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DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE OLIFANTS RIVER WATER SUPPLY SYSTEM

WP10197

Ecoclassification of the 1999 Assessment at EWR Sites in the Olifants River (WMA4)

Original

FINAL

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Report no.: P WMA 04/B50/00/8310/18

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ECOCLASSIFICATION OF THE 1999 ASSESSMENT AT EWR SITES IN THE OLIFANTS RIVER (WMA 4)

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Title	**Ecoclassification of the 1999 Assessment at EWR Sites in the Olifants River (WMA4)**
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- Dr Martin van Veelen (ILISO Consulting);
- Ms Bronwyn Kotze (Clean Stream Biological Services).

List of Abbreviations & Acronyms

ALAB	*Anguilla bengalensis labiata*
AMAR	*Anguilla marmorata*
AMOS	*Anguilla mossambica*
ASCL	*Austroglanis sclateri*
ASPT	Average Score Per Taxon
AURA	*Amphilius uranoscopus*
BAEN	*Labeobarbus aeneus*
BBM	Building Block Methodology
BEUT	*Barbus eutenia*
BLIN	*Barbus lineomaculatuss*
BMAR	*Barbus marequensis*
BMAT	*Barbus matozi*
CCAR	*Cyprinus carpio*
CPRE	Chiloglanis pretoriae
CSWI	Chiloglanis swierstrae
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
EIS	Ecological Importance and Sensitivity
EPA	Environmental Protection Agency
EWR	Environmental Water Requirements
FD	Fast Deep
FRAI	Fish Response Assessment Index
FROC	Fish frequency of occurrence
FS	Fast Shallow
GAFF	*Gambusia affinis*
GAI	Geomorphological Driver Assessment Index
HMOL	*Hypophthalmichthys molitrix*
HVIT	*Hydrocynus vittatus*
IFR	Instream Flow Requirements
IHI	Index of Habitat Integrity
IUCN	International Union of Conservation of Nature
LCAP	*Labeo capensis* (Smith, 1841)
LB	Left bank
LUMB	Labeo umbratus (smith, 1841)
KNP	Kruger National Park
MIRAI	Macroinvertebrate Response Assessment Index
MSAL*	Micropterus salmoides
OMOS	*Oreochromis mossambicus*
OPER	*Opsaridium peringueyi*
PAI	Physico Chemical Driver Assessment Index
PES	Present Ecological State
RB	Right Bank
RC	Reference Condition
REC	Recommended Ecological Category

RQS	Resource Quality Services
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SD	Slow Deep
SP	Species
SS	Slow Shallow
TDS	Total Dissolved Solids
VEGRAI	Riparian Vegetation Response Assessment Index
WMA	Water Management Area

EXECUTIVE SUMMARY

BACKGROUND

This task as part of the Olifants Reconciliation Strategy aimed to update the EWRs undertaken during 1999. No formal monitoring programme was implemented, nor any implementation of the Reserve in terms of adjusting operating rules and supplying the Reserve. This means that the results determined during 1999 are not necessarily applicable, as the baseline might have changed. Added to this complexity is the fact that the approaches followed in the 1999 study are in most cases now obsolete. What is therefore required is a complete revision of the EWR; however this was not within the scope of this study.

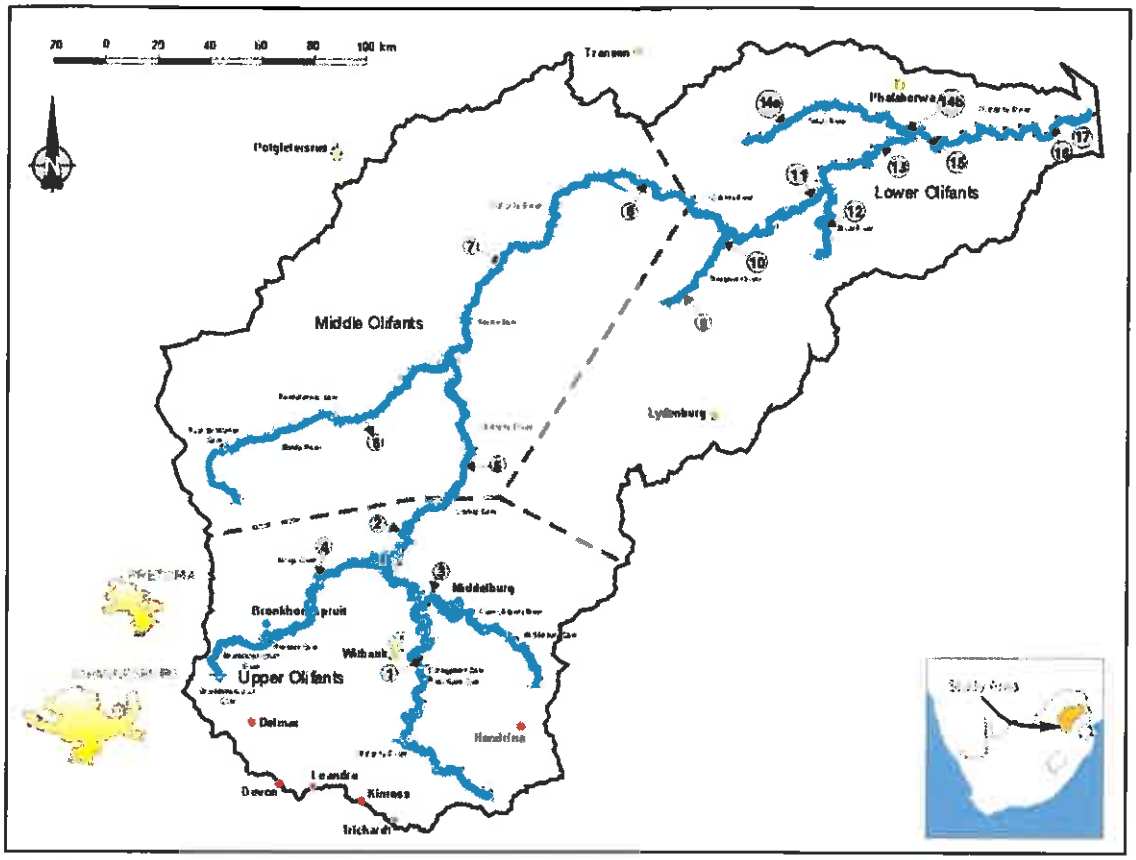
The most practical approach to still use the information generated during 1999 was to accept the flow requirements that were generated, and to determine whether the Recommended Ecological Category requires updating. As EWRs were generated for a range of Ecological Categories, any recommended changes to the 1999 Recommended Ecological Category can result in a different EWR to be recommended for use in planning and for scenario evaluation.

The output of the EcoClassification process would be a defined Present Ecological State as well as a Recommended Ecological Category based on the existing Ecological Importance and Sensitivity information. Any obvious changes in the Present Ecological State since 1999 will be documented and the reasons provided. These changes will not be just because an Ecological Category has changed, but whether there is visible and other indicators of change. I.e., even if the Ecological Category has changed, one will first have to determine whether this change is due to the updated methods, or whether a real change has taken place in terms of degradation or improvement.

STUDY AREA AND LOCATIONS OF EWR SITES

The original (1999) study area consisted of the 18 EWR sites in the following rivers:

- *Olifants*
- *Wilge*
- *Steelpoort*
- *Blyde*
- *Selati*



Study Area and EWR Sites

For the purposes of this study the following sites were excluded:

- *EWR 2 (Olifants River): This site is situated upstream of Loskop Dam. Access to this site is problematic.*
- *EWR 7 (Olifants River): This site was known as the Hijack Site and due to security reasons, and as the site does not provide good indicators or EWR assessment, it was not assessed.*
- *EWR 10 (Steelpoort River): Due to time constraints this site was not visited. It was felt that EWR 9 (upstream of EWR 10) is the key site of this reach.*
- *EWR 11 (Olifants River): This site was always seen as not as important as EWR 13. Due to the access problems (private ground within a share block estate), this site was excluded.*
- *EWR 14a (Selati River): The ownership has changed and the team were refused entrance. This site is in the seasonal part of the system and as operational possibilities are limited, the site was not deemed crucial.*
- *EWR 14b (Selati River): This site is located within the private nature reserve of FOSKOR. Due the security and access problems and the fact that this site is dominated by overriding water quality problems, it was not selected as part of the refinement study.*

For the purposes of this study the following sites were replaced by nearby alternatives.

- *EWR 3 (Klein Olifants River): Access to this site was over private ground and the 4x4 track was previously eroded. Although now apparently rebuilt, access could not be arranged. An alternative site in the Klein Olifants River was visited.*
- *EWR 13 (Olifants River). Access of this site is over private ground. Exact coordinates for the site were not available and Google Earth was used to determine where the site is. A possibility was selected and this site accessed and surveyed. It was not however the original*

site. The original site was found in the end; however it could not be accessed due to the presence of elephants.

Twelve sites therefore formed part of the 2010 study. All of the original rivers were represented apart from the Selati River.

APPROACH

The approach for this task focussed on reviewing the EcoClassification process for determining the Recommended Ecological Category (REC) and whether it has implications for the EWR that will be used in yield modelling. The factors to consider were:

- *A change in Ecological Category (EC) does not necessarily indicate a change in condition as this could be purely a result of applying different methods.*
- *A change in Ecological Category that implies a change in condition will be of low confidence as there is no or limited supporting data based on monitoring during the last 10 years available.*

The following step by step process was followed:

- *Relevant data of 1999 was collated and summarised.*
- *Additional data of surveys (specifically within the Kruger National Park (KNP) and on the Wilge River), were collated.*
- *A reconnaissance survey was undertaken to twelve EWR sites during which photopoint monitoring, rapid fish, macroinvertebrate and riparian vegetation surveys were undertaken.*
- *The results were used to populate the following models:*
  - Index of Habitat Integrity
  - Fish Response Assessment Index
  - Macro-invertebrate Response Assessment Index
  - Riparian vegetation Response Assessment Index
  - Physico-Chemical Driver Assessment Index.
- *Photos as in 2010 were compared with photos in 1999.*
- *The Ecological Importance and Sensitivity (EIS) was determined and compared to 1999*
- *The EcoStatus for the Present Ecological State was determined and compared to 1999.*
- *An analysis was made whether there has been a change since 1999 and the degree of this change.*
- *A recommendation was made on the appropriate EWR rules to be used to represent a REC scenario.*

RESULTS

Below follows a summary table indicating the 1999 EcoStatus, the 2010 EcoStatus, the change as well as which 1999 EC's EWR rule (flow requirements) must be used for yield modelling and planning.

Table of all EWR sites indicating overall change and the appropriate EWR rule to use for yield modelling

EWR site	1999 PES	2010 PES	1999 REC	2010 REC	Change	EWR rule
1	D	D	C	D	-	D
3	D	D	C	D	-	D
4	B	C	B	B	-	B
5	C	C	B	C	=	C
6	E	C/D	D	C/D	+	C
8	E	C/D	D	C/D	=	D
9	D	C/D	D	C/D	=	D
12	B	B/C	B	B	=	B
13	C	C	B	C	=	C
15	C	C	B	B	=	C
16/17	C	C	B	B	=	B

The column named "Change" Denotes a real change in the state of the aquatic ecology as opposed to a change in the PES due to the changed methodology.

Sites 16 and 17 are essentially the same site (close to each other) but were used to model different flow conditions

=:1999 EC is the same as 2010

--: Large scale degradation has taken place; -: Small scale degradation has taken place

++: Large scale improvement has taken place; +: Small scale improvement has taken place

The following conclusions can be made from the above table:

- *EWR 1 (Olifants River) and EWR 3 (Klein Olifants River) above Loskop Dam both show deterioration. The major reasons appear to be worsening water quality and the biological responses to this. The water quality problems appear to be due to the problems regarding sewage works that do not have the capacity to handle the current load.*
- *EWR 4 (Wilge River): This EWR site used to be in a very good condition and is of high EIS. There has since apparently been a marked degradation in instream condition. As it is known that mining (especially around the Saalboomklapspruit) has caused significant problems in the past, it is assumed that these associated water quality problems are the cause. Recent monitoring on the affected tributaries have however showed some improvement and it is hoped that if the mines follow mitigation measures and continue monitoring, there might be a positive trend.*
- *EWR 6 (Elands River): The Elands River is the only site that shows an improvement (instream) and this is due to the recent change in operation of the Mkhombo Dam. It is uncertain why the operation has changed and whether this is permanent.*

RECOMMENDATIONS

The work undertaken for this study was based, in most cases on one survey after 11 years. This survey was an extremely rapid survey as part of the 2010 reconnaissance survey and only 1 hour maximum was allowed on site. The results are still of moderate confidence (Table below). It is however essential that monitoring according to the Ecological Water Resources Monitoring Programme be implemented ASAP. This river is one of the key rivers in SA in terms of water allocation and is also a highly ecological (and in terms of Goods and Services) important. Monitoring should have been implemented immediately after the 1999 EWR study as all data collated during that survey can be seen as historical only. A new baseline has to be set and effectively, the EWR has to be recalculated. The additional motivation for this is the out of date methods that were applied during 1999 and the significant improvement in methods resulting in more accurate and useful results.

Confidence was assessed for the 2010 PES as well as the assessment of whether the ecological state has changed between 1999 and 2010. The confidence score is based on a scale of 0 – 5 and colour coded where:

0 – 1.9: Low *2 – 3.4: Moderate* *3.5 – 5: High*

Confidence evaluation

EWR sites	2010 PES confidence	Confidence in change from 1999
EWR 1	3.0	2.5
EWR 3	3.0	2.7
EWR 4	3.2	3.5
EWR 5	3	2.3
EWR 6	2.7	3.0
EWR 8	3.1	3.3
EWR 9	2.8	3.7
EWR 12	3.1	3.7
EWR 13	3.0	3.3
EWR 15	3.1	3.5
EWR 16/7	2.7	3.7

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1. BACKGROUND AND INTRODUCTION

1.1. INTRODUCTION

The Olifants River Catchment is made up of portions of three provinces, namely, Limpopo, Mpumalanga and Gauteng. A portion of the Kruger National Park (KNP) also falls within the area. The catchment is currently one of South Africa's most stressed catchments as far as water quantity and quality is concerned

The objective of the study is to formulate a reconciliation strategy for the entire Olifants River system up to year 2030. The strategy should:

- Address growing water demands as well as serious water quality problems experienced in the catchment,
- Identify resource development options;
- Provide reconciliation interventions - both structural and administrative/regulatory,
- Ensure that the technical requirements in terms of the future resource classification regulations are followed when seeking the optimum reconciliation interventions.

The specific task documented in this report's objective is to determine whether the ecological state of the river has changed since the EWRs were set (2001) (Louw & Palmer, 2001; Palmer 2001a; Palmer 2001b; Palmer 2001c) and to update the EcoClassification process to comply with recent methods. A Level 3 EcoClassification process will be applied to ensure compliance to DWA requirements.

1.2. 1999 – 2003 ECOLOGICAL RESERVE STUDY

The Comprehensive Olifants Ecological Reserve Study (referred to in the rest of the document as the 1999 study) was the 2nd study commissioned at this level – the first being the study on the Mhlathuze River. The 1999 study assessed the flow requirements at 18 EWR sites (then referred to as Instream Flow Requirement (IFR) sites. The EWRs were assessed for various Ecological categories.

As these studies were one of the first undertaken, many of the methods were not yet developed, or were in development or did not exist. This makes these EFR and the EcoClassification results now out of date.

1.3. 2010 EWR STUDY

This task as part of the Olifants Reconciliation Strategy aimed to update the EWRs determined during 1999. No formal monitoring programme was implemented, nor any implementation of the Reserve in terms of adjusting operating rules and supplying the Reserve. This means that the results determined during 1999 are not necessarily applicable, as the baseline might have changed. Added to this complexity is the fact that the approaches followed are in most cases obsolete. What is therefore required is a complete revision of the EWR; however this was not within the scope of this study.

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Present Ecological State according to the now published EcoClassification methods, Level 3. Only Level 3 will be used as Level 4 would require a large range of specialists to be involved.

The EcoClassification process was provided for reaches in the river represented by the 18 EWR sites. Photographs were taken of the sites for comparative purposes. No biological surveys apart from visual observations for vegetation assessments were undertaken. Only readily available existing information was used for this assessment.

The output of the EcoClassification process would be a defined Present Ecological State as well as a Recommended Ecological Category based on the existing Ecological Importance and Sensitivity information. Any obvious changes in the Present Ecological State since 1999 were documented and the reasons provided. These changes would not be just because an Ecological Category has changed, but whether there is visible and other indicators of change. I.e., even if the Ecological Category has changed, one will first have to determine whether this change is due to the updated methods, or whether a real change has taken place in terms of degradation or improvement.

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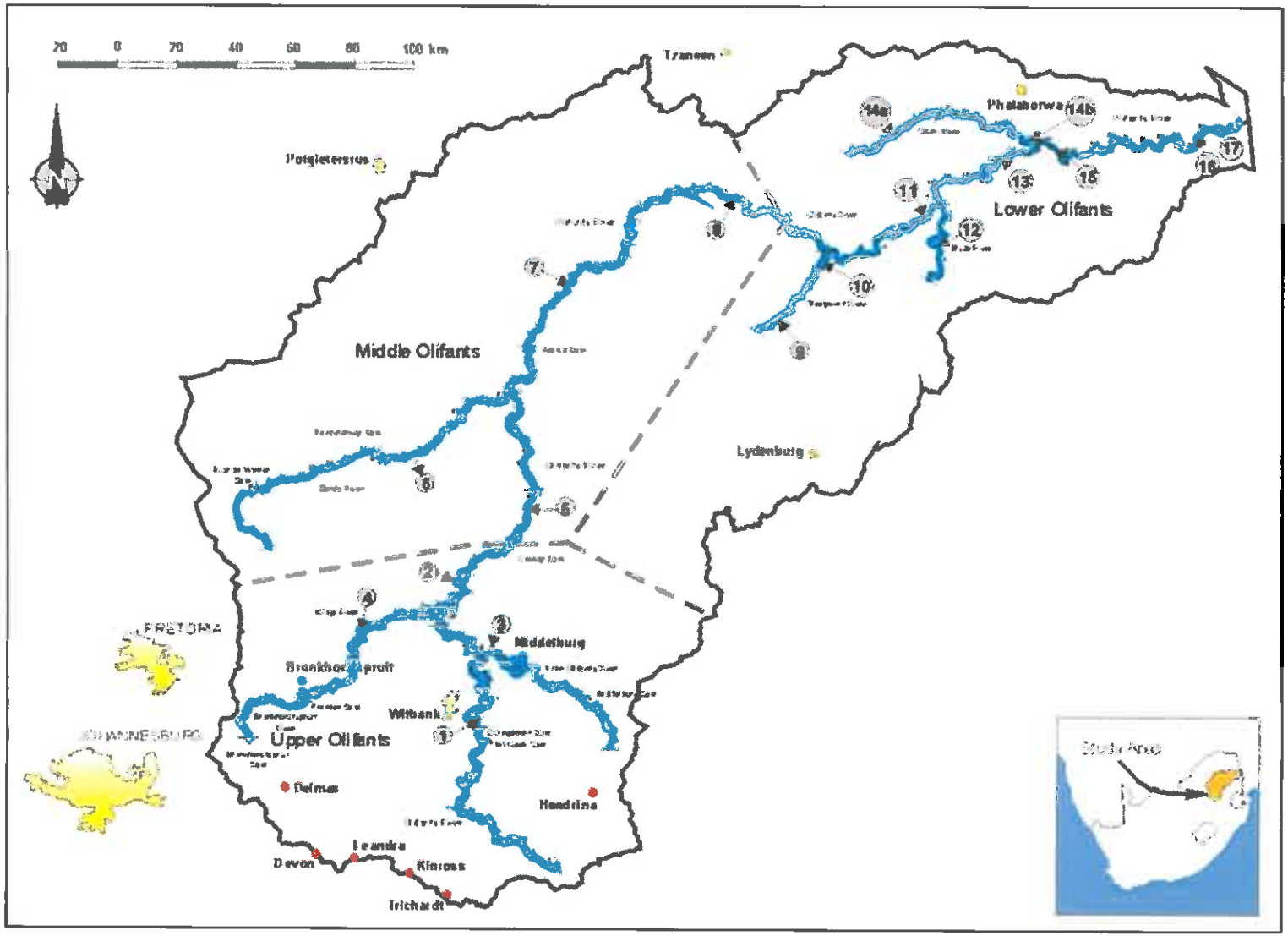

Figure 1.1: Study Area and EWR Sites

2. ECOCLASSIFICATION: EWR OL1: OLIFANTS RIVER LODGE

2.1. EIS RESULTS

The same EIS model that was used during 1999 was applied during this study. The EIS results for EWR OL1 are MODERATE. The highest scoring metrics are:

- Sensitivity of instream habitat to flow related water quality changes.

The 1999 result was HIGH. These results however were based on the importance of the natural state and not the present state, as is nowadays the norm.

2.2. RESOURCE PROTECTION

2.2.1. Summary Of 1999 Results

Table 2.1: Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	16 sp (RC), 8 sp (PES). Mainly tolerant species.	E	High TDS (sulphates) and sewage; flow regulations below Witbank Dam.
Riparian vegetation	RC. Steeper areas common, hardy shrubs, no exotics. PES: Loss of vegetation cover, change in physiognomic structure, encroachment of exotic species and impaired recruitment.	C	Flooding, exotic species, grazing, trampling, back-up from bridges, etc.
Geomorphology	RC: A compound channel is often present with an active channel contained within a macro-channel activated only during infrequent flood events. Floodplain may be present between active and macro channel. PES: Geomorphic thresholds do not appear to have been crossed. This demonstrated by localised bed and bank scour.	C	Dam, weir, roads & bridges.
Macro-invertebrates	ASPT: 4.9 SASS: 106	C	
Water quality	No routine DWAF monitoring points in this river reach. It is possible that toxic substances would be less available in the reach, as could be chemically bound in sediments (within upstream dams). Although there are no quantitative data, it is	D	Spookspruit & Klein Olifants discharge into river reach. Treated sewage effluent is discharged into Olifants River DS of Witbank.

Component	Description	PES	Causes and Sources
	likely that salinity is a major problem.		
EcoStatus	D		**Flow-related:** Regulated flows & altered flow regime (Upstream dam, Klein Olifants inflows agriculture) Water quality (Mines, agriculture, Spookspruit & Klein Olifants inflows). **Non-flow related:** Exotic vegetation, local sedimentation (land-use practices - agriculture, grazing). TDS (coal mining), nutrients (sewage treatment works).

2.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the Ecological category (EC) **(Table 2.2)**.

Table 2.2: 2010 Present Ecological State for EWR OL1

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	The nutrient levels, specifically PO_4, are somewhat elevated.	C	3
Riparian vegetation	**RC:** The site exists within the Grassland Biome and the Mesic Highveld Grassland Bioregion, and the riparian zone is surrounded by the Rand Highveld Grassland vegetation type. The site is dominated by a cobble/boulder riffle and an associated rheophytic community is expected. In this area it would be dominated by *Gomphostigma virgatum, Salix mucronata* and *Cyperus marginatus*. The marginal and lower zones are expected to be dominated by woody vegetation, but with high degree of patchiness with non-woody clumps. *Phragmites* species is not expected to proliferate. The upper zone is expected to be dominated by woody vegetation and grasses. A large (about 20%) proportion of terrestrial woody species expected in the upper zone and macro-channel bank. **PES**: The marginal zone consists of cobble with a high degree of algal instream cover, as well as *Eichornia crassipes*. The zone dominated by a mix of woody and non-woody vegetation, mainly *Nasturtium officionale, Cyperus marginatus, Gomphostigma virgatum, Salix mucronata, Rhus gerrardii.* The lower zone mid-channel bars are dominated by woody debris, mostly exotic woody debris such as *Salix babylonica*, sedges (*C. marginatus*) which dominate where some sediments have accumulated or where backwaters occur, and woody vegetation. Woody vegetation is a mixture of *Salix mucronata* and *Rhus gerrardii* mainly. The upper zone is not present on the LB; the RB has been cleared and mowed, is open and physically disturbed. The macro-channel bank is similar to the upper zone, with tall *Eucalyptus* species.	C	4

Component	Reference condition and PES Description	EC	Conf
Fish	Fifteen fish species expected under reference conditions. Twelve species estimated to still be present. Three species intolerant to moderately intolerant to changes in the environment, namely BLIN, BEUT & BMAT, are estimated to have been lost from this reach, while the catadromous eel (AMOS) has been lost due to presence of downstream migration barriers. The FROC of most of the indigenous species is highly reduced under PES.	D/E	2
Macroinvertebrates	Reference Conditions: SASS5 - 220, ASPT - 7. A total of 66 taxa are expected to occur at this site, 31 of which are expected to occur in at least 50% of the samples and 23 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a stoneflies, a variety of Mayflies(>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), Caddisflies (>2spp Hydropsychidae and Leptoceridae) and Beetles (Dytiscidae, Elmidae, Gyrinidae and Psephenidae) PES: SASS - 117 ASPT - 5.3; MIRAI 44.8 Only a limited number of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae and Leptophlebiidae); Damselflies and Dragonflies (Coenagrionidae, Gomphidae and Libellulidae) Caddisflies (2spp Hydropsychidae, Leptoceridae) and Beetles (Dytiscidae, Elmidae and Gyrinidae).	D	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis). The PES for the components at EWR OL1, as well as the causes and sources for the PES are summarised in **Table 2.3**.

Table 2.3: EWR OL1: PES causes and sources

	PES	Conf	Causes[1]	Sources[2]	F[3]/NF[4]	Conf
Phys-chem[3]	C	3	Increased PO_4 levels	Waste Water Treatment Works	NF	3
Riparian vegetation	C	3.1	Altered species composition	Presence of exotic species	NF	5
			Reduced woody and non-woody cover	Physical removal, disturbance, clearing and mowing	NF	5
			Aquatic and marginal zone exotic invasion	Elevated nutrients and refugia upstream	NF	2
			Elevated sedge cover on seasonal features	Reduced base flows and small flood disturbance	F	3
Fish	D/E	2	Altered substrate quality due to clogging by filamentous algae.	Increased nutrients related to sewage treatment works effluent, agricultural activities.	NF	3
			Loss of fast habitats (overall habitat diversity) resulting in loss of some species.	Abstraction for domestic, agricultural and mining activities. Witbank Dam.	F	

	PES	Conf	Causes[1]	Sources[2]	F[3]/NF[4]	Conf
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	
			Loss of species diversity, especially species intolerant to water quality deterioration	Mining activities, agriculture and dysfunctional sewage treatment facilities.	NF	
			Decreased species diversity and abundance (especially small species) as result of presence of aggressive alien predator (MSAL & GAFF)	Presence of aggressive alien predatory species naturally spreading and introduced for recreation / angling.	NF	
			Increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR (and possibly introduced indigenous LUMB)	NF	
Macro-iverts[4]		3	Filamentous algal growth (Nutrients)	Sewage Treatment works	NF	4
			Altered Flow Regime	Abstraction and US dams	F	4

1. Flow related
2. Non Flow related
3 Physico-chemical variables
4 Macro-invertebrates

2.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 2.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 2.4: EWR OL1: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	3	90
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	4	100
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2.5	60
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	80

INSTREAM BIOTA	Importance Score	Weight
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	100
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**D/E**	
Aquatic invertebrates	**D**	
Confidence rating for instream biological information	**3.25**	
INSTREAM ECOLOGICAL CATEGORY	**D**	
Riparian vegetation	**C**	
Confidence rating for riparian vegetation zone information	2.7	
ECOSTATUS	**D**	

2.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note: = 1999 EC is the same as 2010
-- Large scale degradation has taken place - Small scale degradation has taken place
++ Large scale improvement has taken place + Small scale improvement has taken place

Table 2.5: Comparison between the 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
Physico-chemical	B	C	Reason for change a generally wet period since 1999	=	3
Riparian vegetation	C	C	Marginal and lower zones both scored as class B, but the upper zone and macro-channel bank were in a class C and C/D respectively i.e. a small improvement in the marginal and lower zones is likely due to the flushing effect of large floods, which clear exotic species (among others). However, degraded conditions on the upper zone and macro-channel bank are due to additional clearing and physical disturbance. Overall, therefore a general change has not occurred.	=	2.5
Fish	E	D/E	PES EC slightly higher than 1999 EWR EC. It is estimated that the biotic integrity, based on fish, of this river reach have deteriorated slightly since 1999. This was especially reflected by the extensive algal growth, and the fact that CPRE was	-	2

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
			sampled during 1999 survey and not during the 2010 survey, although it's preferred habitat was sampled adequately.		
Macro-invertebrates	C	D	Slightly higher SASS and ASPT than 1999, might be due to recent good flows in the river. Different methods used. The increased abundance of filamentous algae compared to 1999, has resulted in a slightly decreased invertebrate condition.	-	3

Changes are limited and mostly indicated in the instream biota. The change is negative and is due to a perceived increased in nutrients and associated algal growth.

2.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability thereof.

The EIS at EWR OL1 is MODERATE and the REC is therefore to maintain the PES. This is the most significant change since 1999, where the REC was set to improve the PES due to the HIGH EIS.

It must be noted however that there is a potential for a negative trend due to the increased nutrients, and unless this problem is addressed, it is possible that the river will degrade even further.

2.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

The results for setting EWR scenarios are summarised in **Table 2.6**.

Table 2.6 EWR OL1: Summary of EcoClassification

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	C	C	C/D	
TDS	D	C	C	
WATER QUALITY	D	C	C	=
GEOMORPHOLOGY	C	C		
Response Components	**PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	E	C	D/E	-
MACRO INVERTEBRATES	C	C	D	-
INSTREAM			D	-
RIPARIAN VEGETATION	C	C	C	=
ECOSTATUS	D	C	D	-
INSTREAM IHI	D	C	C/D	-
RIPARIAN IHI	C	C	C	=
EIS	High		Moderate	

2.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWRs were set for a C and a D EC. The C EWR was for the REC based on the HIGH EIS. As the EIS is now MODERATE, and the REC a D, it is recommended that the D EC EWR (1999) should be used for yield modelling purposes and planning.

3. ECOCLASSIFICATION: EWR OL3: KLEIN OLIFANTS

3.1. RESOURCE MANAGEMENT AND CONTROL

The same EIS model that was used during 1999 was applied again. The EIS results for EWR OL3 are MODERATE. The highest scoring metrics are:

- Sensitivity of instream habitat to flow related water quality changes.

The 1999 result was also MODERATE.

3.2. PRESENT ECOLOGICAL STATE

3.2.1. Summary of 1999 results

Table 3.1 Summary of 1999 results extracted from the final reports

Component	Description		Causes and Sources
Fish	15 sp (RC), 8 sp (PES). Mainly tolerant.	D	High TDS, sewage works, flow regulation from Middelburg Dam
Riparian vegetation	RC: Grasslands, no exotic species. PES: Loss of cover, replacement of natural vegetation, changes in species composition, encroachment of exotic sp.	C	Wood cutting, clearing, fire, exotic species, flow regulation, dumping, recreational etc.
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. PES: Geomorphic thresholds appear to have been crossed with river moving towards a new equilibrium. Demonstrated in this reach by extensive bank erosion, numerous islands and sediment deposits.	D	Mismanagement of riparian zone, extensive agriculture, bridges, weirs.
Macro-invertebrates	ASPT: 6.2 SASS score: 100	C	no information provided
Water quality	TDS: C. Nutrients: D. Seasonal changes in water quality are moderated by Middelburg Dam on the US side of reach. Toxic substances would be less available in reach DS of a dam, as they could be chemically bound in sediments. Bioassessment indicates some recovery in this reach - particularly of the invertebrates.	C	Sewage, industrial effluents.
EcoStatus	D	**Flow-related:** Flow regulation, erosion (dams & dam operation) **Non-flow related:** Erosion, exotic vegetation, TDS, nutrients, instream toxicity was not investigated, but is of concern and should be monitored (municipal sewage, industrial effluents).	

3.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 3.2**).

Table 3.2 2010 Present Ecological State for EWR OL3

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	The nutrient levels, specifically PO_4, are somewhat elevated.	C	3
Riparian vegetation	**RC:** The site exists within the Grassland Biome and the Mesic Highveld Grassland Bioregion, and the riparian zone is surrounded by the Rand Highveld Grassland vegetation type. In both the marginal and lower zones, rheophytic communities are expected in the cobble areas (*G. virgatum and C. marginatus*). Expect consolidated alluvial deposits to be dominated by *Salix mucronata*. The upper zone is expected to comprise a patch mosaic of *Cyperus / Juncus* mix and *Gomphostigma / Salix* mix. **PES:** Marginal Zone: The LB is mainly open, and mostly shaded by exotic tree species. The RB has open bedrock, with observed salt deposits and is dominated by reeds or grass / sedge mixture. Lower zone: The lower zone is dominated by *Rhus gerrardii and Cyperus / Juncus* mixture, with small percentage reeds. MCB: The LB of the macro-channel bank is steep and dominated by exotic tree species (mainly Poplar and Wattle) with some terrestrial grassland and woody kloof species. The RB is dominated by grassland (burnt) with *Euclea* and *Eucalypt* species.	C/D	4
Fish	Sixteen fish species expected under reference conditions. Twelve species estimated to still be present. Four species intolerant to moderately intolerant to changes in the environment (BLIN, BEUT & BMAT) are estimated to have been lost from this reach, most probably related to water quality and flow deterioration, while the catadromous eel (AMOS) has been lost due to the presence of downstream migration barriers. The FROC of most of the indigenous species is highly reduced under the PES.	D	2
Macro-invertebrates	Reference Conditions: SASS5 - 220, ASPT - 7. A total of 66 taxa are expected to occur at this site, 31 of which are expected to occur in at least 50% of the samples and 23 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae and Leptoceridae) and Beetles (Dytiscidae, Elmidae, Gyrinidae and Psephenidae) PES: SASS5 – 103, ASPT - 5.7, MIRAI - 39.1. Only a limited number of these taxa were found in the current survey: Mayflies (>2spp Baetidae and Caenidae), Damselflies and Dragonflies (Coenagrionidae, Aeshnidae and Libellulidae), Caddisflies (2spp Hydropsychidae, Leptoceridae) and Beetles (Gyrinidae)	D/E	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL3, as well as the causes and sources for the PES are summarised in **Table 3.3**.

Table 3.3 EWR OL3: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	C	3	Increased PO_4 levels	Waste Water Treatment Works, feed lots	NF	3
Riparian vegetation	C/D	3	Altered species composition	Presence of exotic species	NF	5
			Reduced woody and non-woody cover	Mostly due to shading from exotics, but also high grazing pressure	NF	5
			Elevated sedge cover on seasonal features	Reduced base flows and small flood disturbance (abstraction and dams)	F	2
Fish	D	2	Loss of intolerant fish species and reduced FROC of some fish species due to habitat deterioration associated with poor substrate quality due to clogging by filamentous algae.	Increased nutrients related to sewage treatment works effluent, some agricultural activities.	F/NF	3
			Loss of intolerant species and decreased FROC of some species due to loss of fast habitats (overall habitat diversity).	Abstraction for domestic, agricultural and mining activities. Presence of large dam (Middelburg Dam).	F	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	
			Loss of some species and reduced FROC of other intolerant to water quality deterioration	Mining, agriculture and dysfunctional sewage treatment facilities resulting in water quality deterioration.	NF	
			Decreased species diversity and abundance (especially small species)	Presence of aggressive alien predatory species (MSAL & GAFF) naturally spreading and introduced for recreation / angling.	NF	
			Reduced FROC of some fish species due to increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR (and possibly introduced indigenous LUMB)	NF	
Macro-inverte btrates	D	3	Filamentous algal growth (nutrients)	Sewage treatment works, feedlots	NF	4
			Altered flow regime	Abstraction and US dams	F	4

1. Flow related
2. Non Flow related

3.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 3.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 3.4 EWR OL3: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	3	90
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	4	100
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2.5	60
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	80
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	100
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**D**	
Aquatic invertebrates	**D/E**	
Confidence rating for instream biological information	**2.3**	
INSTREAM ECOLOGICAL CATEGORY	**D/E**	
Riparian vegetation	**C/D**	
Confidence rating for riparian vegetation zone information	**3**	
ECOSTATUS	**D**	

3.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:

=	1999 EC is the same as 2010
-	Large scale degradation has taken place
-	Small scale degradation has taken place
++	Large scale improvement has taken place
-	Small scale improvement has taken place

Table 3.5 Comparison between the 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
Physico-chemical	C	C	There was an increase in the nutrient levels, as well as salinity, but this had no significant impact on the overall EC.	=	1
Riparian vegetation	C	C/D	Elevation in the cover and abundance of exotic vegetation (up to 58% on average in the upper zone), although the site surveyed was an alternate site to the one sampled in 1999.	-	3
Fish	D	D	PES EC similar to 1999 EWR EC. It is estimated that the biotic integrity, based on fish, has reduced slightly since 1999 but remains within the same EC (D). This was reflected especially by the extensive algal growth, and the fact that AURA was sampled during 1999 survey and not during the 2010 survey, although it's preferred habitat was sampled adequately.	-	2
Macro-invertebrates	C	D/E	Similar SASS and ASPT (103 and 5.7) as in 1999 (100 and 6.2). Different methods used. It is likely that the 1999 category was closer to a D category. The presence of a single Crambidae (moth caterpillar) that is quite sensitive (SASS score of 12), pushed up the SASS5 score and ASPT, but does not reflect the general condition of the invertebrates. Without the Crambidae, the SASS5 score would be 91 with an ASPT value of 5.3.	-	3

Changes are limited and mostly indicated in the instream biota. The change is negative and is due to a perceived increase in nutrients and associated algal growth.

3.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL3 is MODERATE and the REC is therefore to maintain the PES. The macroinvertebrates are however in a D/E EC and this must be improved to a D EC. An improvement in nutrients should achieve this. It must be noted, however, that there is a potential for a negative trend due to the increased nutrients and unless this problem is addressed, it is possible that the river will further degrade.

During 1999, the EIS was also MODERATE; however the REC was set to improve.

3.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

The results for setting EWR scenarios are summarised in **Table 3.5.**

Table 3.6 EWR OL3: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	D		C/D		
TDS	C	C	C	C	
WATER QUALITY	C	C	C	C	=
GEOMORPHOLOGY	D	C			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	D	C	D	D	-
MACRO INVERTEBRATES	C	C	D/E	D	-
INSTREAM			D/E	D	-
RIPARIAN VEGETATION	C	C	C/D	C/D	-
ECOSTATUS	D	C	D	D	-
INSTREAM IHI	D	C	C/D		
RIPARIAN IHI	D	C	D		
EIS	Moderate		Moderate		

3.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWRs were set for a C and a D EC. The C EWR was used for the REC. As the EIS is MODERATE there is no motivation to improve the PES (which is a D) and therefore it is recommended that the D EC EWR (1999) is used for yield modelling purposes and planning.

4. ECO CLASSIFICATION: EWER OL4: WILGE RIVER

4.1. CURRENT SURFACE WATER BALANCE

The same EIS model that was used during 1999 was applied again. The EIS results for EWR OL4 are HIGH. The highest scoring metrics are:

- Sensitivity of instream habitat to flow related water quality changes.
- Rare & endangered: 4 vegetation species and crocodiles
- Unique: 4 endemic riparian vegetation species
- Species/taxon richness: (14 fish species)
- Diversity of habitat types
- Refugia habitat

The 1999 result was also HIGH.

4.2. PRESENT ECOLOGICAL STATE

4.2.1. Summary of 1999 results

Table 4.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 10-15 sp. PES: 11 sp	B	Flow regulation below Premier Mine Dam
Riparian vegetation	RC: Grasslands, no exotic species. PES: Slight loss of cover & change in species composition.	B	Grazing & trampling, flow regulation, floods, erosion)
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. PES: May be small change in geomorphology and natural habitats. Demonstrated in reach by limited evidence of anthropogenic influence in a naturally stable channel.	B	Some loss of riparian zone, bridges
Macro-invertebrates	ASPT: 6.5 SASS Score: 152	B	ASPT: 6.5 SASS Score:152
Water quality	Nutrient concentrations were moderately high	B	Agricultural activities and some treated domestic sewage effluent discharged into the stream.
EcoStatus	B	**Flow-related:** Regulated flows, erosion & sedimentation (dam, weirs, agriculture), Water quality problems (dam, agriculture) **Non-flow related:** Sedimentation & erosion (agriculture), TDS & nutrients, water hyacinth (irrigation, limited mining)	

4.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 4.2**). The summarised information is provided in **Table 4.2**.

Table 4.2 Present Ecological State for EWR OL4

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	There is a slight deviation from natural conditions in all respects.	B/C	3
Riparian vegetation	**RC:** The assessed area at EWR 4 occurs within the Central Sandy Bushveld vegetation type. It is expected that the marginal and lower zones be dominated by a patchy mosaic of woody and non-woody rheophytic riparian obligates. The woody component will be dominated by *Gomphostigma virgatum* where cobble/boulder exists and *Salix mucronata* where cobble is embedded or where sediments have deposited. *Combretum erythrophyllum* and *Searsia gerarrdii* is expected to dominate alluvial deposits in the lower and upper zones. *Cyperus* species will dominate the non-woody clumps in the marginal and lower zones, with hydrophilic grasses on the lower and upper zones (such as *Miscanthus junceus*). The macro-channel bank is expected to be dominated by woody thicket, mainly terrestrial and kloof species (related to the Biome), but with *Celtis africana* as a riparian indicator. **PES:** Marginal zone is a mixture of sedge and woody patches (both rheophytic), mainly *Cyperus marginatus* and *Gomphostigma virgatum / Salix mucronata* subsp. *Woodii* respectively. The lower zone is similar to the marginal zone but with high cover and abundance of *Searsia gerrardii* and *Combretum erythrophyllum*. Alluvial deposits on the lower and upper zone supports populations of *Crinum bulbispermum, C. macowanii, Kniphofia spp, Berula thunbergii*. The upper zone also has an extensive population of *Miscanthus junceus*. The macro-channel bank is dominated by woody species, and some exotics have been removed at the site. Most species are terrestrial or kloof species with riparian indicators being *Celtis africana, Ilex mitis*.	A/B	3
Fish	Seventeen fish species expected under reference conditions. Fourteen species estimated to still be present. Two species which are intolerant to changes in the environment (BLIN & BEUT) estimated to have been lost from this reach, while the catadromous eel (AMOS) has been lost due to presence of downstream migration barriers.	C	3.5
Macro-invertebrates	Reference Conditions: SASS5 - 220, ASPT - 7. A total of 62 taxa are expected to occur at this site, 29 of which are expected to occur in at least 50% of the samples and 22 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae and Leptoceridae) and Beetles (Dytiscidae, Elmidae, Gyrinidae and Psephenidae) PES: SASS (51, 90, 110), ASPT (4.6, 5, 5.8); MIRAI (58.2). Only a limited number of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae and Leptophlebiidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae and Gomphidae), Caddisflies (>2spp Hydropsychidae, Leptoceridae) and Beetles (Dytiscidae, Elmidae and Gyrinidae)	C/D	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL4, as well as the causes and sources for the PES are summarised in **Table 4.3**.

Table 4.3 EWR OL4: PES causes and sources

	PES	Conf	Causes	Sources	F[3]/NF[4]	Conf
Phys-chem	C	3	Slight increase in salinity and nutrients	Mining activities	F	NF
Riparian vegetation	A/B	3	Altered species composition	Exotic vegetation	NF	5
			Elevated sedge and grass cover	Flow regulation, reduced flooding disturbance	F	3
Fish	C	3.5	Loss of species diversity, especially species intolerant to water quality deterioration	Mining activities and agriculture - pollution	NF	
			Altering of habitat surfaces due to filamentous algae.	Increased nutrients related to agricultural activities.	F/NF	
			Loss of fast-deep habitats (overall habitat diversity) resulting in loss of some species.	Abstraction for domestic, agricultural and mining activities.	F	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	
			Decreased species diversity and abundance (especially small species) as result of presence of aggressive alien predator (MSAL)	Presence of aggressive alien predatory species naturally spreading and introduced for recreation / angling.	NF	
			Increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR	NF	
Macro-inverte brates	C/D	2.5	Water quality	Mining upstream	NF	4
			Altered Flow Regime	Abstraction and US dams	F	4

1 Flow related
2 Non Flow related

4.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided **Table 4.4** as well as the portion of those percentages used in calculating the EcoStatus.

Table 4.4 EWR OL4: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3	90
2.What is the natural diversity of **fish** species with a preference **for** different cover types?	3	90
3.What is the natural diversity of **fish** species with a preference **for** different flow depth classes?	4	100
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2.5	60
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	4	100
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	100
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**C**	
Aquatic invertebrates	**C/D**	
Confidence rating for instream biological information	**3**	
INSTREAM ECOLOGICAL CATEGORY	**C**	
Riparian vegetation	**A/B**	
Confidence rating for riparian vegetation zone information	**3**	
ECOSTATUS	**C**	

4.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note: = 1999 EC is the same as 2010

-- Large scale degradation has taken place - Small scale degradation has taken place

++ Large scale improvement has taken place - Small scale improvement has taken place

Table 4.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
Physico-chemical	B	B/C	There was a slight increase in the nutrient levels, as well as salinity, but this had no significant impact on the overall EC.	=	3
Riparian vegetation	B	A/B	The EC shows an improvement, but it is likely that actual riparian condition is similar to previous assessments. The difference is likely due to the assessment of flooding disturbance, which was previously seen as an impact, but in this assessment is considered a largely natural impact and part of reference condition shaping.	=	3
Fish	B	C	PES deteriorated since 1999 EWR. Fish assemblage changed since 1999. EWR largely due to increased mining activities resulting in poor water quality.	- -	3.5
Macroinvertebrates	B	CD	Considerably lower SASS5 scores (51-110) and ASPT values (4.6-5.8) than in 1999 (SASS5 - 152; ASPT - 6.5). There has been an increase in mining upstream of the site. The Saalklapspruit upstream of the site seems to be devoid of life. The condition of the Wilge River downstream of the Saalklap/boom is impacted severely. It seems as if the Wilge improves if the flow from the Wilge River upstream of the Saalklap/boom is higher.	- -	4

There is a definite negative change at this site which is supported through monitoring undertaken by the involved specialists to assess mining impacts. Recent mining activities have resulted in the Saalklapspruit to be sterile and during low flow conditions in the Wilge River, this will have negative consequences. Both the fish and invertebrate results support this. As this does not impact on the riparian vegetation, no change was experienced.

4.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL4 is HIGH and the REC is therefore to improve the PES. This improvement can be achieved by improving water quality. The river has already shown an improvement due to the recent wet period. It is possible that certain mitigation measures to minimize these impacts are also being applied by the mines.

During 1999, the EIS was also HIGH, but as the EcoStatus was already in a B, the REC was set to maintain the PES.

4.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 4.6 EWR OL4: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	C		
TDS	A	A	B		
WATER QUALITY	B	B	B/C	B	=
GEOMORPHOLOGY	B	B			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	B	B	C	B	--
MACRO INVERTEBRATES	B	B	C/D	B/C	--
INSTREAM			C	B	
RIPARIAN VEGETATION	B	B	A/B	A/B	=
ECOSTATUS	B	B	C	B	--
INSTREAM IHI	B	B	C		
RIPARIAN IHI	B	B	A/B		
EIS	High		High		

4.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWRs were set for a B and a C EC. The B EWR was for the REC. As the EIS is HIGH, and the REC a B, it is recommended that the B EC EWR (1999) should be used for yield modelling purposes and planning. It must be noted, however, that without addressing the water quality problems, these flows will not achieve the REC.

5. EOCLASSIFICATION: EWR OL5: OLIFANTS RIVER DOWNSTREAM OF LOSKOP DAM

5.1. EIS RESULTS

The same EIS model that was used during 1999 was applied again. The EIS results for EWR4 are MODERATE. The highest scoring metrics are:

- Rare & endangered: 4 *Crinum sp*, *Acacia erioloba* and crocodiles
- Unique: 4 endemic riparian vegetation species

The 1999 result was HIGH as it was based on natural condition and not present as is now the norm.

5.2. PRESENT ECOLOGICAL STATE

5.2.1. Summary of 1999 results

Table 5.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 23 sp. PES: 22 sp	C	Flow regulation & water abstraction from Loskop Dam and Weirs
Riparian vegetation	RC: Riparian vegetation dominated by trees such as *C. erythrophyllum*, especially on floodplain, with *A. sieberana* common on the banks. *Salix mucronata* on river's edge. Transition to *C. africana* and *A. karroo* on edges of the riparian zone. Abundant grass within the riparian zone with sedges common in the marginal zone. PES: Changes in physiognomic structure due to loss of large trees, reduction in vegetation cover & changes in species composition	C	Flooding, grazing, erosion, etc.
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plain often present. PES: moderately modified with some change in geomorphology & instream habitat. Geomorphic thresholds do not appear to have been crossed. Is demonstrated in reach by local aggradation or sedimentation.	C	Dam, weir, irrigation
Macro-invertebrates	ASPT: 6.1 SASS: 169	C	
Physico-chemical	Marked increase in TDS between Loskop Dam to Arabie Dam as nutrient concentrations were generally low. Potential presence of harmful concentrations of pesticides and herbicides. Synergism of elevated salinity and runoff from irrigation could combine to impair community composition	C	Increase in TDS: Impacts of irrigation return flows from the Loskop Dam Irrigation Scheme. Serious attention should be paid to potential for localised toxic effects of pesticides and herbicides
EcoStatus		**Flow-related:** Regulated flows to no-flows, lack of scour flows, erosion (agriculture, Loskop Dam Weir) **Non-flow related:** TDS, (Irrigation)	

5.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC **Table 5.2**.

Table 5.2 2010 Present Ecological State for EWR OL5

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	There is a slight deviation from natural conditions in all respects. Nutrients elevated but within limits.	B/C	3
Riparian vegetation	**RC**: The assessed area at EWR 5 occurs within the Loskop Thornveld vegetation type, which occurs within the Savanna Biome and the Central Bushveld Bioregion. It is expected that the marginal and lower zones be dominated by a patchy mosaic of woody and non-woody rheophytic riparian obligates. The woody component should be dominated by *Gomphostigma virgatum* where cobble/boulder exists and *Salix mucronata* where cobble is embedded or where sediments have formed bars. *Combretum erythrophyllum* and *Searsia gerarrdii* are expected to dominate alluvial deposits in the lower and upper zones. *Cyperus* species should dominate the non-woody patches in the marginal and lower zones, with hydrophilic grasses on the lower and upper zones (such as *Miscanthus junceus*). The site occurs in the lower foothills, thus a small population of *Phragmites mauritianus* will be expected. The macro-channel bank is expected to be dominated by woody thicket, mainly terrestrial and savanna species (related to the Biome), but with *Celtis africana* and *Spirostachys africana* as a riparian indicators. **PES**: The riparian zone EC is comprised as follows: Marginal Zone: B/C – dominated by sedges (*C. marginatus* mainly) with some reed (*P. mauritianus*). Both *Salix mucronata* and *G. virgatum* are absent from the marginal zone. Lower Zone: B – similarly sedge-dominated in cobbled areas, alluvial bars are vegetated with a mixture of *S. mucronata*, *C. erythrophyllum* and *P. mauritianus*. Upper Zone: C – woody component dominated by *C. erythrophyllum* and non-woody component by a mixture of sedge and grasses. This zone also has an artificial wetland area due to constant seepage from upland irrigation. MCB: B – Dominated by woody vegetation, mostly terrestrial species, but with *Celtis africana* and *Sprirostachys africana* as riparian indicators.	B/C	3
Fish	Twenty-eight fish species expected under reference conditions, while twenty-five estimated to still be present. The FROC of most of the indigenous species has been reduced from reference conditions. Two species that are intolerant to moderately intolerant to changes in the environment (BLIN & BEUT), are estimated to have been lost from this reach, most probably related to flow modification (Loskop Dam releases), while water quality deterioration may have contributed to this scenario. The catadromous eel (AMOS) has been lost from this reach due to presence of downstream migration barriers. The presence of the predatory alien fish MSAL also thought to have a notable impact on the indigenous fish species (esp. smaller species).	C/D	2
Macro-invertebrates	Reference Conditions: SASS5 - 220, ASPT - 7. A total of 49 taxa are expected to occur at this site, 29 of which are expected to occur in at least 50% of the samples and 9 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae), Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae, Philopotamidae and Leptoceridae) and Beetles (Elmidae, Gyrinidae and Psephenidae).	CD	3

Component	Reference condition and PES Description	EC	Conf
	PES: SASS5 – 93, ASPT - 5.5, MIRAI - 58.3. Only a limited number of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae and Leptophlebiidae); Damselflies and Dragonflies (Coenagrionidae, Libellulidae and Gomphidae), Caddisflies (>2spp Hydropsychidae, Leptoceridae) and Beetles (Gyrinidae).		

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL5, as well as the causes and sources for the PES are summarised in **Table 5.3**.

Table 5.3 EWR OL5: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	B/C	3	Slight increase in salinity and nutrients	Mining activities, discharge of treated effluent	NF/F	3
Riparian vegetation	B/C	3	Altered species composition	Exotic vegetation, and agricultural seepage that has created an unnatural wetland on the upper zone	NF	5
			Elevated sedge in marginal and lower zone	Flow regulation, reduced flooding disturbance	F	3
			Reduced woody cover and abundance	Selected wood removal	NF	5
Fish	C/D	2	Loss of intolerant fish species and reduced FROC of some fish species due to habitat deterioration associated with poor substrate quality due to clogging by filamentous algae.	Increased nutrients (evident in Loskop Dam being mesotrophic), alteration in turbidity regime (Loskop Dam bottom releases) can result in increased algal growth (with improved water clarity). Potential contribution of nutrients from some agricultural activities.	F/NF	3
			Loss of intolerant species and decreased FROC of some species due to loss of fast habitats (overall habitat diversity) especially in dry season	Flow modification by Loskop Dam (especially in dry season).	F	
			Loss of species and reduced FROC due to loss of overhanging vegetation and undercut banks/rootwad habitats.	Flow modification from Loskop Dam, resulting in frequent fluctuation of water level, decreasing natural overhanging vegetation and undercut banks habitats. This is aggravated by very low flows and even zero flows in dry season.		
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers.	NF	

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
			Loss of some species and reduced FROC of other intolerant to water quality deterioration	Mining activities in upstream catchment, with Loskop Dam as sink for pollutants. Increased nutrients (evident in Loskop Dam being mesotrophic), alteration in temperature and turbidity regime (Loskop Dam bottom releases) and limited some agricultural activities.	NF	
			Decreased species diversity and abundance (especially small species) as result of presence of aggressive alien predator (MSAL)	Presence of aggressive alien predatory species naturally spreading and introduced for recreation / angling.	NF	
			Reduced FROC of some fish species due to increased turbidity, and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR.	NF	
Macro-invertebrates	CD	2.5	Water quality	Land use activities e.g. Irrigation	NF	2
			Altered Flow Regime	Abstraction and US dams	F	4
			Armouring of the Bed	Flow regulation from Loskop Dam	F	4

1 Flow related 2 Non Flow related

5.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 5.4** as well as the portion of those percentages used in calculating the EcoStatus.

Table 5.4 EWR OL5: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	4	100
2.What is the natural diversity of **fish** species with a preference for different cover types?	4	100
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3	90
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2.5	60

INSTREAM BIOTA	Importance Score	Weight
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	4	100
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	100
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**C/D**	
Aquatic invertebrates	**C/D**	
Confidence rating for instream biological information	**2.6**	
INSTREAM ECOLOGICAL CATEGORY	**C/D**	
Riparian vegetation	**B/C**	
Confidence rating for riparian vegetation zone information	2.6	
ECOSTATUS	**C**	

5.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note: = 1999 EC is the same as 2010
-- Large scale degradation has taken place - Small scale degradation has taken place
++ Large scale improvement has taken place - Small scale improvement has taken place

Table 5.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
Physico-chemical	C	B/C	There was a very small increase in the nutrient levels, but a decrease in salinity, but this had no significant impact on the overall EC.	=/+	3
Riparian vegetation	C	B/C	The EC shows a small improvement, but it is likely that actual riparian condition is similar to previous assessments. The difference is likely due to the assessment of flooding disturbance, which previously was taken as an impact, but in this assessment is considered a largely natural impact and part of reference condition shaping.	=	3
Fish	C	C/D	The lower EC calculated for 2010 (C/D) than 1999 (C) can	=	2

COMPONENT	1999 EC	2010 EC	COMMENT	CONCLUSION	CONFIDENCE
			possibly be attributed to different methodology rather than deterioration. It is estimated that the fish assemblage in this reach is still very similar to that of 1999, assuming the release from Loskop Dam has remained the same. (If the introduction of predatory alien species MSAL has occurred since 1999, it may be a source of deterioration, that would indicate a negative trend and possible deterioration since 1999).		
Macro-invertebrates	C	C/D	Considerably lower SASS scores (93) and ASPT values (5.5) than in 1999 (SASS5 - 169; ASPT - 6.1). The reason for the deterioration in the invertebrates downstream of Loskop Dam is not clear. The most likely cause seems to relate to scouring of the bed and the corresponding armouring of the bed, as well as some water quality problems.	--	2

The only negative change was reflected by the macroinvertebrates. The conclusion is that overall the EcoStatus is slightly negative, but probably still within the same EC to what it was in 1999.

5.5. RECOMMENDED ECOLOGICAL CATEGORY (REC)

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL5 is MODERATE and the REC is therefore to maintain the PES. During 1999, the EIS was HIGH and the EcoStatus was set to improve the PES. The 1999 REC was therefore B. In 2010, the REC is now a C.

Table 5.6 EWR OL5: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES & REC	CHANGE
NUTRIENTS	B	C?	C	
TDS	C	C	B	
WATER QUALITY	C	C	B/C	=
GEOMORPHOLOGY	C	C		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**CHANGE**
FISH	C	C	C/D	=
MACRO INVERTEBRATES	C	C	C/D	--
INSTREAM			C/D	-
RIPARIAN VEGETATION	C	C	B/C	=
ECOSTATUS	C	B	C	-
INSTREAM IHI	D	C	C/D	
RIPARIAN IHI	C	C	C	
EIS	High		Moderate	

5.6. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWRs were set for a B and a C EC. The B EWR was for the REC. As the EIS is now MODERATE, it is recommended that the C EC EWR (1999) be used for yield modelling purposes and planning.

6. ECOCLASSIFICATION: EWR OL6: ELANDS RIVER DOWNSTREAM OF RHENOSTERKOP DAM

6.1. EIS RESULTS

The same EIS model as used during 1999 was applied. The EIS results for EWR OL6 are MODERATE. The highest scoring metrics are:

- Unique: 3 endemic riparian vegetation species
- Sensitive habitat to flow changes

The 1999 result was also MODERATE.

6.2. PRESENT ECOLOGICAL STATE

6.2.1. Summary of 1999 results

Table 6.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 25 sp, PES: 10 sp.	E	Flow regulation below Renosterkop Dam
Riparian vegetation	RC: Well developed riparian forest in most areas, dominated by *C. erythrophyllum,* particularly on terraces and floodplains. Large stands of *A. galpinii* are expected to occur. A clear transition to adjacent areas. Isolated patches of *Phragmites* on islands in channel. PES: Large loss of cover & changes in physiognomic structure & species composition, significantly impaired recruitment, encroachment of reeds & exotic species.	D	Grazing & trampling, vegetation removal, flow regulation, impoundments, erosion, exotic species, floods, human settlement, dumping, etc.
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plain often present PES: Geomorphic threshold appear to have been crossed with the river moving towards a new equilibrium. Demonstrated in this reach by over-widening, high suspended sediment loads, and aggradation in form of bar deposits.	D	Extensive agriculture, irrigation, weirs, dams, bridges, sewerage works.
Aquatic invertebrates	ASPT: 5.1 SASS: 97	D	
Physico-chemical variables	Significant increase in TDS concentration in lower Elands River. Impacts were higher during low flow months and increased salinity was also reflected in WQ of Olifants River. Nutrients were generally low. Modified pH.	D	Increase in TDS: Return flows from Loskop Irrigation scheme. Modified pH - irrigation return flows. Pesticides, herbicides
EcoStatus		**Flow-related:** Erosion, regulated and unnatural flow, (Operation of Renosterkop Dam, Agriculture), TDS (Irrigation) **Non-flow related:** TDS, vegetation loss. In-stream toxicity (particularly from pesticides) was not demonstrated, but is of concern, and should be monitored (landuse eg. agriculture, overgrazing, irrigation)	

6.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 6.2**).

Table 6.2 Present Ecological State for EWR OL6

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Salinity is elevated, pH is high and nutrients increased.	C	4
Riparian vegetation	**RC:** The assessed area at EWR OL6 occurs within the Central Sandy Bushveld vegetation type, which occurs within the Savanna Biome and the Central Bushveld Bioregion. It is expected that the marginal and lower zones be dominated by a patchy mosaic of woody and non-woody rheophytic riparian obligates. The woody component will be dominated by *Gomphostigma virgatum* where cobble/boulder exists and *Salix mucronata* where cobble is embedded or where sediments have deposited. *Combretum erythrophyllum* and *Searsia gerarrdii* is expected to dominate alluvial deposits in the lower and upper zones. *Cyperus* species will dominate the non-woody clumps in the marginal and lower zones, with hydrophilic grasses on the lower and upper zones (such as *Miscanthus junceus*). Since the site is in the lower foothills, a reed population (*Phragmites* mauritianus) is expected in the marginal and lower zones associated with alluvial deposits. The macro-channel bank is expected to be dominated by woody thicket, mainly terrestrial and savanna species (related to the Biome), but with *Celtis africana* and *Spirostachys africana* as a riparian indicator. **PES:** The riparian zone EC is comprised as follows: Marginal Zone: C/D – channel appears incised, steep alluvial banks with reeds (*P. mauritianus*), *Miscanthus junceus* and *Combretum erythrophyllum.* Riffle areas are colonised by a mixture of sedge (*Cyperus marginatus* mainly), reed and *Miscanthus junceus.* Obligate marginal zone riparian species are mixed with upper zone riparian species and even some terrestrial species, which suggests severely erratic flows. Lower Zone: C/D – similar to marginal zone Upper Zone: C – alluvial terraces are colonised by mature population of *C. erythrophyllum* and *Acacia karoo*. Recruitment is absent and wood collection has reduced cover. Terrestrialisation is also prevalent. MCB: D – most terrestrial woody species have been removed for firewood, grasses now dominate and are heavily grazed and frequently burnt.	C/D	2.6
Fish	Twenty fish species expected under reference conditions, while seventeen estimated to still be present under present conditions. The FROC of most of the indigenous species has been reduced significantly from reference conditions. Two species, thought to have been lost from this reach (CPRE & CSWIE), have been significantly impacted by flow modification (both species are rheophilic / intolerant to flow modification). The catadromous eel (AMOS) has been lost from this reach due to presence of downstream migration barriers. The primary determining factor at this site is flow modification (releases from Rhenosterkop Dam), with secondary impacts being associated with sedimentation (overgrazing and erosion) and water quality deterioration.	D/E	2.5

Component	Reference condition and PES Description	EC	Conf
Macro-invertebrates	Reference Conditions: SASS5 - 220, ASPT - 7. A total of 59 taxa are expected to occur at this site, 29 of which are expected to occur in at least 50% of the samples and 14 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae, Philopotamidae and Leptoceridae) and Beetles (Elmidae, Gyrinidae and Psephenidae) PES: SASS5 – 154, ASPT -5.5, MIRAI - 74.8. Most of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae, Heptageniidae and Leptophlebiidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Libellulidae and Gomphidae), Caddisflies (2spp Hydropsychidae, Leptoceridae) and Beetles (Gyrinidae).	C	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL6 as well as the causes and sources for the PES are summarised in **Table 6.3**.

Table 6.3 EWR OL6: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	C	3	Significant increase in salinity and pH, slight increase in nutrients	Discharge of treated effluent, irrigation return flow, unknown source of salts.	F/N	3
Rip veg	C/D	2.6	Altered species composition	Exotic vegetation, intense terrestrialization and replacement of woody savanna species by grasses	NF	5
			Reduced cover and abundance in the marginal zone (frequently absent)	Erratic flow regime, reduced base flows and increased prolonged periods of zero flows	F	3
			Reduced woody cover and abundance	Selected wood removal throughout	NF	5
Fish	D/E	2.5	Loss of intolerant species (CPRE & CSWIE) and decreased FROC of some species due to loss of substrate quality (sedimentation)	Sedimentation (embeddedness) of rocky substrates because of catchment and bank erosion (overgrazing, agricultural and rural activities).	F/NF	3
				Flow modification by Rhenosterkop Dam.	F	
			Reduced FROC of some species due to loss of overhanging vegetation and undercut banks/rootwad habitats.	Flow modification from Rhenosterkop Dam, resulting in frequent fluctuation of water level, decreasing natural overhanging vegetation and undercut banks habitats. This is aggravated by very low flows and zero flows.	F	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers.	NF	

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
			Reduced FROC of some species intolerant to water quality deterioration	Agricultural activities and rural area.	NF/F	
			Decreased abundance and possible loss of some species due to over harvesting by local population.	Rural area with low-income household, utilizing available protein resources optimally.	NF	
Macro-invertebrates	C	2.5	Water quality	Land use activities	NF	2
			Altered Flow Regime	Abstraction and US dams	F	4
			Armouring of the Bed	Flow regulation from Loskop Dam	F	4

1 Flow related 2 Non Flow related

6.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 6.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 6.4 EWR OL6: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3	80
2.What is the natural diversity of **fish** species with a preference for different cover types?	3.5	90
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	4	100
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2	60
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	80
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	100
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**D/E**	
Aquatic invertebrates	**C**	

INSTREAM BIOTA	Importance Score	Weight
Confidence rating for instream biological information	2.25	
INSTREAM ECOLOGICAL CATEGORY	D	
Riparian vegetation	C/D	
Confidence rating for riparian vegetation zone information	2.6	
ECOSTATUS	D	

6.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note: = 1999 EC is the same as 2010

-- Large scale degradation has taken place Small scale degradation has taken place

++ Large scale improvement has taken place - Small scale improvement has taken place.

Table 6.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	D	C	Salinity and pH have increased. Previous assessment may have overestimated effect of salinity at the EWR site. Further down the river, the water quality deteriorates significantly, and at the confluence with the Olifants, it is a D due to high salinity and pH.	-	4
Riparian vegetation	D	C/D	Although the EC score is up (a much more quantified assessment), the condition of the riparian zone has deteriorated due to both flow related impacts as well as heavy utilization of the vegetation at the site.	--	3
Fish	E	D/E	Presently in slightly improved condition compared to 1999 EWR. This is mostly related to improved flows at the site over the recent past (2 years). This is related to changed flow management at Rhenosterkop Dam. Conditions are however still poor due to altered flows, sedimentation of bottom substrates, loss of pools (depth) and overhanging vegetation (trampling and overgrazing). Should the flow management of Rhenosterkop Dam revert back to the 1999 procedure, the fish assemblage will again deteriorate towards a category E.	+	3

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Macro-invertebrates	D	C	Considerably higher SASS scores (154) and ASPT values (5.5) than in 1999 (SASS5 - 97; ASPT - 5.1). The reason for the apparent improvement in the invertebrates in the lower Elands River is most likely due to the recent improvement in the releases from the Renosterkop Dam. The invertebrates have a relatively short lifecycle and respond quickly to improved conditions. They are also able to recolonise areas quickly due to adults flying in and depositing eggs. The upper Elands river is still in reasonably good condition providing a source of adults for recolonising the downstream section. This improvement can just as quickly be turned around if the previous "ecologically unfriendly" releases from Renosterkop return.	+	3

During 1999, this river reach was dominated by releases from Renosterpoort Dam. The releases were made on a regular basis as a flushing flow and then zero flows. This resulted in the poor 1999 ecological state, and subsequent monitoring by nature conservation authorities found an even worse situation. The fish and invertebrate surveys during August 2010 however indicated a much improved situation. The observed record from the Renosterpoort gauge was evaluated and steady releases have been made since about May 2009. The dam also recently spilled over for the first time. Although this manner of releases is still not ideal, i.e. too high in winter with no seasonal variability; this was still better than the previous operating rule. Nobody can confirm why this change has taken place and whether this is a permanent change.

The improved instream ecological state is directly related to the change in operating rules. If the operating rules are changed back, the river health state will also revert to the 1999 or worse conditions.

Riparian vegetation did not improve due to these conditions as non-flow regulated activities such as removal of vegetation, especially Acacia species were a more dominant factor than the flow regulation.

6.5. RECOMMENDED ECOLOGICAL CATEGORY (REC)

The EIS at EWR OL6 is MODERATE and the REC is therefore to maintain the PES at a D. The fish should also be improved from a D/E to a D which will probably result in an REC o a C/D. Continued improved operation of the dam should achieve this. During 1999, the EIS was also MODERATE but as the EcoStatus was an E EC which is not deemed a sustainable state, the REC was set to improve the EcoStatus to a D EC.

6.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 6.6 EWR OL6: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	B	B	C	C	
TDS	D	D	D	D	
WATER QUALITY	D	D	C	C	-
GEOMORPHOLOGY	D	D			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	E	D	D/E	D	+
MACRO INVERTEBRATES	D	D	C	C	+
INSTREAM			D	C/D	
RIPARIAN VEGETATION	D	D	C/D	C/D	-
ECOSTATUS	E	D	D	C/D	+
INSTREAM IHI	E	D	D/E		
RIPARIAN IHI	D	D	D		
EIS	Moderate		Moderate		

6.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWRs were set for a D and a C EC. In this situation, it is however more logical to, with whatever volumes are being released, design more ecologically-friendly operating rules. This would be more relevant than an EWR release combined with unfriendly operating rules or other users.

7. ECOCLASSIFICATION: EWR OL8: OLIFANTS RIVER DOWNSTREAM OF THE MOTHLAPITSE CONFLUENCE

7.1. EIS RESULTS

The same EIS model that was used during 1999 was applied again. The EIS results for EWR OL8 are MODERATE. The highest scoring metrics are:

- Unique: 4 endemic riparian vegetation species, 2 fish species (OPER, BEUT), Wolkberg Centre of plan endemism
- Migration routes: Link between lowveld and upper reaches. Important for birds.

The 1999 result was also MODERATE.

7.2. PRESENT ECOLOGICAL STATE

7.2.1. Summary of 1999 results

Table 7.1 Summary of 1999 results extracted from the final reports

Component	Description		Causes and Sources
Fish	RC: 26 sp, PES: 18 sp	D	Flow regulation and abstraction from Arabie Dam. Erosion and sedimentation reduces available habitat.
Riparian vegetation	RC: Well developed riparian forest dominated by *Ficus sycomorus*, *Croton megalobotrys* & *Trichelia emetica* on the macro-channel floor. *Maytenus xenegalensis*, *Acacia robusta* and *Diospyros mespiliformis* should be common on the banks. Phragmites expected to be common in patches within the riverbed. The transition to the adjacent vegetation should be characterised by *Ziziphus mucronata*, *Celtis africana*, *Combretum imberbe* and *Lonchocarpus capassa*. A gallery forest may be present in many areas. Areas with bedrock control and characterised by *Breonadia salicina*. PES: Large loss and replacement of natural vegetation, impaired recruitment, reduced species richness.	D	Wood cutting, localised excavations, grazing and trampling, flow regulation, flooding and reduced flows, exotic species
Geomorphology	RC: Low gradient alluvial sand bed channel, typical regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain. Followed lower down by a lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand and bars common in pools. Pools of significantly greater extent than rapids/riffles. Floodplain often present PES: E Class reach is definitely being seriously modified. An extensive loss of natural in-stream habitat. System appears to be extremely unstable. This is demonstrated by excessive bank undercutting and erosion, sediment	E	Vegetation removal, extensive agriculture, weirs, mining, settlements & bridges

Component	Description		Causes and Sources
	deposition, presence of over-widened channel.		
Macro-invertebrates	SASS score: 100, ASPT: 5.4	C	
Physico-chemical	Increase in TDC. Some of the worst salinity and sediment problems in Olifants.		Irrigation
EcoStatus	**E**	**Flow-related:** Regulated flows to no-flows & sedimentation (agriculture, Arabie Dam and Chueniespoort Weir, abstraction schemes) **Non-flow related:** Sedimentation & vegetation loss (Agriculture (specifically overgrazing, deforestation). TDS (Irrigation, energy provision, land-use).	

7.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 7.2**).

Table 7.2 2010 Present Ecological State for EWR OL8

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Salinity is elevated, pH is high and nutrients increased.	C	2
Riparian vegetation	**RC:** The assessed area at EWR OL8 occurs within the Sekhukhune Plains Bushveld vegetation type, which occurs within the Savanna Biome and the Central Bushveld Bioregion. The site also occurs within the Wolkberg Centre of plant endemism (Van Wyk & Smith, 2001). Naturally, an open site due to high degree of exposed bedrock. Cobble areas in the marginal and lower zones are expected to be dominated by sedges, while alluvial deposits by reeds and some grasses. The upper zone is expected to be dominated by woodlands with some open unconsolidated sediments. Terrestrial woody species will be common in the upper zone and the macro-channel bank. Macro-channel bank should be characterised by large *Combretum imberbe, Spirostachys africana* and *Acacia nigrescence* populations. **PES:** The riparian zone EC is comprised as follows: Marginal Zone: C – mostly open with incised alluvial banks populated by *P. mauritianus.* All non-woody vegetation including reeds is heavily grazed. Embedded cobble supports *Cynodon dactylon,* which is cropped as lawns due to grazing. Sedge cover is minimal and rheophytes are absent. Lower Zone: C – mostly open with a mix of unconsolidated sediment deposits and boulder beds. *Cynodon dactylon* patches occur that are cropped as lawns with some reed (low density, low vigour, highly grazed). Recruitment of *Acacia galpinii* is high. Upper Zone: C – Open unconsolidated sediments with a high proportion of exotic weed cover for lower 10m. from there on woody thickets dominate with a mix of riparian and terrestrial woody species, grass cover is low or absent. MCB: D – similar to the upper zone, a narrow band of tall trees, mainly *Combretum imberbe*, with low or no grass cover.	C	2.7
Fish	Thirty fish species expected under reference conditions. Twenty-eight species estimated to still be present. Two species of catadromous eel (AMAR & AMOS) have been lost due to presence of downstream migration barriers.	D	3.5
Macro-invertebrate	Reference Conditions: SASS5 - 200, ASPT - 7. A total of 55 taxa are expected to occur at this site, 23 of which are expected to occur in at least 50% of the samples and 10 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), and Caddisflies (>2 spp Hydropsychidae and Leptoceridae).	C/D	3

Component	Reference condition and PES Description	EC	Conf
	PES: SASS (94 - 104), ASPT (5.4 – 5.9), MIRAI - 61.9. Some of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae, Heptageniidae and Leptophlebiidae); Damselflies and Dragonflies (Coenagrionidae, Libellulidae and Gomphidae) and Caddisflies (2spp Hydropsychidae, Leptoceridae).		

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL8 as well as the causes and sources for the PES are summarised in **Table 7.3**.

Table 7.3 EWR OL8: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	C	3	Increase in salinity, slight increase in nutrients.	Irrigation return flow, coupled with low flows in the river.	NF/F	3
Riparian vegetation	C	2.7	Altered species composition	Exotic vegetation and terrestrialization	NF	5
			Reduced cover and of riparian obligate species	Reduced base flow and flooding disturbance	F	3
			Reduced woody cover and abundance	Selected wood removal throughout	NF	5
			Altered vegetation structure	Intense grazing pressure	NF	5
Fish	D	3.5	Reduced flows and flooding influencing FROC.	Flow regulation from Arabie Dam.	F	3
			Channel erosion – scouring of banks and undercutting; influencing habitat quality.	Over-grazing, removal of riparian trees and increased run-off surfaces in catchment.	NF	
			Extremely low flows during low flow period impacts on fish habitat, especially at the controls (riffles & rapids).	Abstraction for irrigation and mining.	F	
			Loss of fast-deep habitats (overall habitat diversity) resulting in loss of some species.	Combination of the deposition of sediment resulting from erosion and lower flows due to abstraction for irrigation and mining.	F	
			Loss of natural instream habitat (cobbles, gravel and course sediment)	Deposition of sediment resulting from erosion	NF	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	
Macro-nvertebrates	C/D	3	Water quality	Land use activities	NF	2
			Altered Flow Regime	Abstraction and US dams	F	4
			Reduced habitat due to sedimentation	Overgrazing upstream	NF	4

1 Flow related 2 Non Flow related

7.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 7.4** as well as the portion of those percentages used in calculating the EcoStatus.

Table 7.4 EWR OL8: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	3.5	100
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3	90
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	2.5	60
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	80
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	3	80
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**D**	
Aquatic invertebrates	**C/D**	
Confidence rating for instream biological information	**3**	
INSTREAM ECOLOGICAL CATEOGORY	**C/D**	
Riparian vegetation	**C**	
Confidence rating for riparian vegetation zone information	**2.7**	
ECOSTATUS	**C/D**	

7.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:
= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place.

Table 7.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	D	C	No significant change. Previous assessment may have overestimated effect of salinity at the EWR site.	=	2
Riparian vegetation	D	C	The condition of the riparian zone and its ability to perform riparian functions has not changed dramatically. The improvement in EC score is likely due to different opinion of the reference condition.	=	2
Fish	D	D	PES has not changed since 1999 EWR. Mr Mick Angliss also classified the PES as a D during 2004.	=	4
MacroInvertebrates	D	C/D	The current SASS scores (94- 104) and ASPT values (5.4 – 5.9) are very similar to those from 1999 (SASS5 - 100; ASPT - 5.4). There is no change in the invertebrates from 1999.	=	4

No changes were identified from 1999. This is supported by the fact that land use has not changed significantly. The recent wet period has probably also mitigated any increased abstractions.

7.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The EIS at EWR OL8 is MODERATE and the REC is therefore to maintain the PES at a C/D. During 1999, the EIS was also MODERATE.

7.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 7.6 EWR OL8: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	B	B	B	?
TDS	E	D	C	?
WATER QUALITY	D	D	C	?
GEOMORPHOLOGY	E	?	E	=
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	D	D	D	=
MACRO INVERTEBRATES	D	D	C/D	=
INSTREAM			C/D	
RIPARIAN VEGETATION	D	D	C	=
ECOSTATUS	E	D	C/D	=
INSTREAM IHI	E	D	C/D	
RIPARIAN IHI	E	D	C/D	
EIS	Moderate		Moderate	

7.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The 1999 EWR was set for a D EC which is an improvement of the unacceptable E 1999 EcoStatus. As it is perceived that there has been no change in state since 1999, the EWR for the D EcoStatus would be applicable for the C/D (2010) EcoStatus.

8. ECOCLASSIFICATION: EWR OL9: STEELPOORT

8.1. EIS RESULTS

The same EIS model that was used during 1999 was applied again. The EIS result for EWR OL9 is MODERATE. The highest scoring metrics are:

- Unique: 3 endemic riparian vegetation species, 3 fish species (BLIN, CSWI, OPER)
- Intolerant species (flow and flow-related water quality: 5 intolerant fish species (CPRE, CSWI, OPER, AURA, BLIN) and 4 moderately intolerant species

The 1999 result was HIGH.

8.2. PRESENT ECOLOGICAL STATE

8.2.1. Summary of 1999 results

Table 8.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 20 sp. PES: 17 sp	D	Erosion & sedimentation - reduced habitat etc
Riparian vegetation	RC: Characterised by *Acacia galpinii, C. erythrophyllum* & *Syzigium cordatum*. Well developed riparian forest. Phragmites in isolated patches in riverbed. PES: Large loss of cover, encroachment of reeds & exotic species, changes in species composition & physiognomic structure & impaired recruitment.	D	Vegetation removal, exotic species, subsistence farming, human settlement, dumping, grazing etc.
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Floodplain often present PES: Geomorphic thresholds appear to have been crossed with the river moving towards a new equilibrium. This is demonstrated in this reach by some bank undercutting and extensive channel bank erosion. High suspended sediment loads, tributary bars and mid channel bars.	D	Subsistence agriculture, overgrazing, bridges, weirs
Aquatic invertebrates	ASPT: 5.5 SASS score: 81	D	Chromium causes embeddedness of habit
Physico-chemical	Significant increase in TDS (seasonal). Nutrients elevated. Heavy metal contamination from chrome and vanadium.	C	Mining & some irrigation activities in catchment. Treated domestic effluent from Burgersfort. Chrome and vanadium activities in catchment.
Ecostatus			**Flow-related:** Modification to low flows (agriculture) **Non-flow related:** Erosion, sedimentation (Overgrazing, unstructured development, agriculture, vegetation loss), nutrient enrichment, instream toxicity not demonstrated, but of concern, TDS (mines, irrigation).

8.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 8.2**).

Table 8.2 Present Ecological State for EWR OL9

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Salinity is somewhat elevated, pH is high and nutrients slightly increased.	B	2
Riparian vegetation	**RC**: The assessed area at EWR 9 occurs within the Sekhukhune Mountain Bushveld vegetation type, which occurs within the Savanna Biome and the Central Bushveld Bioregion. The site also occurs within the Sekhukhune Centre of plant endemism (Van Wyk & Smith, 2001). Marginal zone should support rheophytic communities, particularly *Gomphostigma virgatum, Salix mucronata* and *Cyperus marginatus.* Alluvial deposits should support a mixture of reeds and grasses. The upper zone is expected to be dominated by woodlands with some open unconsolidated sediments. Terrestrial woody species will be common in the upper zone and the macro-channel bank. Macro-channel bank should be characterised by large *Combretum imberbe, Spirostachys africana* and *Acacia galpinii* populations. *Schotia brachypetala* should also be present. **PES**: The riparian zone EC is comprise as follows: Marginal Zone: D – dominated by reeds (*Phragmites mauritianus*) with some dicotyledonous hydrophytes (mainly *Persicaria* species). Sedges are absent, as are woody obligates and the rheophytic community. Some open cobble exists, and consolidated alluvium is colonised by *Cynodon dactylon* which shows high levels of grazing. Lower Zone: D – mostly open and utilized as picnic and dumping site. Much of the vegetation is burnt and appears to be frequently burnt. The dominant species is *P. mauritianus.* Upper Zone: D – similar to the lower zone in that this zone is also highly disturbed. *P. mauritianus* and *C. dactylon* occur where woody vegetation is absent. Woody species at the site are all large specimens with recruitment being absent. MCB: C – narrow and steep with high degree of erosion. The MCB consists of mostly open consolidated alluvia or grassed areas (*C. dactylon)* but grazing and disturbance is high. Riparian and terrestrial woody species are scanty and large, also with recruitment being absent.	D	3
Fish	Nineteen fish species expected under reference conditions, while eighteen estimated to still occur under present conditions. The FROC of most of the indigenous species have been reduced significantly from reference conditions. The catadromous eel (AMOS) have been lost from this reach due to presence of downstream migration barriers. The primary impact responsible for the deterioration of the fish assemblage at this site include sedimentation due to overgrazing (catchment and bank erosion) responsible for loss of substrate quality as well as loss of pools (SD), as well as some water quality deterioration. The presence of some intolerant species (OPER, CPRE and possibly CSWI) is promising.	C	2.5

Component	Reference condition and PES Description	EC	Conf
Macroinvertebrates	Reference Conditions: SASS5 - 200, ASPT - 7. A total of 59 taxa are expected to occur at this site, 30 of which are expected to occur in at least 50% of the samples and 14 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae, Philopotamidae and Leptoceridae), Beetles (Elmidae, Gyrinidae and Psephenidae) PES: SASS (69 - 100), ASPT (5.3 – 5.7), MIRAI - 61. Some of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae, Heptageniidae and Leptophlebiidae), Damselflies and Dragonflies (Coenagrionidae, Libellulidae and Gomphidae), Caddisflies (2spp Hydropsychidae, Leptoceridae and Hydroptilidae) and Beetles (Gyrinidae).	C/D	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL9 as well as the causes and sources for the PES are summarised in Table 8.3.

Table 8.3 EWR OL9: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	B/C	3	Increase in salinity, slight increase in nutrients	Irrigation return flow, mining discharge.		
Riparian vegetation	D	3	Altered species composition	Exotic vegetation and terrestrialization	NF	5
			Reduced cover and of riparian obligate species	Reduced base flow and flooding disturbance	F	3
			Reduced woody cover and abundance	Selected wood removal throughout	NF	5
			Altered vegetation structure and reduced non-woody cover	Intense grazing pressure	NF	5
			Unhealthy population structure of woody riparian species	Absence of recruitment due to physical disturbance and grazing of seedlings	NF	4
Fish	C	2.5	Decreased FROC of some species due to loss of substrate quality (sedimentation)	Sedimentation (embeddedness) of rocky substrates as a result of catchment and bank erosion (overgrazing and agricultural and rural activities).	NF	3
			Reduced FROC of some species due to loss of overhanging vegetation.	Overgrazing and trampling in riparian zone.	NF	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers.	NF	

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
			Decreased abundance of some species (esp. OMOS, BMAR, etc.) due to harvesting by local population.	Rural area, utilizing available protein resources.	NF	
Macro-invertebrates	CD	3	Water quality	Land use activities	NF	2
			Altered Flow Regime	Abstraction and US dams	F	4
			Reduced habitat due to sedimentation	Overgrazing and mining upstream	NF	4

1 Flow related
2 Non Flow related

8.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 8.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 8.4 EWR OL9: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	4	100
2.What is the natural diversity of **fish** species with a preference for different cover types?	3.5	80
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3.5	80
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	3.5	80
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	90
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	3	90
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	4	100
Fish	**C**	
Aquatic invertebrates	**C/D**	
Confidence rating for instream biological information	**2.8**	
INSTREAM ECOLOGICAL CATEOGORY	**C/D**	
Riparian vegetation	**D**	
Confidence rating for riparian vegetation zone information	**3**	
ECOSTATUS	**C/D**	

8.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:

= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place

Table 8.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	C	B	No significant change.	=	2
Riparian vegetation	D	D	The condition of the riparian zone and its ability to perform riparian functions has not changed. The condition remains poor and the impacts high.	=	4
Fish	B	C	Although a higher EC was calculated for 2010 assessment compared to 1999, it is estimated that the biotic integrity of the site in terms of the fish assemblage is still in a similar condition (difference therefore attributed to methodology and interpretation).	=	3
Macro-invertebrates	D	C/D	The current SASS scores (69- 100) and ASPT values (5.3 – 5.7) are very similar to those from 1999 (SASS5 81; ASPT 5.5). There is no change in the invertebrates from 1999.	=	4

There is no perceived change at this site.

8.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL9 is MODERATE and the REC is therefore to maintain the PES of a C/D EC.

During 1999, the EIS was HIGH, but the EcoStatus was set for a D EC, which would now equate to the C/D EC.

8.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 8.6 EWR OL9: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	B	B	B	
TDS	C	C	B/C	
WATER QUALITY	C	C	B	=
GEOMORPHOLOGY	D	?		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	D	D	C	=
MACRO INVERTEBRATES	D	D	C/D	=
INSTREAM			C/D	
RIPARIAN VEGETATION	D	D	D	=
ECOSTATUS	D	D	C/D	=
INSTREAM IHI	D	D	C	
RIPARIAN IHI	E	D	C/D	
EIS	High		Moderate	

8.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

During 1999, the EIS was HIGH, but the REC was set for a D EC – it should however have been set for a C REC. However, the EIS is now moderate; the D EC equates to the C/D (2010) EC and the D EWR can be used for yield modelling.

9. ECOCLASSIFICATION: EWR OL12: BLYDE

9.1. EIS RESULTS

The same EIS model as used during 1999 was applied. The EIS result for EWR OL12 is HIGH. The highest scoring metrics are:

- Rare & endangered: Crocodiles, Lowveld riverine forest (critically endangered), 1 IUCN veg species, 2 SANBI protected trees, Pel's Fishing owl
- Unique: 3 endemic riparian vegetation species, 3 fish species (BLIN, BEUT, OPER)
- Intolerant (flow and flow related water quality): 4 intolerant fish species and 9 moderately intolerant.
- Species taxon richness: 28 fish sp out of 30 sp.
- Diversity of habitat types
- Refugia

The 1999 result was also HIGH.

9.2. PRESENT ECOLOGICAL STATE

9.2.1. Summary of 1999 results

Table 9.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC 26 sp; PES 26 sp. Life history of some species are affected	B	Cold water pulses (flood releases from Blydepoort Dam) and flow regulation, temp difference
Riparian vegetation	RC: Well developed riparian forest, gallery forest for most of the area. *B. salicina* is expected in bedrock control areas. High species diversity. PES: Exposed roots, slightly impaired recruitment, slight changes in species composition & physiognomic structure.	B	Flow regulation, inundation, vegetation removal, human impacts etc
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plain often present PES: There may be a small change in geomorphology and natural habitats. Demonstrated in this reach by stable, well vegetated banks. Channel morphology is well defined.	B	Flow regulation, weirs and bridges)
Aquatic invertebrates	ASPT: 8 SASS: 167	B	

Component	Description	PES	Causes and Sources
Water quality	TDS low (largely natural). Nutrient levels elevated.	B	Irrigation activities in Blyde River irrigation scheme. Concerns about potential metal pollution from old gold mining activities in catchment and possible pesticides coming in with Ohrigstad River water.
Ecostatus	B	**Flow-related:** Change in flow regime, erosion (Blydepoort Dam, agriculture, pulsed flow supplement to Olifants, unseasonal releases, abstraction) **Non-flow related:** TDS, nutrients (Irrigation)	

9.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC. The summarised information is provided in **Table 9.2**.

Table 9.2 Present Ecological State for EWR OL12

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Very small change in water quality in general.	B	2
Riparian vegetation	**RC:** The assessed area at EWR 12 occurs within the Lowveld Riverine Forest vegetation type, which is an azonal type (classified as Forest) that is surrounded by the Savanna Biome and the Lowveld Bioregion. Both marginal and lower zones should be dominated by woody riparian forest with closed canopy and scanty understorey due to intense shading. Similarly the upper zone should be dominated by woody species, both a mix of riparian and terrestrial, with some open areas colonised by non-woody grasses. **PES:** The riparian zone EC is comprise as follows: Marginal Zone: B – consists of open and shaded cobble and boulder with near closed canopy of riparian woody obligate species. Exposed roots and root banks are common, as is recruitment by *Syzygium* species. Lower Zone: B/C – similarly, dominated by woody riparian species with dense canopy and a high degree of shading. Some reed patches occur where there is some sediment and the canopy forms an opening. Bedrock dominated. Upper Zone: B/C – also dominated by woody vegetation (a mix of riparian and terrestrial species) with open grass patches. Mainly consolidated alluvium and embedded boulder and a high degree of exotic weeds, mostly annual species MCB: B/C – alluvial, with woody vegetation and high degree of shading, hence non-woody species not well represented. Disturbance and vegetation removal is high in places and is disturbed by citrus servitude and activities. *Casuarina cunninghamiana* rows have also been planted.	B	2.9
Fish	Thirty fish species expected under reference conditions. Twenty-eight species estimated to still be present. Two species of catadromous eel (AMAR & AMOS) have been lost due to presence of downstream migration barriers.	C	3.0

Component	Reference condition and PES Description	EC	Conf
Macro-invertebrates	Reference Conditions: SASS5 220, ASPT 7. A total of 55 taxa are expected to occur at this site, 30 of which are expected to occur in at least 50% of the samples and 12 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as stoneflies, a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae) Caddisflies (>2 spp Hydropsychidae, Philopotamidae and Leptoceridae); Beetles (Elmidae, Gyrinidae and Psephenidae) PES: SASS (178) ASPT (6.6); MIRAI 83. Most of these taxa were found in the current survey: Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Tricorythidae and Leptophlebiidae); Damselflies and Dragonflies (Chlorocyphidae, Coenagrionidae, Aeshnidae, Libellulidae and Gomphidae) Caddisflies (2spp Hydropsychidae and Leptoceridae) and Beetles (Elmidae, Gyrinidae and Psephenidae)	B	3.5

9.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 9.3**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 9.3 EWR OL12: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	3.5	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	4	100
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3.5	90
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	4	100
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	3	80
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	4	90
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	5	100
Fish	**C**	

INSTREAM BIOTA	Importance Score	Weight
Aquatic invertebrates	B	
Confidence rating for instream biological information	3.5	
INSTREAM ECOLOGICAL CATEGORY	B/C	
Riparian vegetation	B	
Confidence rating for riparian vegetation zone information	2.9	
ECOSTATUS	B/C	

9.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:
= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place

Table 9.4 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	B	B	No significant change.	=	2
Riparian vegetation	B	B	The condition of the riparian zone and its ability to perform riparian functions has not changed. The condition remains good with the expected climax community as dominant.	=	4
Fish	B	C	PES changed from a B to a C since 1999 EWR, however new information and higher species diversity render this change to be similar or the same as 1999. Angliss also classify PES at site as a C with a similar score during 2004.	=	3
Macro-invertebrates	B	B	The current SASS5 scores (178) and ASPT values (6.6) are very similar to those from 1999 (SASS4 169; ASPT 7.7). There is no change in the invertebrates from 1999.	=	4

There is no perceived change at this site.

9.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL12 is HIGH and the REC is therefore to improve the PES of a B/C EC to a B.

During 1999, the EIS was HIGH, but as the EcoStatus was a B, no improvement was recommended. It seems however that the B EC was not correct for fish and riparian vegetation and that improvement will be required. The fish improvement can be achieved by the similar volume of EWR set for the previous B EWR, as the present operation of consistent low flows and lack of flow variability seems to be the problem. The riparian vegetation improvement can be achieved by controlling alien vegetation and the release of sufficient small and moderate floods.

9.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 9.5 EWR OL12: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	CHANGE
NUTRIENTS	B	B	B	B	
TDS	B	B	B	B	
WATER QUALITY	B	B	B	B	=
GEOMORPHOLOGY	B	B	B	B	=
Driver Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**CHANGE**
FISH	B	B	C	B	=
MACRO INVERTEBRATES	B	B	B	B	=
INSTREAM			B/C	B	=
RIPARIAN VEGETATION	B	B	B	B	=
ECOSTATUS	B	B	B/C	B	=
INSTREAM IHI	B	B	C		
RIPARIAN IHI	B	B	B/C		
EIS	High		High		

9.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

See 9.5 above.

10. ECOCLASSIFICATION: EWR OL13: OLIFANTS RIVER BETWEEN THE BLYDE AND SELATI RIVERS (TULANI)

10.1. EIS RESULTS

The same EIS model as used during 1999 was applied. The EIS result for EWR OL13 is MODERATE. The highest scoring metrics are:

- Rare & endangered: SANBI protected trees. *C imberbe, B salicina*, *Phylonoptera violacea*. Pels fishing owl, saddle-billed stork, crocodiles, etc
- Species taxon richness: 30 fish sp out of 34 sp.
- Importance of conservation and natural areas: Grietjie - a private nature reserve and part of the Greater Kruger Park.

The 1999 result was HIGH.

10.2. PRESENT ECOLOGICAL STATE

10.2.1. Summary of 1999 results

Table 10.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 31 sp. PES 29 sp	C	Cold water pulses which are a problem for some species. Sporadic sedimentation of habitat
Riparian vegetation	RC: Well developed riparian forest dominated by *Ficus sycomorus, Croton megalobotys & Trichelia emetica* on the macro-channel floor. *Maytenux xenegalensis, Acacia robusta* and *Diospyros mespiliformis* should be common on the banks. Phragmites expected to be common in patches within the river bed. The transition to the adjacent vegetation should be characterised by *Zizphus mucrona, Celtis africana, Combrefum imberbe* and *Lonchocarpus capassa*. A gallery forest may be present in many areas. Areas with bedrock control and characterised by *Breonadia salicina*. PES: Reduced cover. Loss of large trees with changes in population structure and species composition.	C	Scouring and flooding, reduced flows and water level fluctuations, overgrazing and resulting erosion
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plain often present. PES: significant changes in geomorphology and in-stream habitat. Geomorphic thresholds appear to have been crossed with the river moving towards a new equilibrium. Is demonstrated in this reach by an over-widened channel with numerous sand bars and extensive chokes of large woody debris	D	Extensive agriculture, riparian zone mismanagement, bridges and weirs
Macro-invertebrates	ASPT: 4.9 SASS: 103	C	

Component	Description	PES	Causes and Sources
Physico-chemical	Improved WQ in reach is dependent on good quality water from Blyde River. WQ conditions in Blyde river are following a trajectory of deterioration.	C	
EcoStatus			**Flow-related:** Sediment, altered flow regime (US dams & abstraction) **Non-flow related:** Sediment & vegetation loss (poor land use practices, deforestation, unstructured development) Nutrients (agriculture, overgrazing, browsing, irrigation, vegetation loss, TDS, Lack of fish migration (barriers).

10.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the (EC) (**Table 10.2**). The summarised information is provided in **Table 10.2**.

Table 10.2 2010 Present Ecological State for EWR OL13

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Very small change in water quality in general.	B/C	2
Riparian vegetation	**RC:** The assessed area at EWR 13 occurs within the Granite Lowveld vegetation type, which occurs within the Savanna Biome and the Lowveld Bioregion. Typical Lowveld river, with a mix of bedrock and alluvial influence. The marginal and lower zones are likely to be dominated by reeds and non-woody vegetation, but with open sandy and bedrock areas. These bedrock areas should support a healthy population of *Breonadia salicina*. A patchy mosaic of vegetation life forms is important as this signifies that the flooding disturbance regime is such that it maintains diversity of both taxa and habitat types. In the absence of floods, woody species would begin to dominate as is expected on the upper zone and MCB where alluvium supports both riparian and terrestrial woody species. With average annual rainfall in the area of about 470mm a healthy grass layer should also exit on ephemeral features, depending on the season. **PES:** The riparian zone EC is comprise as follows: Marginal Zone: B/C – consists mainly of open alluvium or bedrock with *Phragmites mauritianus* as the dominant, but patchy vegetation. *Breonadia salicina* also occurs where bedrock exists. Lower Zone: B/C – similar to the marginal zone, with a more extensive population of *B. salicina* (where bedrock occurs) and *Ficus sycomorus* (where alluvium occurs) Upper Zone: C – dominated by woody vegetation (a mix of riparian and terrestrial species), but with extensive open patches of alluvium. Grazing pressure seems high with scanty grass cover and a high degree of weed infestation (mostly annuals) MCB: C – similar to the upper zone, with additional disturbance from human habitation. Woody dominated, with both riparian indicators as well as savanna species.	B/C	2.9
Fish	Thirty-four fish species expected under reference conditions, while thirty estimated to still occur under present conditions. The FROC of most of the indigenous species has been reduced significantly from reference conditions. The catadromous eels (AMOS, ALAB & AMAR) have been lost from this reach due to presence of downstream migration barriers. The fourth species that is expected to have disappeared from this reach is HVIT, due to loss of deep habitats (FD & SD) as a result of sedimentation, as well as flow modification and water quality alterations (cold water releases from	D	3

Component	Reference condition and PES Description	EC	Conf
	Blyde River Dam may have impact). Other impacts at this site related to decreased substrate quality (embeddedness by sediment) and possible loss of overhanging vegetation and undercut banks (flow modification).		
Macro-invertebrates	Reference Conditions: SASS5 180 ASPT 6.5. A total of 63 taxa are expected to occur at this site, 31 of which are expected to occur in at least 50% of the samples and 20 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae); Damselflies and Dragonflies (Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae) Caddisflies (>2 spp Hydropsychidae, and Leptoceridae), Beetles (Dytiscidae, Elmidae, Gyrinidae and Hydrophilidae) PES: SASS (39 - 138) ASPT (4.8 – 6.1); MIRAI - 62.5. Some of these taxa were found in the current survey: Mayflies (2spp Baetidae, Caenidae, Heptageniidae, Tricorythidae and Leptophlebiidae), Damselflies and Dragonflies (Coenagrionidae, Libellulidae and Gomphidae), Caddisflies (1sp Hydropsychidae and Leptoceridae) and Beetles (Dytiscidae, Elmidae, Gyrinidae and Hydrophilidae)	C	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL13 as well as the causes and sources for the PES are summarised in **Table 10.3**.

Table 10.3 EWR OL13: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	B/C	3	No change except change in flows.	Upstream abstractions.	F	2
Riparian vegetation	B/C	2.9	Altered species composition	Exotic vegetation (mostly annual weeds) and some terrestrialization	NF	5
			Reduced woody cover and abundance	Some clearing for fences, pumps and dwellings.	NF	5
Fish	D	3	Reduced FROC of some species due to loss of substrate quality (sedimentation)	Sedimentation (embeddedness) of rocky substrates as a result of catchment and bank erosion	NF/F	3
			Reduced FROC of pool dwellers due to loss of pools (SD) habitats associated with sedimentation	Increased sedimentation due to extensive catchment erosion.	F/NF	
			Reduced FROC of some species due to loss of overhanging vegetation and undercut banks.	Flow modifications (unnatural flow regime associated with Blyde River releases)	F	
			Loss of catadromous eels and reduced FROC of potadromous fish species.	Downstream migration barriers.	NF	

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Macro-invertebrates	C	3	Water quality	Land use activities e.g. agriculture	NF	2
			Altered Flow Regime	Abstraction and US dams	F	4

1 Flow related 2 Non Flow related

10.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 10.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 10.4 EWR OL13: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	4	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	4.5	100
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3.5	80
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	3	70
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	2.5	70
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	2.5	70
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	3	100
Fish	**D**	
Aquatic invertebrates	**C**	
Confidence rating for instream biological information	**3**	
INSTREAM ECOLOGICAL CATEGORY	**D**	
Riparian vegetation	**B/C**	
Confidence rating for riparian vegetation zone information	2.9	
ECOSTATUS	**C**	

10.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:
= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place

Table 10.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	C	B/C	No significant change. Previous assessment may have overestimated the effect of salinity.	=	2
Riparian vegetation	C	B/C	The condition of the riparian zone and its ability to perform riparian functions has not changed. The condition remains good, but with some impact. The EC score is an improvement from the 1999 assessment, but this is mainly due to the inclusion [in that assessment] of flooding disturbance as a deviation from reference conditions. This has not been applied in the current assessment as the damage done by floods is seen to be largely part of the dynamics of the reference condition.	=	4
Fish	C	B	Although a lower EC was calculated for 2010, assessment compared to 1999, it is estimated that the biotic integrity of the site in terms of the fish assemblage is still in a similar condition (difference therefore attributed to methodology and interpretation). Conditions have not changes significantly since 1999, and the fish assemblage did not reflect any significant changes since the 1999 EWR.	=	3
Macro-invertebrates	C	C	The current SASS5 scores and ASPT values are very similar to those from 1999. There is no or very little change in the invertebrates from 1999.	=	3

There is no perceived change at this site.

10.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL13 is MODERATE and the REC is therefore to maintain the PES of a B/C EC.

During 1999, the EIS was HIGH, and the REC was set for a B, i.e. to improve the system from a C EC.

10.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 10.6 EWR OL13: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES & REC	CHANGE
NUTRIENTS	C	B	B	
TDS	C	C	C	
WATER QUALITY	C	B/C	B/C	=
GEOMORPHOLOGY	D	D		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**CHANGE**
FISH	C	C	D	=
MACRO INVERTEBRATES	C	C	C	=
INSTREAM			D	=
RIPARIAN VEGETATION	C	C	B/C	=
ECOSTATUS	C	B	C	=
INSTREAM IHI	D	C	C	
RIPARIAN IHI	C	C	B/C	
EIS	High		Moderate	

10.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a C is the same as the 2010 PES of a C, and the EIS is MODERATE, the EWRs must maintain the PES. The C (1999) must be used for yield modelling and planning.

11. ECOCLASSIFICATION: EWR OL15: OLIFANTS AT MAMBA

11.1. EIS RESULTS

The same EIS model that was used during 1999 was applied again. The EIS result for EWR OL15 is HIGH. The highest scoring metrics are:

- Rare & endangered: SANBI protected trees. *C imberbe, B salicina, Phylonoptera violacea*. Pels fishing owl, saddle-billed stork, crocodiles, HVIT etc
- Species taxon richness: 31 fish sp out of 34 sp.
- Importance of conservation and natural areas: Kruger National Park.

The 1999 result was also HIGH.

11.2. PRESENT ECOLOGICAL STATE

11.2.1. Summary of 1999 results

Table 11.1 Summary of 1999 results extracted from the final reports

Component	Description		Causes and Sources
Fish	RC 35 sp. PES 31 sp	C	Increased TDS from Selati and high TSS events from Phalaborwa Barrage
Riparian vegetation	RC: Well developed riparian forest dominated by *Ficus sycomorus, Croton megalobotys* & *Trichelia emetica* on the macro-channel floor. *Maytenus xenegalensis, Acacia robusta and Diospyros mespiliformis* should be common on the banks. Phragmites expected to be common in patches within the riverbed. A gallery forest may be present in many areas. Areas with bedrock control and characterised by *Breonadia salicina*. PES: Reduced cover, significant loss of large trees with changes in population structure and species composition	C	Modifying determinants: Scouring and flooding, reduced flows as well as water level fluctuations. Overgrazing and resulting erosion.
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plain often present. PES: Some change in geomorphology and in-stream habitat. Geomorphic thresholds do not appear to have been crossed. This is demonstrated in this reach by local areas of bank instability, high suspended loads and local aggradation.	C	Modifying determinants: Catchment gullying and erosion, weirs, the Phalaborwa barrage and bridges
Macro-invertebrates	ASPT: 5.1 SASS: 104	C	

Component	Description		Causes and Sources
Physico-chemical	The ameliorating effect of the Blyde River has decreased, and IDS has deteriorated to a Category D. However during the summer months, TDS is in a Category B, falling to a Category E in winter. Long distance effect of good quality water from in the Blyde River is particularly important during low flow months. Nutrients were moderately high		
EcoStatus		**Flow related:** Increased mud & sand, altered flow regime, (barrage). Poor water quality (Selati River inflow with mine effluent) **Non-flow related:** Sediment, (poor land use practices). Water quality - TDS and possibly toxicity which is of concern and requires better assessment in this reach (mining). Lack of fish, prawn and eel migration (barriers).	

11.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 11.2**).

Table 11.2 Present Ecological State for EWR OL15

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Significant change in salinity and nutrients. Also occasional de-sludging discharges from the Phalaborwa Weir.	C	2
Riparian vegetation	**RC:** The assessed area at EWR 15 occurs within the Lowveld Rugged Mopaneveld vegetation type, which occurs within the Savanna Biome and the Mopane Bioregion. Typical Lowveld river, with a mix of bedrock and alluvial influence. The marginal and lower zones are likely to be dominated by reeds and non-woody vegetation, but with open sandy and bedrock areas. These bedrock areas should support a healthy population of *Breonadia salicina*. A patchy mosaic of vegetation life forms is important as this signifies that the flooding disturbance regime is such that it maintains diversity of both taxa and habitat types. In the absence of floods, woody species would begin to dominate as is expected on the upper zone and MCB where alluvium supports both riparian and terrestrial woody species. With average annual rainfall in the area of about 470mm a healthy grass layer should also exit on ephemeral features, depending on the season. **PES:** The riparian zone EC is comprise as follows: Marginal Zone: B/C – consists mainly of open alluvium or bedrock with narrow band of *Phragmites mauritianus* as the dominant vegetation. *Breonadia salicina* also occurs where bedrock exists and *Ficus sycomorus* overhangs the zone in places. Lower Zone: B – similar to the marginal zone, with a more extensive population of *B. salicina* (where bedrock occurs) and *Ficus sycomorus* (where alluvium occurs) Upper Zone: B/C – dominated by woody vegetation (a mix of riparian and terrestrial species), but with extensive open patches of alluvium. Grazing pressure seems high with scanty grass cover and a lack of woody species recruitment. MCB: C – similar to the upper zone. Woody dominated, with both riparian indicators as well as savanna species. As with the upper zone, utilization seems high even though the site is within a National Park.	B/C	2.7

Component	Reference condition and PES Description	EC	Conf
Fish	Thirty-four fish species expected under reference conditions. Thirty-one species estimated to still be present. Two species of catadromous eel (AMAR & AMOS) have been lost due to presence of downstream migration barriers. OPER lost due to poor water quality (silt releases from Phalaborwa Barrage and water quality impact from Phalaborwa mining complex).	D	3.5
Macro-invertebrates		C	

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL15 as well as the causes and sources for the PES are summarised in **Table 11.3**.

Table 11.3 EWR OL15: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	C	3	Change in salinity, nutrients, occasional high turbidity.	Selati River (Foskor) and releases from Phalaborwa Weir.		
Riparian vegetation	B/C	2.7	Altered species composition	Exotic vegetation (mostly annual weeds), but with low impact, and some terrestrialization	NF	5
			Reduced woody and non-woody cover and abundance	Utilization of riparian vegetation is high, even though the site occurs within a protected area.	NF	2
Fish	D	3.5	Lower flows during low flow period impacts on fish habitat, especially at the controls (riffles & rapids). Reduced flows and flooding influencing FROC.	Abstraction for irrigation, towns and mining.	F	3
			Loss of fast-deep habitats (overall habitat diversity) resulting in loss of some species.	Deposition of sediment resulting from silt releases from Phalaborwa Barrage. Sediment resulting from upstream erosion.	F	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	
			Loss of species diversity, especially species intolerant to water quality deterioration.	Mining activities and agriculture – pollution.	NF	
			Altering of habitat surfaces due to filamentous algae.	Increased nutrients related to agricultural activities.	NF	
			Increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR and HMOL	NF	
			Lowered FROC due to fish kills.	Fish kills during immense silt releases from Phalaborwa Barrage	NF	

1 Flow related 2 Non Flow related

11.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in **Table 11.4**, as well as the portion of those percentages used in calculating the EcoStatus.

Table 11.4 EWR OL15: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural diversity of **fish** species with different flow requirements?	4	90
2.What is the natural diversity of **fish** species with a preference for different cover types?	4.5	100
3.What is the natural diversity of **fish** species with a preference for different flow depth classes?	3.5	80
4. What is the natural diversity of **fish** species with various tolerances to modified water quality?	3	70
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	2.5	70
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	2.5	70
3. What is the natural diversity of **invertebrate** taxa with different tolerances to modified water quality?	3	100
Fish	**D**	
Aquatic invertebrates	**C**	
Confidence rating for instream biological information	**3.4**	
INSTREAM ECOLOGICAL CATEOGORY	**C/D**	
Riparian vegetation	**B/C**	
Confidence rating for riparian vegetation zone information	2.7	
ECOSTATUS	**C**	

11.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:

= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place

Table 11.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	D	C	No significant change. Previous assessment may have overestimated the effect of salinity.	=	2
Riparian vegetation	C	B/C	The condition of the riparian zone and its ability to perform riparian functions has not changed. The condition remains good, but with apparent over-utilization of riparian vegetation. The EC score is an improvement from the 1999 assessment, but this is mainly due to the inclusion [in that assessment] of flooding disturbance as a deviation from reference conditions. This has not been applied in the current assessment as the damage done by floods is seen to be largely part of the dynamics of the reference condition. The previous assessment also noted the heavy utilization of vegetation in general.	=	4
Fish	C	D	PES changed from a C to a D since 1999 EWR, however new information and higher species diversity render this change to be similar or the same as 1999. Angliss also classifies PES at site as a D with a similar score during 2004.	=	3

There is no perceived change at this site.

11.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL15 is HIGH and the REC is therefore to improve the PES of a C EC to a B EC. The major issues at this site are the sediment problems associated with the operation of Phalaborwa Barrage and the decreased low flows. Management and operation of the Phalaborwa Barrage has improved, and if the recommendations on operation are followed, continued improvement of the aquatic system will be possible. This should, with implementation of the low flow Reserve, achieve the required improvements.

During 1999 the EIS was VERY HIGH, and the REC was also set to improve the system from a C to a B EC.

11.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 11.6 EWR OL15: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	D	C	
TDS	D	C	D	C	
WATER QUALITY	D	C	C	C	=
GEOMORPHOLOGY	C	C			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	C	C	D	C	=
MACRO INVERTEBRATES	C	C	C	B	=
INSTREAM			C/D	B/C	=
RIPARIAN VEGETATION	C	C	B/C	B	=
ECOSTATUS	C	B	C	B	=
INSTREAM IHI	C	C	D		
RIPARIAN IHI	C	C	B		
EIS	Very High		High		

11.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a B REC is the same as the 2010 REC of a B EC, the EWRs set for the B (1999) must be used for yield modelling and planning.

12. ECOCLASSIFICATION: EWR OL17 & OL16: OLIFANTS AT BALULE

Note these sites are situated within a km from each other. The reason why two sites were selected was that the one site was more suitable for setting high flows and the other for low flows. In this assessment the two EWR sites are treated as one site.

12.1. EIS RESULTS

The same EIS model as used during 1999 was applied. The EIS result for EWR15 is HIGH. The highest scoring metrics are:

- Rare & endangered: SANBI protected trees. *C imberbe, B salicina, Phylonoptera violacea*. Crinum sp (declining). Pels fishing owl, saddle-billed stork, crocodiles, HVIT, etc.
- Species taxon richness: 31 fish sp out of 33 sp.
- Importance of conservation and natural areas: Kruger National Park.

The 1999 result was VERY HIGH.

12.2. PRESENT ECOLOGICAL STATE

12.2.1. Summary of 1999 results

Table 12.1 Summary of 1999 results extracted from the final reports

Component	Description	PES	Causes and Sources
Fish	RC: 35 sp; PES 31 sp.	C	Increased TDS from Selati and high TSS events from Phalaborwa Barrage
Riparian vegetation	RC: Well developed riparian forest dominated by *Ficus sycomorus, Croton megalobotys & Trichelia emetica* on the macro-channel floor. *Maytenux xenegalensis, Acacia robusta* and *Diospyros mespiliformis* should be common on the banks. Phragmites expected to be common in patches within the riverbed. Areas with bedrock control and characterised by *Breonadia salicina.* PES: Reduced cover, significant loss of large trees with changes in population structure and species composition	C	Scouring and flooding, reduced flows as well as water level fluctuations. Overgrazing and resulting erosion
Geomorphology	RC: Mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Pool-riffle/pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids/riffles. Flood plains often present PES: The C class reach is defined as being moderately modified with some change in geomorphology and in-stream habitat. Geomorphic thresholds do not appear to have been crossed. This is demonstrated in this reach by local areas of bank instability, height suspended loads and local aggradation.	C	Catchment gullying and erosion, weirs, the Phalaborwa barrage and bridges

Component	Description	PES	Causes and Sources
Macro-invertebrates	ASPT: 5.1 SASS: 104	C	
Physico-chemical variables	The ameliorating effect of the Blyde River has decreased, and IDS has deteriorated to a Category D. However, during the summer months, TDS is in a Category B, falling to a Category E in winter. Long distance effect of good quality water from in the Blyde River is particularly important during low flow months. Nutrients were moderately high.	D	
EcoStatus			**Flow related:** Increased mud & sand, altered flow regime, (barrage). Poor water quality (Selati River inflow with mine effluent). **Non-flow related:** Sediment (poor land use practices). Water quality - TDS and possibly toxicity which is of concern and requires better assessment in this reach (mining). Lack of fish, prawn and eel migration (barriers).

12.2.2. Summary of 2010 results

The PES reflects the changes from reference conditions in terms of the EC (**Table 12.2**). The summarised information is provided in **Table 12.2**.

Table 12.2 2010 Present Ecological State for EWR OL17

Component	Reference condition and PES Description	EC	Conf
Physico-chemical	Significant change in salinity and nutrients.	C	2
Riparian vegetation	**RC: The assessed area at EWR OL17 occurs** within the Tshokwane-Hlane Basalt Lowveld vegetation type, which occurs within the Savanna Biome and the Lowveld Bioregion. Typical Lowveld river, with a mix of bedrock and alluvial influence. The marginal and lower zones are likely to be dominated by reeds and non-woody vegetation, but with open sandy and bedrock areas. These bedrock areas should support a healthy population of *Breonadia salicina*. A patchy mosaic of vegetation life forms is important as this signifies that the flooding disturbance regime is such that it maintains diversity of both taxa and habitat types. In the absence of floods, woody species would begin to dominate as is expected on the upper zone and MCB where alluvium supports both riparian and terrestrial woody species. With average annual rainfall in the area of about 500mm a healthy grass layer should also exit on ephemeral features, depending on the season. **PES**: The riparian zone EC is comprise as follows: Marginal Zone: B/C – consists mainly of open alluvium or bedrock with patches of *Phragmites mauritianus* as the dominant vegetation. *Breonadia salicina* also occurs where bedrock exists, even in-between reeds. The zone has extensive algae. Lower Zone: B/C – mainly open bedrock and boulder beds with alluvial bars that are colonised by grasses (mainly *Cynodon dactylon* lawns). Boulder beds are dominated by *B. salicina* and *Asclepias* species. Upper Zone: B/C – terraces characterised by *C. dactylon* lawns (signifying heavy grazing), and some sedge populations, mainly *Cyperus sexundularis.* MCB: C –Woody dominated, with both riparian indicators as well as savanna species (mainly *Nuxia oppositifolia, Acacia robusta, Croton megalobotrya, Ficus sycomorus*). As with the upper zone, utilization seems high even though the site is within a National Park.	B/C	2.6

Component	Reference condition and PES Description	EC	Conf
Fish	Thirty-three fish species expected under reference conditions. Thirty-one species estimated to still be present. Two species of catadromous eel (AMAR & AMOS) have been lost due to presence of downstream migration barriers.	C	3.5
Macro-invertebrates	Reference Conditions: SASS5 – 180, ASPT - 6.5. A total of 64 taxa are expected to occur at this site, 35 of which are expected to occur in at least 50% of the samples and 15 of which are only expected to occur in <25% of the samples. The taxa expected to occur in at least 50% of the samples include sensitive taxa such as a variety of Mayflies (>2spp Baetidae, Caenidae, Heptageniidae, Leptophlebiidae, Tricorythidae), Damselflies and Dragonflies (Coenagrionidae, Aeshnidae, Gomphidae, Libellulidae), Caddisflies (>2 spp Hydropsychidae, Philopotamidae and Leptoceridae), Beetles (Dytiscidae, Elmidae, Gyrinidae, Psephenidae and Hydrophilidae). PES: SASS5 (71 - 142), ASPT (4.4 – 5.9), MIRAI - 63.2. Some of these taxa were found in the current survey: Mayflies (2spp Baetidae, Caenidae, Tricorythidae and Leptophlebiidae); Damselflies and Dragonflies (Coenagrionidae, Libellulidae and Gomphidae), Caddisflies (2spp Hydropsychidae, Philopotamidae and Leptoceridae) and Beetles (Dytiscidae, Elmidae, Gyrinidae and Hydrophilidae).	C	3

The reasons for changes from reference conditions must be identified and understood. These are referred to as causes and sources (http://cfpub.epa.gov/caddis/). The PES for the components at EWR OL17 as well as the causes and sources for the PES are summarised in **Table 12.3**.

Table 12.3 EWR OL17: PES causes and sources

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
Phys-chem	C	3	Change in salinity and nutrients.	Selati River (Foskor).	F/NF	3
Riparian vegetation	B/C	2.6	Altered species composition	Exotic vegetation (mostly annual weeds), but with low impact, and some terrestrialization	NF	5
			Reduced woody and non-woody cover and abundance	Utilization of riparian vegetation is high, even though the site occurs within a protected area.	NF	2
Fish	C	3.5	Lower flows during low flow period impacts on fish habitat, especially at the controls (riffles & rapids). Reduced flows and flooding influencing FROC.	Abstraction for irrigation, towns and mining upstream of KNP.	F	4
			Loss of fast-deep habitats (overall habitat diversity) resulting in loss of some species.	Deposition of sediment resulting from silt import upstream. Sediment resulting from upstream erosion.	NF	
			Loss of catadromous eel and reduced FROC of potadromous fish species.	Downstream migration barriers (physical and chemical).	NF	

	PES	Conf	Causes	Sources	F[1]/NF[2]	Conf
			Loss of species diversity, especially species intolerant to water quality deterioration.	Mining activities and agriculture – pollution.	NF	
			Altering of habitat surfaces due to filamentous algae.	Increased nutrients related to agricultural activities.	NF	
			Increased turbidity and disturbed bottom substrates reduce bottom substrate quality and water quality for indigenous fish.	Presence of alien CCAR and HMOL	NF	
			Loss of species diversity, impacted by sedimentation of backwaters and lack of marginal vegetation); inundation of cobble by sediment and algae	Deposition of sediment resulting from silt import upstream. Sediment resulting from upstream erosion.	NF	
Macro-invertebrates	C	3	Water quality	Land use activities e.g. agriculture and mining	NF	3
			Altered Flow Regime	Abstraction and US dams	F	4
			Sedimentation of the habitat	2000 floods, as well as scouring from the Phalaborwa Barrage	F	3

1 Flow related 2 Non Flow related

12.3. PES ECOSTATUS

To determine the EcoStatus, the macroinvertebrates and fish must first be combined to determine an instream category. The instream and riparian categories are integrated to determine the EcoStatus. Confidence is used to determine the weight that the EC should carry when integrating into an EcoStatus (riparian, instream and overall). The EC percentages are provided in Table 12.4, as well as the portion of those percentages used in calculating the EcoStatus.

Table 12.4 EWR OL17: Instream Ecological Category and EcoStatus

INSTREAM BIOTA	Importance Score	Weight
FISH		
1.What is the natural **diversity** of **fish** species with different flow requirements?	4	90
2.What is the natural **diversity** of **fish** species with a preference **for** different cover types**?**	4.5	100
3.What is the natural **diversity** of **fish** species with a preference **for** different flow depth **classes?**	3.5	80
4. What is the natural **diversity** of **fish** species with various tolerances to modified water quality?	3	70

INSTREAM BIOTA	Importance Score	Weight
AQUATIC INVERTEBRATES		
1. What is the natural diversity of **invertebrate** biotopes?	2.5	70
2. What is the natural diversity of **invertebrate** taxa with different velocity requirements?	2.5	70
3. What is the natural diversity of **Invertebrate** taxa with different tolerances to modified water quality?	3	100
Fish	**C**	
Aquatic invertebrates	**C**	
Confidence rating for instream biological information	**3.4**	
INSTREAM ECOLOGICAL CATEOGORY	**C**	
Riparian vegetation	**B/C**	
Confidence rating for riparian vegetation zone information	2.6	
ECOSTATUS	**C**	

12.4. CHANGES SINCE 1999

The results are summarised below and a comparison between 1999 and 2010 is provided. The Conclusions refer to whether an actual change or not has taken place according to the symbols described below. Confidence relates to values from 0 (no confidence) to 5 (very high confidence).

Note:
= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
- Small scale improvement has taken place

Table 12.5 Comparison between 1999 and 2010 results

COMPONENT	1999 EC	2010 EC	COMMENT	CONCL	CONF
Physico-chemical	D	C	No significant change. Previous assessment may have overestimated the effect of salinity.	=	2
Riparian vegetation	C	B/C	The condition of the riparian zone and its ability to perform riparian functions has not changed. The condition remains good, but with apparent over-utilization of riparian vegetation. The EC score is an improvement from the 1999 assessment, but this is mainly due to the inclusion [in that assessment] of flooding disturbance as a deviation from reference conditions. This has not been applied in the current assessment as the damage done by floods is seen to be largely part of the dynamics of the reference condition. The previous assessment also noted the heavy utilization of vegetation in general.	=	4

Fish	C	C	PES has not changed since 1999 EWR.	=	4
Macroinvertebrates	C	C	The current SASS5 scores and ASPT values are higher than those of 1999, but are lower than those obtained at the downstream site in 1999. Overall, there is no or very little change in the invertebrates from 1999.	=	3

There is no perceived change at this site.

12.5. RECOMMENDED ECOLOGICAL CATEGORY (REC):

The REC is determined based on ecological criteria only and considers the EIS, the restoration potential and attainability there-of.

The EIS at EWR OL17 is HIGH and the REC is therefore to improve the PES of a C EC to a B EC. The major issues at this site are the sediment problems associated with the operation of Phalaborwa Barrage and the decreased low flows. Management and operation of the Phalaborwa Barrage have improved, and if the recommendations on operation are followed, continued improvement of the aquatic system will be possible. This should, together with implementation of the low flow Reserve, achieve the requirement improvements.

During 1999, the EIS was VERY HIGH, and the REC was also set to improve the system from a C to a B EC.

12.6. SUMMARY AND COMPARISON OF ECOCLASSIFICATION RESULTS

Table 12.6 EWR OL17: Summary of EcoClassification results

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	D	C	
TDS	D	C	D	C	
WATER QUALITY	D	C	C	C	=
GEOMORPHOLOGY	C	C			
Driver Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	C	C	C	B	=
MACRO INVERTEBRATES	C	C	C	B	=
INSTREAM			C	B	=
RIPARIAN VEGETATION	C	C	B/C	B	=
ECOSTATUS	C	B	C	B	=
INSTREAM IHI	C	C	C/D		
RIPARIAN IHI	C	C	B/C		
EIS	Very High		High		

12.7. CONCLUSIONS IN TERMS OF USE OF 1999 EWR RESULTS

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a B REC is the same as the 2010 REC of a B EC, the EWRs set for the B (1999) must be used for yield modelling and planning.

13. SUMMARY AND CONCLUSIONS

13.1. SUMMARY

The table below provides the 1999 results of EcoClassification in terms of the Present Ecological State and the Recommended Ecological Category, and then the 2010 results. The Ecological Category for each relevant Driver and Response components are provided.

The last column headed Change indicates whether the change in Category from 1999 to 2010 really means a change or whether it is just a result from using different methods that provide a different Ecological Category. The symbols used are as follows:

Note:
= 1999 EC is the same as 2010
-- Large scale degradation has taken place
- Small scale degradation has taken place
++ Large scale improvement has taken place
+ Small scale improvement has taken place

Table 13.1 Summary tables of each EWR site and conclusions re EWR rules or ECs or yield modelling.

EWR 1: OLIFANTS RIVER LODGE

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	C	C	C/D	
TDS	D	C	C	
WATER QUALITY	D	C	C	=
GEOMORPHOLOGY	C	C		
Response Components	**PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	E	C	D/E	-
MACRO INVERTEBRATES	C	C	D	-
INSTREAM			D	-
RIPARIAN VEGETATION	C	C	C	=
ECOSTATUS	D	C	D	-
INSTREAM IHI	D	C	C/D	-
RIPARIAN IHI	C	C	C	=
EIS	High		Moderate	

The 1999 EWRs were set for a C and a D EC. The C EWR was for the REC based on the HIGH EIS. As the EIS is now MODERATE, and the REC a D, it is recommended that the D EC EWR (1999) should be used for yield modelling purposes and planning

EWR 3: KLEIN OLIFANTS RIVER LODGE

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	D		C/D		
TDS	C	C	C	C	
WATER QUALITY	C	C	C	C	=
GEOMORPHOLOGY	D	C			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	D	C	D	D	-
MACRO INVERTEBRATES	C	C	D/E	D	-
INSTREAM			D/E	D	-
RIPARIAN VEGETATION	C	C	C/D	C/D	-
ECOSTATUS	D	C	D	D	-
INSTREAM IHI	D	C	C/D		
RIPARIAN IHI	D	C	D		
EIS	Moderate		Moderate		

The 1999 EWRs were set for a C and a D EC. The C EWR was used for the REC. As the EIS is MODERATE there is no motivation to improve the PES (which is a D) and therefore it is recommended that the D EC EWR (1999) is used for yield modelling purposes and planning

EWR 4: WILGE RIVER

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	C		
TDS	A	A	B		
WATER QUALITY	B	B	B/C	B	=
GEOMORPHOLOGY	B	B			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	B	B	C	B	--
MACRO INVERTEBRATES	B	B	C/D	B/C	--
INSTREAM			C	B	
RIPARIAN VEGETATION	B	B	A/B	A/B	=
ECOSTATUS	B	B	C	B	--
INSTREAM IHI	B	B	C		
RIPARIAN IHI	B	B	A/B		
EIS	High		High		

The 1999 EWRs were set for a B and a C EC. The B EWR was for the REC. As the EIS is HIGH, and the REC a B, it is recommended that the B EC EWR (1999) should be used for yield modelling purposes and planning. It must be noted, however, that without addressing the water quality problems, these flows will not achieve the REC.

EWR 5: OLIFANTS RIVER (THE MANSION)

Driver Components	1999 PES	1999 REC	2010 PES & REC	CHANGE
NUTRIENTS	B	C?	C	
TDS	C	C	B	
WATER QUALITY	C	C	B/C	=
GEOMORPHOLOGY	C	C		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**CHANGE**
FISH	C	C	C/D	=
MACRO INVERTEBRATES	C	C	C/D	--
INSTREAM			C/D	-
RIPARIAN VEGETATION	C	C	B/C	=
ECOSTATUS	C	B	C	-
INSTREAM IHI	D	C	C/D	
RIPARIAN IHI	C	C	C	
EIS	High		Moderate	

The 1999 EWRs were set for a B and a C EC. The B EWR was for the REC. As the EIS is now MODERATE, it is recommended that the C EC EWR (1999) be used for yield modelling purposes and planning. The EIS was HIGH in 1999 and therefore the REC EWR rule for a B was used.

EWR 6: ELANDS RIVER

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	B	B	C	C	
TDS	D	D	D	D	
WATER QUALITY	D	D	C	C	-
GEOMORPHOLOGY	D	D			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	E	D	D/E	D	+
MACRO INVERTEBRATES	D	D	C	C	+
INSTREAM			D	C/D	
RIPARIAN VEGETATION	D	D	C/D	C/D	-
ECOSTATUS	E	D	D	C/D	+
INSTREAM IHI	E	D	D/E		
RIPARIAN IHI	D	D	D		
EIS	Moderate		Moderate		

The 1999 EWRs were set for a D and a C EC. In this situation, it is however more logical to, with whatever volumes are being released, design more ecologically-friendly operating rules. This would be more relevant than an EWR release combined with unfriendly operating rules or other users

EWR 8: OLIFANTS RIVER (STELLENBOSCH)

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	B	B	B	?
TDS	E	D	C	?
WATER QUALITY	D	D	C	?
GEOMORPHOLOGY	E	?	E	=
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	D	D	D	=
MACRO INVERTEBRATES	D	D	C/D	=
INSTREAM			C/D	
RIPARIAN VEGETATION	D	D	C	=
ECOSTATUS	E	D	C/D	=
INSTREAM IHI	E	D	C/D	
RIPARIAN IHI	E	D	C/D	
EIS	Moderate		Moderate	

The 1999 EWR was set for a D EC which is an improvement of the unacceptable E 1999 EcoStatus. As it is perceived that there has been no change in state since 1999, the EWR for the D EcoStatus would be applicable for the C/D (2010) EcoStatus

EWR 9: STEELPOORT RIVER

Driver Components	1999 PES	1999 REC	2010 PES & REC	Change
NUTRIENTS	B	B	B	
TDS	C	C	B/C	
WATER QUALITY	C	C	B	=
GEOMORPHOLOGY	D	?		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**Change**
FISH	D	D	C	=
MACRO INVERTEBRATES	D	D	C/D	=
INSTREAM			C/D	
RIPARIAN VEGETATION	D	D	D	=
ECOSTATUS	D	D	C/D	=
INSTREAM IHI	D	D	C	
RIPARIAN IHI	E	D	C/D	
EIS	High		Moderate	

During 1999, the EIS was HIGH, but the REC was set for a D EC – it should however have been set for a C REC. However, the EIS is now moderate; the D EC equates to the C/D (2010) EC and the D EWR can be used for yield modelling

EWR 12: BLYDE RIVER

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	CHANGE
NUTRIENTS	B	B	B	B	
TDS	B	B	B	B	
WATER QUALITY	B	B	B	B	=
GEOMORPHOLOGY	B	B	B	B	=
Driver Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**CHANGE**
FISH	B	B	C	B	=
MACRO INVERTEBRATES	B	B	B	B	=
INSTREAM			B/C	B	=
RIPARIAN VEGETATION	B	B	B	B	=
ECOSTATUS	B	B	B/C	B	=
INSTREAM IHI	B	B	C		
RIPARIAN IHI	B	B	B/C		
EIS	High		High		

During 1999, the EIS was HIGH, but as the EcoStatus was a B, no improvement was recommended. It seems however that the B EC was not correct for fish and riparian vegetation and that improvement will be required. The fish improvement can be achieved by the similar volume of EWR set for the previous B EWR, as the present operation of consistent low flows and lack of flow variability seems to be the problem. The riparian vegetation improvement can be achieved by controlling alien vegetation and the release of sufficient small and moderate floods.

EWR 13: OLIFANTS RIVER (GRIETJIE)

Driver Components	1999 PES	1999 REC	2010 PES & REC	CHANGE
NUTRIENTS	C	B	B	
TDS	C	C	C	
WATER QUALITY	C	B/C	B/C	=
GEOMORPHOLOGY	D	D		
Response Components	**1999 PES**	**1999 REC**	**2010 PES & REC**	**CHANGE**
FISH	C	C	D	=
MACRO INVERTEBRATES	C	C	C	=
INSTREAM			D	=
RIPARIAN VEGETATION	C	C	B/C	=
ECOSTATUS	C	B	C	=
INSTREAM IHI	D	C	C	
RIPARIAN IHI	C	C	B/C	
EIS	High		Moderate	

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a C is the same as the 2010 PES of a C, and the EIS is MODERATE, the EWRs must maintain the PES. The C (1999) must be used for yield modelling and planning.

EWR 15: OLIFANTS RIVER (MAMBA)

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	D	C	
TDS	D	C	D	C	
WATER QUALITY	D	C	C	C	=
GEOMORPHOLOGY	C	C			
Response Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	C	C	D	C	=
MACRO INVERTEBRATES	C	C	C	B	=
INSTREAM			C/D	B/C	=
RIPARIAN VEGETATION	C	C	B/C	B	=
ECOSTATUS	C	B	C	B	=
INSTREAM IHI	C	C	D		
RIPARIAN IHI	C	C	B		
EIS	Very High		High		

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a B REC is the same as the 2010 REC of a B EC, the EWRs set for the B (1999) must be used for yield modelling and planning.

EWR 16 & 17: OLIFANTS RIVER (BALULE)

Driver Components	1999 PES	1999 REC	2010 PES	2010 REC	Change
NUTRIENTS	C	B	D	C	
TDS	D	C	D	C	
WATER QUALITY	D	C	C	C	=
GEOMORPHOLOGY	C	C			
Driver Components	**1999 PES**	**1999 REC**	**2010 PES**	**2010 REC**	**Change**
FISH	C	C	C	B	=
MACRO INVERTEBRATES	C	C	C	B	=
INSTREAM			C	B	=
RIPARIAN VEGETATION	C	C	B/C	B	=
ECOSTATUS	C	B	C	B	=
INSTREAM IHI	C	C	C/D		
RIPARIAN IHI	C	C	B/C		
EIS	Very High		High		

The EWRs in 1999 were set for a C (PES) and a B (REC). As the PES of 1999 of a B REC is the same as the 2010 REC of a B EC, the EWRs set for the B (1999) must be used for yield modelling and planning.

13.2. CONCLUSIONS

Below follows a summary table indicating the 1999 EcoStatus, the 2010 EcoStatus, the change as well as which 1999 EC's EWR rule (flow requirements) must be used for yield modelling and planning.

Table 13.2 Table of all EWR sites indicating overall change and the appropriate EWR rule to use for yield modelling

EWR site	1999 PES	2010 PES	1999 REC	2010 REC	Change	EWR rule
1	D	D	C	D	-	D
3	D	D	C	D	-	D
4	B	C	B	B	-	B
5	C	C	B	C	=	C
6	E	C/D	D	C/D	+	C
8	E	C/D	D	C/D	=	D
9	D	C/D	D	C/D	=	D
12	B	B/C	B	B	=	B
13	C	C	B	C	=	C
15	C	C	B	B	=	C
16/17	C	C	B	B	=	B

- The column named "Change" denotes a real change in the state of the aquatic ecology as opposed to a change in the PES due to revised methodology.
- *Sites 16 and 17 are essentially the same site (close to each other) but were used to model different flow conditions*
- *=:1999 EC is the same as 2010*
- *--: Large scale degradation has taken place; -: Small scale degradation has taken place*
- *++: Large scale improvement has taken place; +: Small scale improvement has taken place*

The following conclusions can be made from the above table:

- EWR 1 (Olifants River) and EWR 3 (Klein Olifants River) above Loskop Dam both show deterioration. The major reasons appear to be worsening water quality and the biological responses to this. The water quality problems appear to be due to the problems regarding sewage works that do not have the capacity to handle the current load.

- EWR 4 (Wilge River): This EWR site used to be in a very good condition and is of high EIS. There has since apparently been a marked degradation in instream condition. As it is known that mining (especially around the Saalboomklapspruit) has caused significant problems in the past, it is assumed that these associated water quality problems are the cause. Recent monitoring on the affected tributaries have however showed some improvement and it hoped that if the mines follow mitigation measures and continue monitoring, there might be a positive trend.
- EWR 6 (Elands River): The Elands River is the only site that shows an improvement (instream) and this is due to the recent change in operation of the Renosterpoort Dam. It is uncertain why the operation has changed and whether this is permanent.

13.3. RECOMMENDATIONS

The work undertaken for this study was based in most cases on one survey during the last 11 years. This survey was an extremely rapid survey as part of the 2010 reconnaissance survey and only 1 hour maximum was allowed on site. The results are still of moderate confidence (Table 13.3). It is however essential that monitoring according to the Ecological Water Resources Monitoring Programme be implemented ASAP. This river is one of the key rivers in SA in terms of water allocation and is also a highly ecological (and in terms of Goods and Services) important. Monitoring should have been implemented immediately after the 1999 EWR study as all data collated during that survey can be seen as historical only. A new baseline has to be set and effectively, the EWR has to be recalculated. The additional motivation for this is the out of date methods that were applied during 1999 and the significant improvement in methods resulting in more accurate and useful results.

Confidence were assessed for the 2010 PES as well as the assessment of whether the ecological state has changed between 1999 and 2010. The confidence score is based on a scale of 0 – 5 and colour coded where:
0 – 1.9: Low 2 – 3.4: Moderate 3.5 – 5: High

Table 13.3 Confidence evaluation

EWR sites	2010 PES confidence	Confidence in change from 1999
EWR 1	3.0	2.5
EWR 3	3.0	2.7
EWR 4	3.2	3.5
EWR 5	3	2.3
EWR 6	2.7	3.0
EWR 8	3.1	3.3
EWR 9	2.8	3.7
EWR 12	3.1	3.7
EWR 13	3.0	3.3
EWR 15	3.1	3.5
EWR 16/7	2.7	3.7

14. REFERENCES

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