terrestrial woody species cover above 20%.*
	RHAM data recorded 12% cover in the upper zone.	

28 IUA X3-4: RESOURCE QUALITY OBJECTIVES

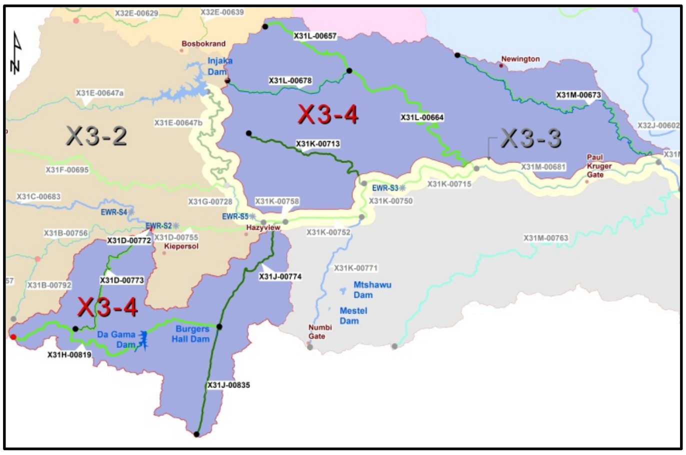
28.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Noord-Sand and White Waters Rivers as well as the Saringwa and Musutlu Rivers on the north bank of the Sabie River. This terrain is undulating and land uses are varied, consisting of forestry, intense irrigation activity, and numerous villages. Water use in this IUA consists of irrigation, supplied out of the Da Gama dams and farm dams on the Sabaan River, as well as large domestic use, supplied from the Sabie River.

The river reaches range between slightly/moderately modified (B/C PES) to largely modified (D PES). The river reaches in slightly/moderately modified condition include those with some of its catchment falling within nature conservation areas (Musutklu and upper Saringwa). The rest of the reaches in moderately modified states include the lower Saringa, Matsavana and White Waters. The reaches on largely modified condition (C/D to D PES) include the Noord-Sand and Bejani. The primary impacts in this zone are non-flow related (agriculture, high and low density rural and urban settlements) and to some extent water quality deterioration (increased nutrients).

IUA X3-4 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-4 – SABAAN*, NOORD-SAND, BEJANI, SARINGWA, MUSUTLU RIVERS



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU S5	*X31H-00819*	*White Waters*	C	C	2
RU S6	*X31J-00774*	*Noord-Sand*	D	D	3WQ
	X31J-00835	*Noord-Sand*	D	D	
RU S9	*X31K-00713*	*Bejani*	D	D	3WQ
RU S10	*X31L-00657*	*Matsavana*	C	C	2
	X31L-00664	*Saringwa*	C	C	
	X31L-00678	*Saringwa*	B/C	B/C	
RU S11	*X31M-00673*	*Musutlu*	B/C	B/C	2

**Note: The Sabaan is in an RU that falls under X3-2 and is discussed in Section 26.1.*

*The RQOs are provided below for a **Water Resource Class III** (DWS, 2014a) and the catchment configuration as illustrated above.*

28.2 RQOs FOR RU S5: MODERATE PRIORITY - 2 (X31H-00819)

This SQ situated in RU S5 requires improvement to achieve the TEC of a B/C. The flow-related actions required are improved flows, however Da Gama Dam probably has insufficient outlets to release flows, and therefore an improvement in riparian vegetation is needed to achieve the REC. This will be flagged for further investigation but improvement may be unattainable due to the constraints associated with Da Gama Dam outlets. Due to this uncertainty, the catchment configuration of a C EC was recommended (DWS, 2014a).

28.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 28.1 RU S5: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31H-00819										
C	*28.94*	*16.18*	*7.508*	*25.9*	*9.093*	*31.4*	*0.063*	*0.173*	*0.098*	*0.202*

28.2.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 28.2.

Table 28.2 RU S5: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland) and grassland.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	*To improve 25% of existing perennial aliens within the riparian zone should be removed*
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve.*	*To improve forestry and agricultural encroachment into or within the riparian zone should be reduced by 25%*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve forestry and agricultural encroachment into or within the riparian zone should be reduced by 25%*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Six endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (C. macowanii; G. perpensa and I. mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 95 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 13 under the PES. Flows should be adequate to ensure suitable habitats for primary indicator species (CANO/BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation*	*Maintain indigenous species richness (AURA, BANO, BMAR, BTRI, BUNI, CANO, CGAR, LMOL, MACU, MMAC, PPHI, TSPA and TREN) of estimated 13 species within this RU and prevent invasion or spread of alien fish species. Maintain current habitat diversity to meet requirements of all species.*
Primary indicator		*Maintain suitable flows (all seasons) to*

Indicators	Narrative RQO	Numerical RQO
species: CANO/BMAR (flow and flow related water quality, substrate condition, migration)	*as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*sustain these rheophilic and semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicators: Flow: AURA, LMOL Water quality: AURA, MMAC Substrate: AURA, LMOL Vegetation: BANO[1], PPHI, TSPA Migration: BMAR		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction in the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae	*Flows and water quality should be adequate to ensure suitable habitats for this flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*Maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

1 According to the MPTA, this species has elevated conservation status in Mpumalanga as it may potentially consist of a complex of species.

28.3 RQOs FOR RU S6: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X31J-00774, 00835)

28.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 28.3 RU S6: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31J-00774										
D	45.08	20.2	4.214	9.3	7.221	16	0.053	0.066	0.086	0.123
X31J-00835										

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
D	12.01	11.01	2.908	24.2	3.755	31.3	0.081	0.086	0.025	0.057

28.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Rural settlements, urban areas and irrigation return flows.*
Water quality issue: *Nutrients, salts, toxics, turbidity.*

Narrative and numerical details for RU S6 are provided in Table 28.4.

Table 28.4 RU S6: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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 (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

28.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 28.5 are provided for riparian vegetation only as the system is seasonal.

Table 28.5 RU S6: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain woody (woodland) but with patches of grassland and reeds common.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain largely modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	

Indicators	Narrative RQO	Numerical RQO
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*One endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 45 riparian plant taxa within the RU.*

28.4 RQOs FOR RU S9: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X31K-00713)

28.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 28.6 RU S9: Flow RQOs

TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31K-00713										
D	*2.38*	*2.36*	*0.403*	*16.9*	*0.611*	*25.7*	*0.001*	*0.007*	*0.002*	*0.009*

28.4.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Urban areas and irrigation return flows, including Mkhuhlu WWTW.*
Water quality issue: *Nutrients, salts, toxics, turbidity.*

Narrative and numerical details for RU S6are provided in Table 28.7

Table 28.7 RU S9: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 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 (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

28.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 28.8 are provided for riparian vegetation only as the system is seasonal.

Table 28.8 RU S9: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland), grassland and reeds beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain largely modified, or improve*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Four endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 30 riparian plant taxa within the RU.*

28.5 RQOs FOR RU S10: MODERATE PRIORITY – 2 (X31L-00657, 00664, 00678)

28.5.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 28.9 RU S10: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31L-00657										
C	*3.84*	*2.57*	*0.165*	*4.3*	*0.645*	*16.8*	*0*	*0*	*0.003*	*0.004*
X31L-00664										
C	*10.89*	*9.51*	*1.473*	*13.5*	*2.666*	*24.5*	*0.022*	*0.027*	*0.016*	*0.041*
X31L-00678										
B/C	*3.24*	*3.24*	*0.059*	*18.2*	*0.997*	*30.8*	*0.003*	*0.009*	*0.005*	*0.013*

28.5.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Extensive settlements.*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU S10 are provided in Table 28.10.

Table 28.10 RU S10: 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 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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).*

28.5.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 28.11.

Table 28.11 RU S10: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland), grassland areas and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain moderate or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain largely modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Four endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 30 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 13 under the PES. Flows should be adequate to ensure suitable habitats for primary indicator species (BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (BMAR, BPAU, BTRI, BUNI, BVIV, CGAR, LMOL, LCYL, LROS, MACU, MBRE, OMOS, PPHI, SINT, SMER and TREN) of estimated 16 species within this RU and prevent invasion or spread of alien fish species. Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: BMAR (flow and flow related water quality, substrate condition, migration)		*Maintain suitable flows to meet the requirements of this large semi-rheophilic species. Floods and catchment management should be adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*

Indicators	Narrative RQO	Numerical RQO
Secondary indicators: Flow: LMOL, LCYL Water quality: MACU, MBRE Substrate: LCYL, LMOL Vegetation: BPAU, PPHI Migration: LMOL, TREN		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction in the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Libellulidae	*Flows should be adequate to ensure suitable habitats for this moderate flow dependant taxon.*	*Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Coenagrionidae	*MV habitat should be adequate to accommodate this key taxon.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.*

28.6 RQOs FOR RU S11: MODERATE PRIORITY – 2 (X31M-00673)

28.6.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*

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

Table 28.12 RU S11: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31M-00673										
B/C	*1.8*	*1.8*	*0.19*	*10.6*	*0.34*	*19*	*0.001*	*0.001*	*0.002*	*0.005*

28.6.2 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 28.13.

Table 28.13 RU S11: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland), grassland areas and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone	*Riparian zone fragmentation should*	

Indicators	Narrative RQO	Numerical RQO
fragmentation	not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.	
Plant endemism	Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.	Three endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).
Threatened riparian species	Viable populations of riparian plant species with IUCN status should remain within the RU.	One listed riparian species should remain within the RU (Balanites maughamii subsp. maughamii).
Taxon richness	Maintain riparian taxon richness within the RU.	Maintain the presence of at least 55 riparian plant taxa within the RU.
FISH		
Species richness	Indigenous fish species richness estimated to be low with only five expected in reach under PES. Most species are tolerant to alterations, with the most intolerant species, and hence best indicator species, being BPAU and TREN. Conditions should remain adequate to ensure suitable habitats for the indicators. Maintain adequate flow to ensure inundation of vegetation as cover fish species and limit the construction of migration barriers to fish and colonization by alien fish species.	Maintain relative low indigenous species richness (BPAU, CGAR, OMOS, PPHI and TREN) of estimated five species within this RU and prevent invasion or spread of alien fish species. Maintain current habitat diversity to meet requirements of all species.
Primary indicator species: BPAU/TREN (vegetation, migration)		Maintain adequate flow to ensure inundation of vegetation as cover fish species and limit the construction of migration barriers to fish and colonization by alien fish species.
Secondary indicator species: none		N/A.
MACRO-INVERTEBRATES		
Libellulidae	Flows should be adequate to ensure suitable habitats for this moderate flow dependant taxon.	Maintain suitable conditions for this flow dependent taxon (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).
Coenagrionidae	MV habitat should be adequate to accommodate this key taxon.	Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for this key taxon.

29 IUA X3-5: RESOURCE QUALITY OBJECTIVES

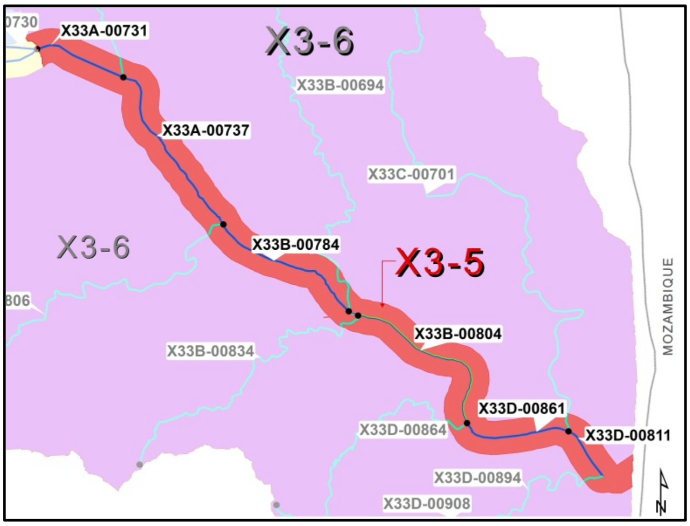
29.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the main stem of the Sabie River downstream of the confluence with Sand River. There are no dams in the IUA. The landscape is flat and is exclusively a contained within the KNP. Water use within this IUA is for game watering and domestic use at the camps within the park.

The entire main stem of the Sabie River in this IUA is protected in the KNP and only impacted by upstream influences or less significant tourist facility pressure. This places the river in a PES that varies between PES of A/B and B, except for the reach that includes the Lower Sabie Rest Camp where the impacts of the instream dam and associated influences cause a localised drop in PES.

IUA X3-5 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-5 - SABIE RIVER DS FROM SAND



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Sabie C*	*X33A-00731*	*Sabie*	**A/B**	**A/B**	**3WQ 3b**
	X33A-00737	*Sabie*	**A/B**	**A/B**	
	X33B-00784	*Sabie*	**A/B**	**A/B**	
	X33B-00804	*Sabie*	**A/B**	**A/B**	
	X33B-00829	*Sabie*	**A/B**	**A/B**	
	X33D-00811	*Sabie*	**A/B**	**A/B**	
	X33D-00861	*Sabie*	**A/B**	**A/B**	

** These SQs form part of EWR S3, which is situated in IUA X3-3, MRU Sabie B. Please refer to Section 27.3 for further details.*

*The RQOs are provided below for a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

The SQs falling within MRU Sabie C in IUA X3-5 have a 3 Priority Rating for water quality. While water quality and flow RQOs are provided in the following section for MRU Sabie C, the biotic requirements are represented by EWR S3, which is situated largely in IUA X3-3 in MRU Sabie B. Please refer to Section 27.3 for further detail on habitat and biotic RQOs.

29.2 RQOs FOR MRU SABIE C: HIGH PRIORITY - 3 FOR WATER QUALITY (X33A-00731, 00737, X33B-00784, 00804, X33D-00811, 00861)

29.2.1 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used. Note that this reach extends to the Mozambican border, so a more detailed list of objectives is provided (as required by the 2002 IncoMaputo agreement).*
Model: *N/A.*
Users: *Skukuza camp in the Kruger National Park; international obligations.*

Water quality issue: *Nutrients.*

Narrative and numerical details for MRU SABIE C are provided in Table 29.1.

Table 29.1 MRU SABIE C: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P.*
Ensure that electrical conductivity (salt) levels are within Ideal limits.	*95^{th} percentile of the data must be less than or equal to 42 mS/m.*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity.*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
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 water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

30 IUA X3-6: RESOURCE QUALITY OBJECTIVES

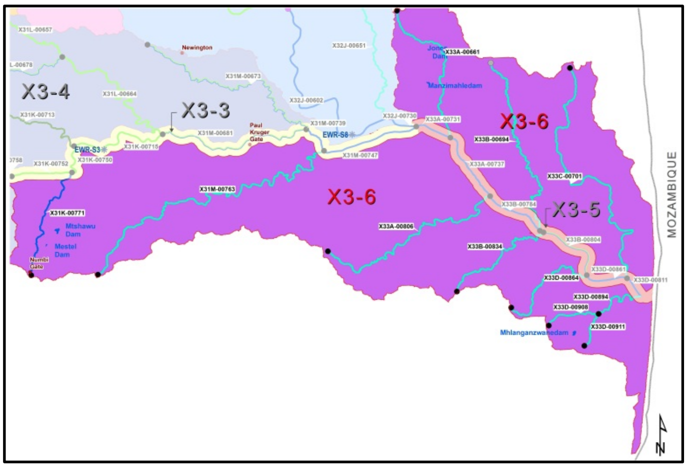
30.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of the tributaries of the Sabie River downstream of the confluence with the Sand River located within the KNP. There are no dams in this IUA. The landscape is very flat and the land is all wilderness area. Water use is linked to tourism.

The Pabeni River flows in the KNP but close to the border, with mostly small non-flow impacts such as grazing and flooding, bank erosion due to the bridge and roads, thus it has a B PES. All the other rivers fall within the KNP and have no or limited impacts, i.e. in an A PES.

IUA X3-6 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-6 - SOUTHERN AND NORTHERN TRIBS OF THE SABIE IN THE KNP DS OF THE SAND CONFLUENCE INCLUDING THE PHABENI



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU S7	*X33D-00864*	*Mosehla*	A	A	1
	X33D-00894	*Nhlowa*	A	A	
	X33D-00908	*Shimangwana*	A	A	
	X33A-00806	*Nwatimhiri*	A	A	
	X33B-00694	*Salitje*	A	A	
	X31M-00763	*Nwaswitshaka*	A	A	
	X33A-00661	*Nwatindlopfu*	A	A	
	X33B-00834	*Lubyelubye*	A	A	
	X33C-00701	*Mnondozi*	A	A	
	X33D-00911	*Nhlowa*	A	A	
	X31K-00771	*Phabeni*	B	B	

*The IUA is a **Water Resource Class I** (DWS, 2014a) and the catchment configuration as illustrated above.*

31 IUA X3-7: RESOURCE QUALITY OBJECTIVES

31.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the Mutlumuvi River, a major tributary of the Sand River. There are no dams on this river although the failed Zoeknog Dam was located on this river. The Mutlumuvi River rises on escarpment and drops rapidly to the Lowveld plains. Land use consists of forestry on the mountain slopes, numerous villages, grazing, limited irrigation and subsistence dry-land agriculture. Water use in this IUA is domestic water use supplied mostly from the Inyaka Dam but still supplemented from run-of-river abstractions. There is also limited supply to irrigation via the New Forest canal which diverts water out of the river at the New Forest weir.

This IUA is situated in an area dominated by rural agriculture and urbanization, and the main influence on the rivers is non-flow issues, such as agricultural fields, vegetation removal, overgrazing and trampling, sedimentation, bed and channel disturbance. However, additional smaller flow and water quality impacts also cause the SQs in the IUA to vary in PES levels between C/D and D/E.

IUA X3-7 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

UA X3-7 - MUTLUMUVI RIVER

PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Mut A	*X32D-00605**	*Mutlumuvi*			3
	X32F-00597 EWR S6	*Mutlumuvi*	C	C	
RU S13	*X32E-00639*	*Ndlobesuthu*	D/E	D/E	3WQ
RU S12	*X32F-00628*	*Nwarhele*	C/D	C/D	2
	X32E-00629	*Nwarhele*	C/D	C	

** Where SQ does not have a EC the EC is different from the EWR S6. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this MRU.*

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

31.1 RQOs FOR MRU MUT A: HIGH PRIORITY – 3 (EWR S6: X32F-00597; INCLUDING X32D-00605)

The TECs is provided for EWR S6 below. Note that EWR S6 represents the Mutlumuvi River and will be impacted by Sc S71 which was the preferred scenario for the Sand River System (refer to section 1.6.4). It must be noted that as S71 includes a new dam (the New Forest Dam) that may only be constructed in the far future, therefore the current state in the short term was recommended and S71 in the long term if New Forest Dam is constructed (DWS, 2014a).

Table 31.1 TECs for EWR S6

Component	PES, Immediately applicable	REC	Sc S71
Physico chemical	B/C	B/C	C
Geomorphology	C	C	D
Fish	C	B	C/D
Invertebrates	B/C	B	C
Riparian vegetation	C	B	C
EcoStatus	C	B	C

31.1.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 31.2 MRU MUT A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X32F-00597 (EWR S6)											
C	C[1]	45.0	36.6	10	22.21	12.81	28.46	0.016	0.042	0.111	0.193
C	C[2]	45.0	36.6	12.9	29	27.8	61.7	0.18	0.27	0.27	0.33

1 C RQO for the short term EC.
2 C RQO associated with Sc S71. Note these are the total flows flowing past the site and includes requirements for other users.

31.1.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Settlements and irrigation return flows.*
Water quality issue: *Nutrients, salts, toxics, turbidity/suspended solids.*
Narrative and Numerical: *Details for MRU MUT A are provided in Tables 31.3 and 31.4 (EWR S6). Data used for water quality assessments should be collected from X3H008Q01.*

Table 31.3 MRU MUT A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 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/clarity or Total Suspended Solids (TSS) levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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).*

Narrative RQO	Numerical RQO
Ensure that toxics are within CEV limits.	95th percentile of the data must be within the CEV limits in DWAF (2008b). Numerical limits can be found in DWAF (1996a) and DWAF (2008b).
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	See specified biota requirements.

Table 31.4 EWR S6: Water quality EcoSpecs and TPCs (PES and TEC: B/C; Sc S71: C)

River: Mutlumuvi Monitoring site: X3H008Q01	PES: B/C EC Sc S71: 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 13 - 16mg/L.
Na_2SO_4	The 95th percentile of the data must be ≤ 20 mg/L. The 95th percentile of the data must be ≤ 33 mg/L.	The 95th percentile of the data must be 16 - 20 mg/L. The 95th percentile of the data must be 26 - 33 mg/L.
$MgCl_2$	The 95th percentile of the data must be ≤ 15 mg/L	The 95th percentile of the data must be 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 17 - 21 mg/L.
NaCl	The 95th percentile of the data must be ≤ 45 mg/L. The 95th percentile of the data must be ≤ 191 mg/L.	The 95th percentile of the data must be 36 - 45 mg/L. The 95th percentile of the data must be 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 280 - 351 mg/L.
Physical variables		
Electrical Conductivity	The 95th percentile of the data must be ≤ 42 mS/m (A/B Category). The 95th percentile of the data must be ≤ 55 mS/m.	The 95th percentile of the data must be 35 - 42 mS/m. The 95th percentile of the data must be 45 - 55 mS/m.
pH	The 5th percentile of the data must range from 6.5 to 8.0, and the 95th percentile from 6.5 to 8.8.	The 5th percentile of the data must be < 6.7 and > 7.8, and the 95th percentile must be < 6.7 and > 8.6.
Temperature[(b)]	Small deviation from the natural temperature range.	Initiate baseline monitoring for this variable.
Dissolved oxygen[(b)]	The 5th percentile of the data must be ≥ 7.0 mg/L. The 5th percentile of the data must be ≥ 6.0 mg/L.	The 5th percentile of the data must be 7.2 - 7 mg/L. Initiate baseline monitoring for this variable. The 5th percentile of the data must be 6.2 - 6 mg/L.
Turbidity[(b)]	Small to moderate changes to the catchment land-use resulting in minor effects of silting of habitats, largely of a temporary nature, with very intermittent temporary unnaturally high sediment loads and high turbidities.	Initiate baseline monitoring for this variable.
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 0.56 - 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 0.1 - 0.125 mg/L.
Response variables		
Chl-a	The 50th percentile of the data must be <10	The 50th percentile of the data must be 8 -

River: Mutlumuvi Monitoring site: X3H008Q01		PES: B/C EC Sc S71: C EC
Water quality metrics	**EcoSpecs**	**TPC**
phytoplankton(b)	*µg/L.*	*10 µg/L.*
Chl-a periphyton	*The 50th percentile of the data must be ≤ 84 mg/m².*	*The 50th percentile of the data must be 67 - 84 mg/m².*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).* *The 95th percentile of the data must be within the CEV as stated in DWAF (1996a).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996a) or the A category boundary as stated in DWAF (2008b).* *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 (if available) when the TPC for Electrical Conductivity 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.

31.1.3 Habitat and biota RQOs (EcoSpecs)

31.1.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this MRU was indicated as a C (DWAF, 2010a) and it should be aimed to maintain this EC in future. Under Sc S71 it is estimated that the ecological status of the fish assemblage will deteriorate slightly towards a Category C/D. The overall indigenous fish species richness of this reach is high, estimated to be as high as twenty-nine species under present conditions. Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this unit include the small rheophilic pennant-tail suckermouth (CANO) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU is especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien fish species*

Numerical: *EcoSpecs and TPCs for EWR S6 are provided in Table 31.5.*

Table 31.5 EWR S6: Fish EcoSpecs and TPCs (PES and TEC: C; Sc S71: C/D)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc S71
Ecological status	*All spp.*	*Baseline FRAI[3] score of 69.2% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of indicator species mentioned in this table OR FRAI scores decreasing below 65% (C/D EC).*	*Any deterioration in habitat that results in decrease in FROC of species.*	*Ecological status based on fish expected to decrease to a Category C/D.*
Species richness	*All indigenous species*	*14 out 29 expected indigenous fish species were sampled during the baseline (EWR) survey at the EWR site.*	*Less than 12 fish species sampled during a survey at EWR site when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*	*No change in species richness, although abundance and FROC of especially intolerant species may be reduced.*
Relative abundance	*N/A.*	*During recent surveys fish were sampled at 5.2 ind/min.*	*Relative abundance of less than 4.5 ind/min sampled at the site (during same season as baseline data).*	*N/A*	*Slight overall decrease in abundance of fish expected.*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*	*No notable change.*
FD Habitats	**CANO BMAR**	*During the recent baseline (EWR) survey CANO was present at a relative abundance of 0.50 ind/min and BMAR at 0.55 ind/min.*	*CANO and BMAR absent during any survey or present at relative abundance of < 0.30 ind/min for CANO and < 0.35 ind/min for BMAR.*	*Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to substrate and water quality deterioration.*
FS habitats	*CANO CSWI BMAR*	*During the recent baseline (EWR) survey CANO was present at a relative abundance of 0.50 ind/min, CSWI at 0.03 ind/min and BMAR at 0.55 ind/min.*	*CANO and BMAR absent during any survey or present at relative abundance of < 0.30 ind/min for CANO and < 0.35 ind/min for BMAR and CSWI absent for two consecutive surveys.*		
Substrate	*CANO LMOL BMAR*	*During the recent baseline (EWR) survey CANO was present at a relative abundance of 0.50 ind/min, LMOL at 0.08 ind/min and BMAR at 0.55 ind/min.*	*CANO and BMAR absent during any survey or present at relative abundance of < 0.30 ind/min for CANO and < 0.35 ind/min for BMAR and LMOL absent for two consecutive surveys.*		*Decreased FROC and abundance expected due to substrate and water quality deterioration (no notable change in flows, only floods).*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc S71
Flow dependant spp. (flow alteration)	*CANO CSWI BEUT*	*CANO, CSWI and BEUT will be most appropriate indicators of flow at the site. During the recent baseline (EWR) survey CANO was present at a relative abundance of 0.50 ind/min, CSWI at 0.03 ind/min and BEUT at 0.43 ind/min.*	*CANO and BEUT absent during any survey or present at relative abundance of < 0.30 ind/min for CANO and < 0.20 ind/min for BEUT and CSWI absent for two consecutive surveys.*		*Decreased FROC and abundance expected due to substrate and water quality deterioration (no notable change in flows, only floods).*
Water quality intolerance	*CANO BEUT*	*CANO and BEUT will be most appropriate indicators of water quality at the site. During the recent baseline (EWR) survey CANO was present at a relative abundance of 0.50 ind/min and BEUT at 0.43 ind/min.*	*CANO and BEUT absent during any survey OR present at relative abundance of < 0.30 ind/min for CANO and < 0.20 ind/min for BEUT.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*	*Decreased FROC and abundance expected due to substrate and water quality deterioration (no notable change in flows, only floods).*
SD habitats	*OMOS BMAR*	*OMOS and BMAR will be most appropriate indicators of SD habitats at the site. During the recent baseline (EWR) survey OMOS was present at a relative abundance of 0.72 ind/min and BMAR at 0.55 ind/min.*	*OMOS and BMAR absent during any survey or present at relative abundance of < 0.35 ind/min for BMAR and < 0.50 ind/min for OMOS.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to substrate, water quality and vegetative habitat deterioration (no notable change in flows, only floods).*
Water column	*MBRE BMAR*	*Species with high indicator value for water column is MBRE and BMAR. During the recent baseline (EWR) survey MBRE was present at a relative abundance of 0.02 ind/min and BMAR at 0.55 ind/min.*	*BMAR absent during any survey or present at a relative abundance of < 0.35 ind/min and MBRE absent for two consecutive surveys.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*	*Decreased FROC and abundance expected due to substrate, water quality and vegetative habitat deterioration (no notable change in flows, only floods).*
SS habitats	*BVIV MACU*	*BVIV and MACU will be most appropriate indicators of SS habitats at the site. During the recent baseline (EWR) survey BVIV was present at a relative abundance of 0.12 ind/min and MACU at 0.03 ind/min.*	*BVIV absent during any survey or present at a relative abundance of < 0.05 ind/min and MACU absent for two consecutive surveys.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to water quality and vegetative habitat deterioration (no notable change in flows, only floods).*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)	Estimated change in Ecospecs under Sc S71
Overhanging vegetation	*BVIV BTRI*	*BVIV and BTRI will be the most appropriate indicators of overhanging vegetation habitats at the site. During the recent baseline (EWR) survey BVIV was present at a relative abundance of 0.12 ind/min and BTRI at 0.72 ind/min.*	*BVIV & BTRI absent during any survey or BVIV present with relative abundance < 0.05 ind/min and BTRI < 0.5 ind/min.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to water quality and vegetative habitat deterioration (no notable change in flows, only floods).*
Undercut banks	*MMAC BEUT*	*MMAC and BEUT will be the most appropriate indicators of undercut banks habitat at the site. During the recent baseline (EWR) survey MMAC was present at a relative abundance of 0.03 ind/min and BEUT at 0.43 ind/min.*	*BEUT absent during any survey or present at a relative abundance of < 0.20 ind/min and MMAC absent for two consecutive surveys.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to water quality and vegetative habitat deterioration (no notable change in flows, only floods).*
Instream vegetation	*TREN BVIV*	*Species with high indicator value for instream vegetation at this site is TREN and BVIV. During the recent baseline (EWR) survey TREN was present at a relative abundance of 0.07 ind/min and BVIV at 0.12 ind/min.*	*BVIV absent during any survey or with relative abundance < 0.05 ind/min and TREN absent for two consecutive surveys.*	*Significant change in instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*	*Decreased FROC and abundance expected due to water quality and vegetative habitat deterioration (no notable change in flows, only floods).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*	*Decrease abundance and FROC of migratory species due to construction of migration barrier (dam wall).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold***.*

31.1.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S6 is a Category B/C for the PES and a Category B for the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized Lowveld river associated with perennial flows; a slow-flowing river with a sandy substrate (alluvial), and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools surrounded by reeds. Under Sc S71 the macro-invertebrates deteriorate to a C EC.*

Numerical: *Indicator taxa for EWR S6 are provided in Table 31.6 and EcoSpecs and TPCs in Table 31.7.*

Table 31.6 EWR S6: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Hydropsychidae*	*0.3 - 0.6*	*Cobbles*	*Low*
2	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*

Table 31.7 EWR S6: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B/C; Sc S71: C)

EcoSpecs	TPCs	Estimated change in Ecospecs under Sc S71
SASS5 scores and ASPT values occur in the following range: SASS5 score: > 180; ASPT value: > 6.	*SASS5 scores below 190 and ASPT below 6.*	*Ensure that the SASS5 scores are > 170*
Ensure that the MIRAI score remains within the range of a B/C category (>77.4 – <82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 64% or less.*	*Ensure that the MIRAI score remains in a C category (>62-77%).*
Presence of Heptageniidae and Hydropsychidae 2 spp.	*Absence of Heptageniidae, and/or less than 2 spp. of hydropsychids or individuals only.*	*Presence of Heptageniidae and Hydropsychidae 2 spp.*
Balanced community structure, i.e. majority of macroinvertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae, Baetidae, and Heptageniidae). *No group to dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.*	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*	*Balanced community structure, i.e. majority of macroinvertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae, Baetidae, and Heptageniidae).* *No group to dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.*

31.1.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S6 (as at October 2007) for riparian vegetation was a Category C (75.6%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S6 are provided in Table 31.8. There was moderate confidence in the EcoSpecs and TPCs since only VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 31.8 EWR S6: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Indigenous riparian woody cover	*Riparian woody cover between 1 and 80%.*	*An increase in riparian woody cover of more than 70% OR a decrease below 5%.*
	VEGRAI data recorded <10% cover.	
Phragmites (reed) cover	*Reed cover between 10% and 20%.*	*A decrease in reed cover below 20%.*
	VEGRAI data recorded 20 - 30% cover.	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 15 - 20%.*	*An increase in alien species cover above 20%.*
	VEGRAI data recorded <10% (marginal zone, annuals), 10 - 20% (lower zone), and <10% (upper zone).	
Lower zone		
Indigenous riparian woody cover	*Riparian woody cover between 5 and 60%.*	*An increase in riparian woody cover of more than 50% OR a decrease below 10%.*
	VEGRAI data recorded 10 - 20% cover.	
Phragmites (reed) cover	*Reed cover between 10% and 90%.*	*An increase in reed cover above 80% or a decrease below 20%.*
	VEGRAI data recorded 20 - 40% cover.	
Upper zone		
Indigenous riparian woody cover	*Riparian woody cover between 20 and 70%.*	*A decrease in riparian woody species cover below 20% OR above 70%.*
	VEGRAI recorded 20 - 40% cover.	
Phragmites (reed) cover	*Reed cover between 40% and 50%.*	*An increase in reed cover above 40%.*
	VEGRAI data recorded <20% cover.	

31.2 RQOs FOR RU S13: HIGH PRIORITY - 3 FOR WATER QUALITY (X32E-00639)

X32E-00639 requires improvement to achieve the TEC of a D. However the area is highly populated and improvement is unlikely. The PES of a D/E is likely to be maintained in the future (DWS, 2014a). No flow RQOs are therefore provided.

31.2.1 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Extensive settlements. Urban runoff and effluent discharge (Bushbuckridge) resulting in high algal levels.*
Water quality issue: *Nutrients, salts, turbidity, toxics.*

Narrative and numerical details for RU S13 are provided in Table 31.10.

Table 31.9 RU S13: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that periphyton chl-a levels are within Tolerable limits.	*50^{th} percentile of the data must be less than or equal to 84 mg/m^2 (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 42 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95^{th} percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Meet faecal coliform and E.coli targets for recreational (full contact) use.	*Meet the TWQR of 0 - 130 counts per 100 ml (DWAF, 1996a).*

31.3 RQOs FOR RU S12: MODERATE PRIORITY – 2 (X32F-00628, X32E-00629)

X32E-00629 requires improvement to achieve the TEC. Riparian zone improvement will improve the upper reaches of the river, however the lower reaches have very dense settlements and improvement is unlikely. The riparian zone improvement can improve the EC by half a category. This is attainable and the EC of a C will then also be the result of Sc S71 as this flow scenario does not impact on this node and reach of the river (DWS, 2014a).

31.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 31.10 RU S12: Flow RQOs

REC (EWR)	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X32F-00628										
C/D	*14.77*	*13.99*	*3.437*	*23.3*	*4.629*	*31.3*	*0.02*	*0.041*	*0.027*	*0.07*
X32E-00629										
C[1]	*10.58*	*9.93*	*2.133*	*20.2*	*3.029*	*28.6*	*0.039*	*0.043*	*0.031*	*0.052*

** The EWR rule is provided for a C/D as the improvements to a C are based on non flow-related measures.*

31.3.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Extensive settlements.*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU S12 are provided in Table 31.11.

Table 31.11 RU S12: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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).*

31.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 31.12.

Table 31.12 RU S12: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland), grassland areas and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	*To improve 10% of existing perennial aliens within the riparian zone should be removed*
Riparian zone continuity	*Riparian zone continuity should remain largely modified, or improve*	*N/A*
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	*To improve agricultural and forestry encroachment into or within the riparian zone should be reduced by 15%*
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Twelve endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Three listed riparian species should remain within the RU (Cyathea capensis var. capensis, Erica rivularis and Ilex mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 90 riparian plant taxa within the RU.*
FISH		
Species richness	*Indigenous fish species richness estimated to be 19 under PES. Flows should be adequate to ensure suitable habitats for primary indicator species (CANO/BMAR). Flood regime, catchment management and water quality should also be optimised to maintain adequate rocky substrate quality. Maintain adequate vegetation as cover for some fish species and do not allow an increase in migration barriers to fish and further increase in alien predatory fish species.*	*Maintain indigenous species richness (AMOS, BANN, BEUT, BRAD, BMAR, BTRI, BUNI, BVIV, CANO, CGAR, LCYL, LMOL, MACU, MBRE, MMAC, OMOS, PCAT, PPHI and TREN) of estimated 19 species within this RU and prevent invasion or spread of alien fish species. Maintain current habitat diversity to meet requirements of all species.*
Primary indicator species: CANO/BMAR (flow, flow related water quality,		*Maintain suitable flows (all seasons) to sustain these rheophilic and semi-rheophilic species. Floods and catchment management should be*

Indicators	Narrative RQO	Numerical RQO
substrate condition, migration)		*adequate to prevent deterioration in rocky substrate condition. Adequate depth should also be provided to facilitate migration (especially wet season).*
Secondary indicator species: Flow: BEUT, LMOL Water quality: BEUT, MMAC Substrate: BEUT, LMOL Vegetation: BANN, BRAD, PPHI Migration: LMOL		*Ensure the habitat requirements of the secondary indicator species are maintained and do not allow reduction in the FROC of these species in the reach. Prevent the construction of any further migration barriers to fish movement.*
MACRO-INVERTEBRATES		
Perlidae Oligoneuridae	*Flows and water quality should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and good water quality in the SIC biotope (15 cm depth).*
Psephenidae Trichorythidae Philopotamidae	*Flows should be adequate to ensure suitable habitats for these flow dependant taxa.*	*To maintain suitable conditions for these flow dependent taxa (high velocity: > 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Heptageniidae	*Habitat and water quality should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions in the SIC habitat regarding moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Elmidae	*Habitat and medium flows should be adequate to ensure suitable habitats for this sensitive taxon.*	*To maintain suitable conditions for this flow dependent taxon (moderate velocity: 0.3 - 0.6 m/s) and moderate water quality in the SIC biotope (15 cm depth).*
Pyralidae	*MV habitat and water quality should be adequate to accommodate this key taxon.*	*To maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) and good water quality for this taxon.*
Coenagrionidae Hydraenidae	*MV habitat should be adequate to accommodate these key taxa.*	*Maintain suitable conditions in the MV in moderate velocity (0.3 - 0.6 m/s) for these key taxa.*

32 IUA X3-8: RESOURCE QUALITY OBJECTIVES

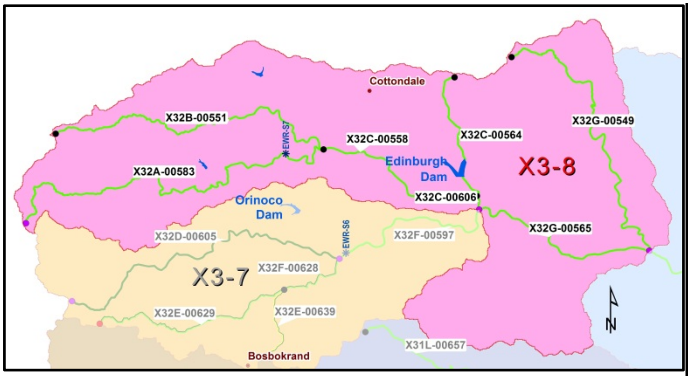
32.1 IUA OVERVIEW AND DESCRIPTION

This IUA consists of the northern tributaries of the Sand River, i.e. the Klein-sand and Thulandziteka Rivers. There are several small dams in the IUA, namely, the Kasteel, Acornhoek, Orinoco and Edinburgh dams. The terrain is the same as the IUA Sab7 with the rivers rising on the escarpment and falling rapidly to the Lowveld plains. Landuse is forestry, grazing, villages, irrigation and dry-land subsistence agriculture.

Most of the impacts on the rivers in IUA X3-8 are related to rural agriculture and urbanization such as agricultural fields, vegetation removal, overgrazing and trampling, sedimentation, bed and channel disturbance. This puts all the SQs in a C PES.

IUA X3-8 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-8 - NORTHERN SAND TRIBUTARIES



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
MRU Sand A	*X32A-00583 EWR S7*	*Tlulandziteka*	C	C	3
	*X32C-00558**	*Nwandlamuhari*			
	*X32C-00606**	*Nwandlamuhari*			
RU S14	*X32B-00551*	*Motlamogatsana*	C	C	3WQ
	X32C-00564	*Mphyanyana*	C	C	2
RU S15	*X32G-00549*		C	C	2

** Where SQ does not have a EC the EC is different from the EWR S7. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this MRU.*

*The RQOs are provided below for a **Water Resource Class II** (DWS, 2014a) and the catchment configuration as illustrated above.*

32.2 RQOs FOR MRU SAND A: HIGH PRIORITY – 3 (EWR S7: X32A-00583; INCLUDING X32C-00558, 00606)

32.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*
Scenario model: *WReMP (Mallory et al., 2010).*

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

Table 32.1 MRU SAND A: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X32A-00583 (EWR S7)											
C	C	*28.9*	*15.6*	*5.12*	*17.7*	*8.3*	*28.7*	*0.008*	*0.025*	*0.077*	*0.118*

32.2.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Rural settlements and irrigation return flows.*
Water quality issue: *Nutrients, salts, toxics, turbidity/suspended solids.*
Narrative and Numerical: *Details for MRU SAND A are provided in Tables 32.2 and 32.3 (EWR S7). Data used for water quality assessments should be collected from X3H008Q01.*

Table 32.2 MRU SAND A: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50th percentile of the data must be less than 0.125 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 42 mS/m (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A moderate change from present with temporary high sediment loads and turbidity (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 or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*
Ensure water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 32.3 EWR S7: Water quality EcoSpecs and TPCs (PES and TEC: C)

River: Tlulandziteka	**PES: C EC**	
Monitoring site: X3H008Q01		
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 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 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 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 17 - 21 mg/L.*
NaCl	*The 95th percentile of the data must be ≤ 45 mg/L.*	*The 95th percentile of the data must be 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 280 - 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95th percentile of the data must be ≤ 42 mS/m (A/B Category).*	*The 95th percentile of the data must be 35 - 42 mS/m.*
pH	*The 5th percentile of the data must range from 6.5 to 8.0, and the 95th percentile from 6.5 to 8.8.*	*The 5th percentile of the data must be < 6.7 and > 7.8, and the 95th percentile must be < 6.7 and > 8.6.*
Temperature(b)	*Small deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved	*The 5th percentile of the data must be ≥*	*The 5th percentile of the data must be 7.2*

River: Tlulandziteka Monitoring site: X3H008Q01		PES: C EC
Water quality metrics	**EcoSpecs**	**TPC**
oxygen[(b)]	*7.0 mg/L.*	*- 7 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Moderate changes to the catchment land-use resulting in temporary unnaturally high sediment loads and high turbidities.*	*Initiate baseline monitoring for this variable.*
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 0.56 - 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 0.1 - 0.125 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50th percentile of the data must be <10 µg/L.*	*The 50th percentile of the data must be 8 - 10 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 67 - 84 mg/m^2.*
Toxics		
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

32.2.3 Habitat and biota RQOs (EcoSpecs)

32.2.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this MRU was indicated as a C (DWAF, 2010a) and it should be aimed to maintain this EC in future. The overall indigenous fish species richness of this reach is high, estimated to be as high as 29 species under present conditions. Various species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this MRU include the small rheophilic pennant-tail suckermouth (CANO) and the large semi-rheophilic largescale yellowfish (BMAR). Both these species are good indicators of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspect of the ecosystem. Fish in this MRU are especially vulnerable to flow modification (reduced baseflows and floods), water quality deterioration, bed modification and the spread of alien fish species.*

Numerical: *EcoSpecs and TPCs for EWR S7 are provided in Table 32.4.*

Table 32.4 EWR S7: Fish EcoSpecs and TPCs (PES and TEC: C)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI*[3] *score of 65.4% calculated for reach (DWA, 2010a).*	*Any decreased FROC*[2] *in reach of indicator species mentioned in this table (refer to sheet 5-FROC*[5]*) OR FRAI scores*	*Any deterioration in habitat that results in decrease in FROC of species.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
			decreasing below 62% (C/D EC).	
Species richness	All indigenous species	Five of the 28 expected indigenous fish species were sampled during the baseline (EWR) survey. Sampling conditions were not optimal due to high flows and it can be expected that at least 14 species are present at the site.	Less than 10 fish species sampled during a survey at EWR site when sampling conditions are optimal and habitat can be sampled efficiently.	Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).
Relative abundance	N/A.	During recent baseline (EWR) survey fish were sampled at 3.5 ind/min. This may be even higher during optimal sampling conditions.	Relative abundance of less than 2 ind/min sampled at the site (during same season as baseline data with optimal sampling conditions).	N/A
Alien fish species	Any alien/intro-duced spp.	No alien fish species sampled at site during recent surveys.	Presence of any alien/introduced fish species at site during any survey.	N/A.
FD Habitats	CANO BMAR	During recent baseline (EWR) survey CANO was present at site at a relative abundance of 0.15 ind/min and BMAR at a relative abundance of 1.56 ind/min.	CANO and BMAR absent from site during any survey OR present at relative abundance < 0.1 ind/min for CANO and < 1.2 ind/min for BMAR.	Reduced suitability (abundance and quality) of FD and FS habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).
FS habitats				
Substrate				
Flow dependant spp. (flow alteration)	CANO BEUT	CANO and BEUT will be most appropriate indicators of flow at the site. During the recent baseline survey CANO was present at site at a relative abundance of 0.15 ind/min and BEUT at a relative abundance of 1.13 ind/min.	CANO and BEUT absent from site during any survey OR present at relative abundance < 0.1 ind/min for CANO and < 0.9 ind/min for BEUT.	
Water quality intolerance				Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).
SD habitats	OMOS BMAR	OMOS and BMAR will be most appropriate indicators of SD, SS & water column habitats at the site. During recent baseline (EWR) survey OMOS was present at site at a relative abundance of 0.02 ind/min and BMAR at a relative abundance of 1.56 ind/min.	OMOS and BMAR absent from site during any survey OR BMAR present at relative abundance of < 1. 2 ind/min.	Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).
Water column	BMAR OMOS			Reduction in suitability of water column (i.e. increased sedimentation of pools).

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
SS habitats	*OMOS BMAR*			*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).*
Overhanging vegetation	*BTRI BEUT*	*BTRI and BEUT will be most appropriate indicators of overhanging vegetation habitats at the site. During recent baseline (EWR) survey BTRI was present at site at a relative abundance of 0.67 ind/min and BEUT at a relative abundance of 1.13 ind/min.*	*BTRI and BEUT absent from site during any survey OR present at relative abundance < 0.40 ind/min for BTRI and < 0.9 ind/min for BEUT.*	*Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009).*
Undercut banks	*BEUT*	*BEUT is the most appropriate indicator of undercut banks at this site. During recent baseline (EWR) survey BEUT was present at site at a relative abundance of 1.13 ind/min*	*BEUT absent during any survey or present with relative abundance < 0.9 ind/min.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Instream vegetation	*TREN BVIV BPAU BANO*	*No indicator species for instream vegetation were sampled during the recent baseline (EWR) survey and therefore the TPCs and EcoSpecs for this habitat at this site cannot be derived at present. Should any of these species be sampled in future, TPCs should be derived at that stage.*		*Significant change in instream vegetation habitats (to be quantified by RHAM; DWA, 2009).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous[1] species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.
5 Provided electronically.

32.2.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S7 is a Category B/C for the PES and a Category B for the REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized Lowveld river associated with perennial flows; a slow-flowing river with a sandy substrate (alluvial), and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools surrounded by reeds.*

Numerical: *Indicator taxa for EWR S7 are provided in Table 32.5 and EcoSpecs and TPCs in Table 32.6.*

Table 32.5 EWR S7: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*
3	*Elmidae*	*0.3 - 0.6*	*Cobbles*	*Moderate*

Table 32.6 EWR S7: Macro-invertebrate EcoSpecs and TPCs (PES and TEC: B/C)

EcoSpecs	TPCs
SASS5 scores and ASPT values occur in the following range: SASS5 score: > 190; ASPT value: > 6.	*SASS5 scores below 195 and ASPT below 6.2.*
MIRAI score remains within the range of a B/C category (77.4% - 82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 80% or less.*
Presence of at least 4 of the following 5 taxa at A (or greater) abundance: Perlidae, Heptageniidae, Chlorocyphidae, Helodidae, Athericidae. At least 2 spp. of Hydropsychidae and Baetidae.	*Absence (or individuals only) of any 2 of the following taxa over Perlidae, Heptageniidae, Chlorocyphidae, Helodidae, Athericidae. Less than 2 spp. of baetids or hydropsychids.*
Balanced community structure, i.e. majority of macroinvertebrates at A abundance, certain taxa at B abundance (e.g. Simuliidae, Hydropsychidae, Baetidae, and Heptageniidae). No group to dominate the fauna, i.e. be present in C abundance (> 100) over more than two consecutive surveys.	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*

32.2.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S7 (as at October 2007) for riparian vegetation was a Category C (66.6%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S7 are provided in Table 32.7. There was moderate confidence in the EcoSpecs and TPCs since only VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 32.7 EWR S7: Riparian vegetation EcoSpecs and TPCs (PES and TEC: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Indigenous riparian woody cover	*Riparian woody cover between 1 and 80%.*	*An increase in riparian woody cover of more than 70% OR a decrease below 5%.*
	VEGRAI data recorded <10% cover.	
Phragmites (reed) cover	*Reed cover between 10% and 20%.*	*A decrease in reed cover below 20%.*
	VEGRAI data recorded 10 - 20% cover.	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 15 - 20%.*	*An increase in alien species cover above 20%.*
	VEGRAI recorded data: 10% (marginal zone), 10 - 20% (lower zone), and 40 -	

Assessed Metric	EcoSpec	TPC
	60% (upper zone).	
Lower zone		
Terrestrialisation	*Terrestrial woody cover between 5 and 10%.*	*An increase in terrestrial woody species cover >10%.*
	Not high, but removal of selected riparian species for wood will facilitate higher values.	
Indigenous riparian woody cover	*Riparian woody cover between 5 and 60%.*	*An increase in riparian woody cover of more than 50% OR a decrease below 10%.*
	VEGRAI data recorded 10 - 20% cover.	
Phragmites (reed) cover	*Reed cover between 10% and 90%.*	*An increase in reed cover above 80% or a decrease below 20%.*
	VEGRAI data recorded 20 - 40% cover.	
Upper zone		
Terrestrialisation	*Terrestrial woody cover between 20 and 30%.*	*An increase in terrestrial woody species cover >30%.*
	Not high, but removal of selected riparian species for wood will facilitate higher values.	
Indigenous riparian woody cover	*Riparian woody cover between 20 and 70%.*	*A decrease in riparian woody species cover below 20% OR above 70%.*
	VEGRAI data recorded 10 - 20% cover.	
Phragmites (reed) cover	*Reed cover between 40% and 50%.*	*An increase in reed cover above 40%.*
	VEGRAI data recorded 10 - 20% cover.	

32.3 RQOs FOR RU S14: HIGH PRIORITY - 3 FOR WATER QUALITY AND MODERATE FOR BIOTA AND HABITAT (X32B-00551, X32C-00564)

32.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *X32B-00551: RDRM (Hughes et al., 2013); X32C-00564: DRM (Hughes and Hunnart, 2003).*

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

Table 32.8 RU S14: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X32B-00551										
C	*15.36*	*10.36*	*2.75*	*17.9*	*3.945*	*25.7*	*0.015*	*0.026*	*0.025*	*0.058*
X32C-00564										
C	*3.1*	*2*	*0.05*	*1.6*	*0.33*	*10.5*	*0*	*0*	*0*	*0*

32.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Hospital WWTW (Acornhoek area).*
Water quality issue: *Nutrients, toxics, suspended solids.*

Narrative and numerical details for RU S14 are provided in Table 32.9.

Table 32.9 RU S14: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Acceptable limits.	*50th percentile of the data must be less than 0.025 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 -1 30 counts per 100 ml (DWAF, 1996a).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*
Ensure that toxics are within Ideal limits or A categories or TWQR.	*95th percentile of the data must be within the TWQR for toxics or the upper limit of the A category in DWAF (2008b). Numerical limits can be found in DWAF (1996c) and DWAF (2008b).*

32.3.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 32.10.

Table 32.10 RU S14: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland) and reed beds.*	*N/A.*
Presence of alien plant species in the riparian zone	*The extent of perennial alien plant species within the riparian zone should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain moderately modified, or improve*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*One endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Threatened riparian species	*Viable populations of riparian plant species with IUCN status should remain within the RU.*	*Two listed riparian species should remain within the RU (B. maughamii subsp. maughamii and Ilex mitis var. mitis).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 30 riparian plant taxa within the RU.*

32.3.4 Wetland RQOs

Wetland RQOs are provided in Table 32.11.

Table 32.11 RU S14: Wetland RQOs

SQ	TEC	Wetland RQO
X32B-00551	C	*Maintain TEC and High EIS.* *Cessation of land use encroachment on channelled valley bottom wetlands.* *To improve to C wetland buffers need to be defined and recognised, and overgrazing should be reduced.*

32.4 RQOs FOR RU S15: MODERATE PRIORITY – 2 (X32G-00549)

32.4.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 32.12 RU S15: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X31L-00657										
C	*3.94*	*3.82*	*0.409*	*10.4*	*0.669*	*17*	*0.001*	*0.005*	*0.003*	*0.009*

32.4.2 Water quality RQOs

Source: *No detailed water quality assessment conducted. PES 2011 data and literature sources (e.g. DWA, 2012b; 2013a; DWS, 2014b) were used.*
Model: *N/A.*
Users: *Extensive settlements.*
Water quality issue: *Nutrients, turbidity.*

Narrative and numerical details for RU S15 are provided in Table 32.13.

Table 32.13 RU S15: 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 0.025 mg/L PO_4-P (aquatic ecosystems: driver).*
Ensure that turbidity/clarity or TSS levels stay within Acceptable limits.	*A small change from present with minor silting of habitats and turbidity loads; or <10% change from background TSS levels (aquatic ecosystems: driver).*

32.4.3 Habitat and Biota RQOs (EcoSpecs)

Habitat and biota RQOs are provided in Table 32.14.

Table 32.14 RU S15: Narrative and numerical habitat and biota RQOs

Indicators	Narrative RQO	Numerical RQO
RIPARIAN VEGETATION		
Dominant vegetation cover	*The dominant vegetation cover should remain mixed woody (woodland) and reed beds.*	*N/A.*
Presence of alien plant species in the	*The extent of perennial alien plant species within the riparian zone*	

Indicators	Narrative RQO	Numerical RQO
riparian zone	*should remain small or decrease.*	
Riparian zone continuity	*Riparian zone continuity should remain slightly modified, or improve.*	
Riparian zone fragmentation	*Riparian zone fragmentation should not increase (from its 2014 state). There should be no expansion of agricultural or forestry activities into the riparian zone and existing agriculture or forestry should not expand or intensify towards or within the riparian zone.*	
Plant endemism	*Levels of riparian plant endemism determined during the PES 2011 project (DWS, 2014b) should be maintained.*	*Two endemic riparian plant species should remain present within the RU (refer to DWS (2014b) for species list).*
Taxon richness	*Maintain riparian taxon richness within the RU.*	*Maintain the presence of at least 20 riparian plant taxa within the RU.*

33 IUA X3-9: RESOURCE QUALITY OBJECTIVES

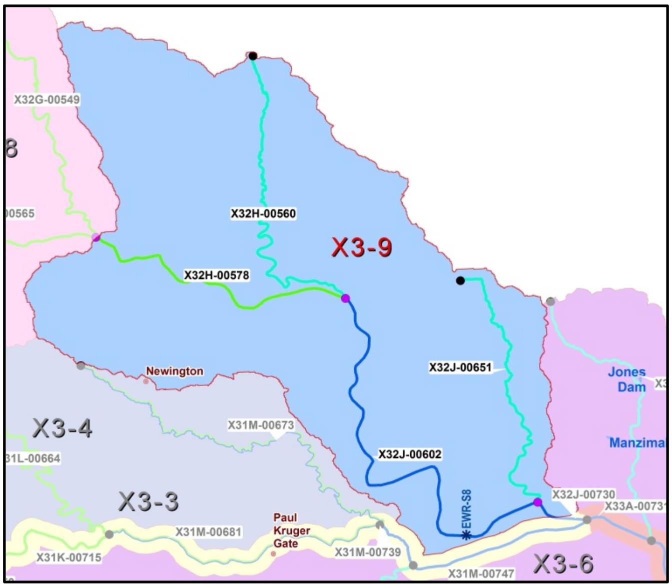
33.1 IUA OVERVIEW AND DESCRIPTION

This IUA consist of the Sand River catchment downstream of the Kholovela River, which is approximately at the border with the Sabi Sand Game Reserve. There are no dams in this IUA. The terrain is flat and the area falls entirely within wilderness area, either the Sabi Sand Park or the KNP. Water use is for game watering and camps within these parks. Groundwater for domestic use or irrigation in this IUA is minimal and the main economic activity is thus tourism and nature conservation. The IUA includes the settlement of Phungwe and Utlha and tourism and recreational aspects elevate the Ecosystem Services importance.

All of these rivers are situated in conservation areas and thus fairly well protected. These rivers are thus without the burden of local impacts, therefore the good PES levels that varies between PES of A and B. However, the Sand which forms the upstream link to the IUA is still under pressure owing to high levels of sedimentation that has washed in from upstream, putting the reach in a PES of a C.

IUA X3-9 is depicted below and the associated priority rating of the biophysical nodes are provided in the accompanying Table.

IUA X3-9 - SAND RIVER SYSTEM DS OF THE KHOLOVELA RIVER



PRIORITY RATINGS

RU	SQ	RIVER	PES	TEC	PR
RU S16	*X32H-00560*	*Phungwe*	A	A	1a
	X32J-00651	*Mutlumuvi*	A	A	1b
MRU Sand B	*X32H-00578*	*Sand**			3
	X32J-00602 EWR S8	*Sand*	B	B	
	X32J-00730	*Sand**			
	X32G-00565	*Sand**			

** Where SQ does not have a EC the EC is different from the EWR S8. But because the EWR site has a higher priority rating, the EWR site is the driver for the other sites in this MRU.*

The RQOs are provided below for a ***Water Resource Class I*** *(DWS, 2014a) and the catchment configuration as illustrated above.*

33.2 RQOS FOR RU C16: LOW PRIORITY – 1A AND B (X32H-00560, X32J-00651)

33.2.1 Flow RQOs

Source: *DWA (2014).*
Model: *RDRM (Hughes et al., 2013).*

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

Table 33.1 RU S16: Flow RQOs

TEC	nMAR (MCM)[2]	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Feb	
							90%	60%	90%	60%
X332H-00560										
A	*7.59*	*7.31*	*1.189*	*15.7*	*1.982*	*26.1*	*0.01*	*0.021*	*0.016*	*0.027*

33.3 RQOs FOR MRU SAND B: HIGH PRIORITY – 3 (EWR S8: X32J-00602; INCLUDING X32H-00578, X32J-00730, X32G-00565)

The TECs is provided for EWR S8 below. Note that EWR S8 represents the Sand River System downstream of the Kholovela River and will be impacted by Sc S71 which was the preferred scenario for the Sand River System (refer to section 1.6.4). It must be noted that as S71 includes a new dam (the New Forest Dam) that may only be constructed in the far future, therefore the current state in the short term was recommended and S71 in the long term if New Forest Dam is constructed (DWS, 2014a).

Table 33.2 TECs for EWR S8

Component	PES, REC, Immediately applicable	Sc S71
Physico chemical	**B**	**B**
Geomorphology	**C**	**C**
Fish	**B**	**B**
Invertebrates	**B**	**B**
Riparian vegetation	**B**	**B**
EcoStatus	**B**	**B**

33.3.1 Flow RQOs

Source: *DWA (2014).*
Model: *DRM (Hughes and Hunnart, 2003).*

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

Table 33.3 MRU SAND B: Flow RQOs

PES (EWR)	TEC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	Total flows (MCM)	Total (%nMAR)	Oct		Mar	
								90%	60%	90%	60%
X32J-00602 (EWR S8)											
B	**B**	*133.6*	*104.0*	*4.49*	*3.36*	*33*	*24.71*	*0.028*	*0.088*	*0.235*	*0.605*

33.3.2 Water quality RQOs

Source: *Water quality assessment was conducted as part of the 2010 Inkomati Intermediate Reserve study (DWA, 2010a).*
Model: *TEACHA and PAI models (DWAF, 2008b).*
Users: *Thulmahaxi WWTW (outside the Reserve).*
Water quality issue: *Nutrients.*
Narrative and Numerical: *Details for MRU SAND B are provided in Tables 33.4 and 33.5 (EWR S8). Data used for water quality assessments should be collected from X3H008Q01.*

Table 33.4 MRU SAND B: Narrative and numerical water quality RQOs

Narrative RQO	Numerical RQO
Ensure that nutrient levels are within Tolerable limits.	*50^{th} percentile of the data must be less than 0.125 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 water quality state maintains biotic requirements as specified by RQOs for biota.	*See specified biota requirements.*

Table 33.5 EWR S8: Water quality EcoSpecs and TPCs (PES, TEC and Sc S71: B)

River: Lower Sand	**PES: B/C EC**	
Monitoring site: X3H008Q01		
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 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 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 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 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 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 280 - 351 mg/L.*
Physical variables		
Electrical Conductivity	*The 95^{th} percentile of the data must be ≤ 42 mS/m.*	*The 95^{th} percentile of the data must be 35 - 42 mS/m.*
pH	*The 5^{th} percentile of the data must range from 6.5 to 8.0, and the 95^{th} percentile from 6.5 to 8.8.*	*The 5^{th} percentile of the data must be < 6.7 and > 7.8, and the 95^{th} percentile must be < 6.7 and > 8.6.*
Temperature[(b)]	*Small deviation from the natural temperature range.*	*Initiate baseline monitoring for this variable.*
Dissolved oxygen[(b)]	*The 5^{th} percentile of the data must be ≥ 7.5 mg/L.*	*The 5^{th} percentile of the data must be 7.8 – 7.5 mg/L. Initiate baseline monitoring for this variable.*
Turbidity[(b)]	*Small to moderate changes to the catchment land-use resulting in minor effects of silting of habitats, largely of a temporary nature, with very intermittent temporary unnaturally high sediment loads and high turbidities.*	*Initiate baseline monitoring for this variable.*
Nutrients		
Total Inorganic Nitrogen (TIN)	*The 50^{th} percentile of the data must be ≤ 0.7 mg/L.*	*The 50^{th} percentile of the data must be 0.56 - 0.7 mg/L.*
PO_4-P	*The 50^{th} percentile of the data must be ≤ 0.125 mg/L.*	*The 50^{th} percentile of the data must be 0.1 - 0.125 mg/L.*
Response variables		
Chl-a phytoplankton[(b)]	*The 50^{th} percentile of the data must be <10 µg/L.*	*The 50^{th} percentile of the data must be 8 - 10 µg/L.*
Chl-a periphyton	*The 50^{th} percentile of the data must be ≤ 21 mg/m^2.*	*The 50^{th} percentile of the data must be 17 - 21 mg/m^2.*
Toxics		

River: Lower Sand		PES: B/C EC
Monitoring site: X3H008Q01		
Water quality metrics	**EcoSpecs**	**TPC**
Toxics	*The 95th percentile of the data must be within the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*	*An impact is expected if the 95th percentile of the data exceeds the TWQR as stated in DWAF (1996c) or the A category boundary as stated in DWAF (2008b).*

(a) To be generated using TEACHA (if available) when the TPC for Electrical Conductivity 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.

33.3.3 Habitat and biota RQOs (EcoSpecs)

33.3.3.1 Fish EcoSpecs and TPCs

Narrative: *The PES based of on the EWR assessment of this MRU was indicated as a B (DWAF, 2010a) and it should be aimed to maintain this EC in future. The overall indigenous fish species richness of this reach was estimated to be as high as 35 species under present conditions. Some species in this MRU are intolerant to alteration or have a high preference for specific habitat features and can serve as valuable indicators to monitor potential change. The primary indicator fish species for this MRU is the large semi-rheophilic Largescale yellowfish (BMAR). This species is a good indicator of flow modification (fast flowing habitats), rocky substrate condition, water quality and migratory success. Various other secondary indicators species are also present to monitor other aspects of the ecosystem. Fish in this MRU are especially vulnerable to change in seasonality, water quality deterioration, bed modification and the spread of alien fish species.*

Numerical: *EcoSpecs and TPCs for EWR S8 are provided in Table 33.6.*

Table 33.6 EWR S8: Fish EcoSpecs and TPCs (PES, TEC and Sc S71: B)

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Ecological status	*All spp.*	*Baseline FRAI[3] score of 86.8% calculated for reach (DWA, 2010a).*	*Any decreased FROC[2] in reach of especially BMAR, LCYL, LMOL, OPER, CSWI, and BVIV OR FRAI scores decreasing below 82.5% (B EC).*	*Any deterioration in habitat that results in decrease in FROC of species.*
Species richness	*All indigenous species*	*Thirteen of the 30 expected indigenous fish species (for the reach) were sampled during the baseline (EWR) survey at EWR 8 (35 species estimated in SQ reach under PES).*	*Less than ten fish species sampled during a survey when habitat can be sampled efficiently.*	*Loss in diversity, abundance and condition of velocity-depth categories and cover features (to be quantified by RHAM; DWA, 2009b).*
Relative abundance	*N/A.*	*During recent surveys fish were sampled at 13.1 ind/min.*	*Relative abundance of less than 8.0 ind/min sampled at the site (during same season as baseline data) when habitat can be sampled efficiently.*	*N/A*
Alien fish species	*Any alien/intro-duced spp.*	*No alien fish species sampled at site during recent surveys.*	*Presence of any alien/introduced fish species at site during any survey.*	*N/A.*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
FD Habitats *FS habitats* *Substrate* *Flow dependant spp. (flow alteration)*	**BMAR** *LCYL* *LMOL* *(CANO)*	*BMAR and LCYL will be most appropriate indicators of these metrics at the site. BMAR is expected to always be present at the site at a relative abundance of 0.24 ind/min electrofishing (conditions similar to baseline conditions). Under baseline survey LCYL were absent at site EWR S8 while LMOL was monitored at very low numbers (0.02 ind/min.)*	*BMAR absent during any survey (or with relative abundance < 0.18 ind/min.) AND/OR both LMOL and LCYL absent during any survey.*	*Reduced suitability (abundance and quality) of the flow dependant species in FD, FS and substrate habitats (i.e. decreased flows, increased zero flows), increased sedimentation of riffle/rapid substrates, excessive algal growth on substrates (to be quantified by RHAM; DWA, 2009b).*
Water quality intolerance	*LCYL* *LMOL*	*Under baseline survey LCYL were absent at site EWR 8 while LMOL was monitored at very low numbers (0.02 ind/min.)*	**Both** *LMOL and LCYL absent during any survey.*	*Decreased water quality (as indicated by PAI, RHAM visual, or water quality assessments).*
SD habitats	*TREN* *OMOS*	*TREN and OMOS will be most appropriate indicators of SD habitats and expected to always be present at the site. Under baseline conditions TREN was monitored at a relative abundance of 0.17 ind/min, while OMOS was monitored at 3.69 ind/min.*	*TREN and OMOS absent during any survey AND/OR TREN present with relative abundance < 0.10 ind/min and OMOS < 2.0 ind/min.*	*Reduced suitability of SD habitats (i.e. increased flows in dry season, alteration in seasonality, sedimentation of pools) (to be quantified by RHAM; DWA, 2009b).*
Water column	*BMAR* *OMOS*	*BMAR and OMOS will be most appropriate indicators of Water column habitats and expected to always be present at the site. Under baseline conditions BMAR was sampled at a relative abundance of 0.24 ind/min electrofishing and OMOS was monitored at a relative abundance of 3.69 ind/min.*	*BMAR and OMOS absent during any survey AND/OR BMAR present with relative abundance < 0.18 ind/min and OMOS < 2.0 ind/min.*	*Reduction in suitability of water column (i.e. increased sedimentation of pools).*
SS habitats *Overhanging vegetation*	*TREN* *BVIV*	*TREN and BVIV will be most appropriate indicators of SS, overhanging vegetation and instream vegetation habitats and expected to always be present at the site. Under baseline conditions TREN was monitored at a relative abundance of 0.17 ind/min, and BVIV was monitored at a relative abundance of 4.05*	*TREN and BVIV absent during any survey AND/OR TREN present with relative abundance < 0.10 ind/min and BVIV < 2.0 ind/min.*	*Significant change in SS habitat suitability (i.e. increased flows, altered seasonality, increased sedimentation of slow habitats) (to be quantified by RHAM; DWA, 2009b).* *Significant change in overhanging vegetation habitats (to be quantified by RHAM; DWA, 2009).*

Metric	Indicator spp.[1]	EcoSpecs	TPC (Biotic)	TPC (Habitat)
Instream vegetation		*ind/min,.*		*Significant change in instream vegetation habitats (to be quantified by RHAM; DWA, 2009b).*
Undercut banks	*PPHI*	*PPHI is the best indicators of undercut banks and should be present at site EWR S8 100% of the time at a relative abundance > 3.81 ind/min.*	*PPHI absent during any survey or present with relative abundance < 0.2 ind/min.*	*Significant change in undercut bank habitats (to be quantified by RHAM; DWA, 2009b).*
Migratory requirement[4]	*AMOS BMAR*	*AMOS is a catadromous species while the rest of the indicator species can be described as potamodromous species in terms of their migratory requirements, requiring movement between river reaches.*	*Any decreased FROC in reach of indicator species.*	*Alteration of longitudinal habitat through the creation of migration barriers (dams, weirs, zero flows, poor water quality causing chemical barriers).*

1 - 4: Refer to Table 5.4. Primary indicator species (flow and flow related aspects) indicated in **bold**.

33.3.3.2 Macro-invertebrate EcoSpecs and TPCs

Narrative: *The EC for the macro-invertebrates at EWR S8 is a Category B for the PES and REC. The macro-invertebrate communities at these sites should be representative of a taxa assemblage related to the following river type: a medium-sized lowveld river associated with perennial flows; a slow-flowing river with a sandy substrate (alluvial), and emerging macrophytes (reeds). The macro-invertebrate habitats in the river are dominated by alluvial sandy substrate, forming channels and pools surrounded by reeds.*

Numerical: *Indicator taxa for EWR S8 are provided in Table 33.7 and EcoSpecs and TPCs in Table 33.8.*

Table 33.7 EWR S8: Macro-invertebrate indicator taxa

Indicator group	Families	Velocity (m/s)	Substratum	Water Quality
1	*Perlidae*	*> 0.6*	*Cobbles*	*High*
2	*Philopotamidae*	*> 0.6*	*Cobbles*	*Moderate*
3	*Heptageniidae*	*0.3 - 0.6*	*Cobbles*	*High*

Table 33.8 EWR S8: Macro-invertebrate EcoSpecs and TPCs (PES, TEC and Sc S71: B)

EcoSpecs	TPCs
To ensure that the SASS5 scores and ASPT values occur in the following range: SASS5 score: > 130; ASPT value: > 6.	*SASS5 scores below 120 and ASPT below 6.2.*
To ensure that the MIRAI score remains within the range of a B category (> 82.01 – 87.4%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 83.0% or less.*
To ensure that the MIRAI score remains within the range of a B category (> 82.01%), using the same reference data used in this study (DWA, 2010a).	*A MIRAI score of 82.01% or less.*
Presence of at least 5 of the following 6 high-scoring taxa: Perlidae, Heptageniidae, Baetidae > 2 spp., Athericidae,	*Two or more of the following taxa present only as individuals, or absent altogether:*

EcoSpecs	TPCs
Philopotamidae and Chlorocyphidae.	*Perlidae, Heptageniidae, Athericidae, Chlorocyphidae, and Philopotamidae. Less than 2 spp. of Baetidae.*
Balanced community structure, i.e. majority of invertebrates at A abundance, certain taxa can be at B abundance (e.g. Simuliidae, Baetidae). No group to consistently dominate the fauna i.e. be present in C abundance (> 100) over more than two consecutive surveys.	*The presence of one or more taxon occurring in C abundance, i.e. > 100 individuals for two consecutive surveys.*

33.3.3.3 Riparian vegetation EcoSpecs and TPCs

Narrative: *The overall PES at EWR S8 (as at October 2007) for riparian vegetation was a Category B (86.7%). Vegetation cover (woody and non-woody) should be maintained in a range that supports the EC of the riparian zone or sub-zone. Perennial invasive alien species should be kept in check to prevent a deterioration in the EC. Similarly, species composition within the riparian zone should reflect specifications in keeping with the EC. Both riparian zone integrity and longitudinal continuity should not deteriorate from its state in 2012 (PES 2011; DWS 2014b).*

Numerical: *EcoSpecs and TPCs for EWR S8 are provided in Table 33.9. There was high confidence in the EcoSpecs and TPCs since RHAM (DWA, 2009b) and VEGRAI (DWA, 2010a) data were available for the EWR site.*

Table 33.9 EWR S8: Riparian vegetation EcoSpecs and TPCs (PES, TEC and Sc S71: C)

Assessed Metric	EcoSpec	TPC
Marginal zone		
Phragmites (reed) cover	*Reed cover above 30%.*	*A decrease in reed cover below 30%.*
	RHAM data recorded an average of 60% cover.	
Riparian zone		
Alien invasion (perennial alien species)	*Alien species cover between 15 - 10%.*	*An increase in alien species cover above 10%.*
	VEGRAI data recorded <10% in all zones. No aliens were recorded in RHAM zone.	
Lower zone		
Terrestrialisation	*The absence of terrestrial woody species.*	*An increase in terrestrial woody species cover >5%.*
	RHAM site was different from VEGRAI, and does not extend into the upper zone. No terrestrial species occurred in plots.	
Phragmites (reed) cover	*Reed cover between 20% and 80%.*	*An increase in reed cover above 80% or a decrease below 20%.*
	RHAM data recorded an average of 14% cover and this baseline value falls below the TPC. It is therefore necessary to increase the sampling area of subsequent RHAM assessments and to recheck. VEGRAI recorded a range of 40 - 60% cover which is well above the TPC, but is at a different position on the river.	

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