DEPARTMENT OF WATER AFFAIRS AND FORESTRY

CHIEF DIRECTORATE: RESOURCE DIRECTED MEASURES

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

ECOLOGICAL WATER REQUIREMENTS

Report Number: RDM/WMA02/00/CON/CLA/0313

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ECOLOGICAL WATER REQUIREMENTS: DRAFT

Report Number: RDM/WMA02/00/CON/CLA/0313

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EXECUTIVE SUMMARY

BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study (DWA, 2013a).

In summary, this task refers to integrated step 3: Quantify EWRs and changes in non-water quality ecosystem services. The main emphasis consists of the EcoClassification and Ecological Water Requirement (EWR) determination at various biophysical nodes in the system.

RESOURCE UNITS

Resource Units (RU) as determined during the 2006 comprehensive EWR study is accepted and tabled below:

Summary of the Resource Units delineated during the 2006 EWR study

RU	Rationale	Delineation
GROOT LETABA RIVER		
RU A	*The upper Letaba River catchment is highly afforested and the catchment above Ebenezer Dam, which includes the Dap Naude Dam, is small. There are three weirs between Ebenezer and Tzaneen Dam but due to the short length of this RU (30 km), and the many similar structures in the Groot Letaba River, these weirs were not considered important enough to subdivide this RU. The Tzaneen Dam due to its large size and being instream makes a logical end point to this RU.*	*Groot Letaba River from the source above Dap Naude Dam, to Ebenezer Dam and down to Tzaneen Dam.*
RU B	*This RU is divided at the upper section by the Tzaneen Dam and the lower end by the Prieska weir. The majority of this section of the Letaba River lies in one EcoRegion and one geomorphology zone. The EcoRegions are too small to warrant its own RU. The water quality in this section of the river is driven by the flow releases from Tzaneen Dam and the irrigation usage from the four weirs.*	*Groot Letaba River from the Tzaneen Dam to Prieska Weir.*
RU C	*This section of the river is approximately 40 km to the confluence with the Klein Letaba at the Kruger National Park (KNP) and consists of one weir namely the Nondweni weir. This section of the river system consists of complex operational rules and is driven by irrigation demands downstream as well as KNP releases. The majority of this section of the Letaba River lies in one EcoRegion and one geomorphology zone.*	*Groot Letaba from Prieska weir to the confluence with Klein Letaba River.*
RU D	*Approximately 95% of this RU lies in one geomorphological zone and there are four EcoRegions. The Habitat Integrity is the same for this whole area, and for reasons of practicality, only one RU was delineated. The water quality does not change in this section of the Letaba River as there are no major anthropogenic influences.*	*Groot Letaba River from the confluence with the Klein Letaba River to the confluence with the Olifants River.*
KLEIN LETABA RIVER		
RU E	*The Klein Letaba River has various geomorphological zones and two EcoRegions. The instream habitat integrity is the same for this whole area, and for reasons of practicality, only one RU was delineated for the Klein Letaba River. The water quality does not change in this section of the Klein Letaba River as there are no major anthropogenic influences. The Middle Letaba Dam is located on the Middle Letaba River about 7 km upstream of the confluence of the Middle and Klein Letaba rivers.*	*Head waters of the Klein Letaba to the confluence with the Groot Letaba River.*
LETSITELE RIVER		

RU	Rationale	Delineation
RU F	The Letsitele River has various geomorphological zones and two EcoRegions. The instream and riparian habitat integrity also has two regions. The water quality does change in the Letsitele from the upper catchment due to the dense settlements in the lower catchment. Only one RU was delineated for the Letsitele River.	Head waters, of the Letsitele down to the confluence with the Groot Letaba River.
MOLOTOTSI RIVER		
RU G	The Molototsi River has various geomorphological zones and three EcoRegions. The instream and riparian habitat integrity also has only two regions. The water quality does change in the Molototsi River from the upper catchment to the confluence with the Groot Letaba River. The river is highly seasonal with long periods of no flow in the winter months. Only one RU was delineated for the Molototsi River.	Head waters, of the Molototsi down to the confluence with the Groot Letaba River.
THABINA RIVER		
RU H	The Thabina River consists mainly of one EcoRegion, is a relative short river that is a tributary of the Letsitele River. The instream and riparian habitat integrity also has only two regions. The water quality is not expected to change below the Thabina Dam due to only seepage flow and spilling floodwaters is released from the dam. Only one RU was delineated for the Thabina River.	Upper of the Thabina River (or head waters – above the Thabina Dam) down to the confluence with the Letsitele River.

EWR SITES

Seven EWR sites as determined during the 2006 comprehensive EWR study is accepted and tabled below:

Details of the EWR sites selected during the 2006 EWR study

EWR Site number	EWR Site name	River	Co-ordinates		RU
			Latitude	Longitude	
EWR 1	Appel	Groot Letaba	-23.91769	30.05083	A
EWR 2	Letsitele Tank	Letsitele	-23.88806	30.36125	F
EWR 3	Hans Marensky	Groot Letaba	-23.64939	30.66064	C
EWR 4	Letaba Ranch	Groot Letaba	-23.67753	31.09864	E
EWR 5	Klein Letaba	Klein Letaba	-23.25081	30.49572	B
EWR 6	Lonely Bull	Groot Letaba	-23.75264	31.40731	D
EWR 7	Letaba Bridge	Groot Letaba	-23.80983	31.59081	D

ECOCLASSIFICATION RESULTS (LEVEL IV)

The 2006 EcoClassification results were updated using the EcoClassification models as well as additional information that has become available since the 2006 study. The results (2013) are summarised below.

Summary of the updated 2006 EcoClassification results

Component	EWR 1	EWR 3	EWR 4	EWR 7	EWR 2	EWR 5
Physico chemical	B	B/C	B/C	B	C	B/C
Geomorphology	C/D	D	C/D	C	D	C/D
Fish	C	C	C	C	C/D	C
Invertebrates	C	C	C	C	C	C/D
Riparian vegetation	C	C/D	C	C	D	C
EcoStatus	C	C	C	C	D	C

EWR RESULTS AT EWR SITES (KEY BIOPHYSICAL NODES)

The 2006 EWR results were updated using the updated natural and present day hydrology. The PES results are summarised below as percentage of the natural Mean Annual Runoff (nMAR). The Recommended Ecological Category (REC) is an improvement on the Present Ecological State (PES) at EWR 3, 4 and 7 and these results are also provided.

Updated 2006 EWR results

				Long term mean					
EWR site	**PES**	**nMAR (MCM)[1]**	**pMAR[2] (MCM)**	**Low flows (MCM)**	**Low flows (%nMAR)**	**High flows (MCM)**	**High flows (%nMAR)**	**Total flows (MCM)**	**Total (%nMAR)**
EWR 1	*C*	*99.84*	*53.1*	*10.807*	*10.8*	*9.2*	*9.215*	*19.998*	*20*
EWR 2	*C*	*116.55*	*76.42*	*17.865*	*15.3*	*9.799*	*8.4*	*27.664*	*23.7*
EWR 3	*C*	*394.91*	*181.98*	*23.72*	*6*	*22.235*	*5.6*	*45.955*	*11.6*
EWR 4	*D*	*441.39*	*217.92*	*52.057*	*11.8*	*56.547*	*12.8*	*108.604*	*24.6*
EWR 5	*C*	*124.18*	*67.08*	*4.831*	*3.9*	*15.036*	*12.1*	*19.867*	*16*
EWR 7	*B/C*	*646.28*	*360.69*	*47.772*	*7.4*	*60.983*	*9.4*	*108.755*	*16.8*
EWR site	**REC**	**nMAR (MCM)**	**pMAR (MCM)**	**Low flows (MCM)**	**Low flows (%nMAR)**	**High flows (MCM)**	**High flows (%nMAR)**	**Total flows (MCM)**	**Total (%nMAR)**
EWR 3	*B/C*	*394.91*	*181.98*	*31.544*	*8*	*27.04*	*6.8*	*58.584*	*14.8*
EWR 4	*B/C*	*441.39*	*217.92*	*39.887*	*9*	*44.857*	*10.2*	*84.744*	*19.2*
EWR 7	*B*	*646.28*	*360.69*	*50.173*	*7.8*	*65.165*	*10*	*115.338*	*17.8*

1 Million Cubic Meters *2 Present MAR*

ECOCLASSIFICATION RESULTS AT THE DESKTOP BIOPHYSICAL NODES

The PES and Ecological Importance (EI) - Ecological Sensitivity (ES) (PESEIS; DWA, 2013b)) study results were used to determine the PES and REC. These results are summarised below and includes the Integrated Environmental Importance (IEI) of the nodes.

Summary of the EcoClassification results at the desktop biophysical nodes

Node name	River	PES (EC[-1])	IEI	REC
B81A-00242	*Broederstroom*	*C*	*3*	*B*
B81A-00256		*D*	*3*	*D*
B81A-00263		*D*	*2*	*D*
B81A-00270	*Broederstroom*	*C*	*5*	*C*
B81B-00233	*Mahitse*	*C*	*4*	*C*
B81B-00234	*Mahitse*	*C*	*3*	*C*
B81B-00246	*Politsi*	*C*	*5*	*C*
B81B-00251		*D*	*2*	*D*
B81B-00269	*Morudi*	*B*	*5*	*B*
B81B-00227	*Mahitse*	*D*	*3*	*D*
B81B-00240	*Politsi*	*C*	*3*	*C*
B81D-00277	*Thabina*	*D*	*3*	*D*
B81D-00280	*Bobs*	*B*	*5*	*B*
B81D-00296	*Mothlaka-Semeetse*	*B*	*5*	*B*
B81D-00272	*Letsitele*	*C*	*5*	*C*

Node name	River	PES (EC[1])	IEI	REC
B81E-00213	Nwanedzi	D	3	C
B81F-00189	Merekome	C	3	C
B81F-00203	Lerwatlou	C	3	C
B81F-00228	Reshwele	B	4	B
B81F-00232	Makwena	B	4	B
B81G-00164	Molototsi	D	2	D
B81H-00162	Metsemola	C	3	C
B81H-00171	Molototsi	D	2	D
B81J-00187	Mbhawula	C	3	C
B82A-00168	Middel Letaba	C	3	C
B82B-00173	Koedoes	D	2	D
B82C-00175	Brandboontjies	E	3	D
B82D-00163	Lebjelebore	C	3	C
B82D-00154	Middel Letaba	D	2	D
B82D-00166	Mosukodutsi	D	2	D
B82E-00149	Khwali	B	5	B
B82E-00150	Little Letaba	C	3	C
B82F-00141	Soeketse	C	3	C
B82F-00128	Little Letaba	C	3	C
B82F-00137	Little Letaba	D	2	D
B82H-00127	Nsama	C	3	C
B82H-00139	Magobe	B	4	B
B82H-00157	Nsama	B	4	B
B82J-00197	Ka-Malilibone	B	4	B

1 Ecological Category

EWR RESULTS AT THE DESKTOP BIOPHYSICAL NODES

The Revised Desktop Reserve Model (RDRM) was used to estimate EWRs at all desktop biophysical nodes, excluding those that fall in its totality in conservation areas. The results are summarised in the table below.

EWR results at the desktop biophysical nodes

Node	MAR (10^6 m^3)		REC	Long-term requirements			
	Natural	PD[1]		Low flows		Total flows	
				10^6 m^3	%MAR	10^6 m^3	%MAR
B81A-00242	23.83	15.16	C	3.310	13.9	5.215	21.9
B81A-00256	16.34	12.18	D	2.499	15.3	3.573	21.9
B81A-00263	5.75	4.00	D	0.867	15.1	1.258	21.9
B81A-00270	44.47	29.99	C	8.447	19.0	12.043	27.1
B81B-00227	13.60	10.77	D	2.006	14.8	3.005	22.1
B81B-00233	2.69	2.08	C	0.500	18.6	0.738	27.4

Node	MAR (10^6 m^3)		REC	Long-term requirements			
	Natural	PD[1]		Low flows		Total flows	
				10^6 m^3	%MAR	10^6 m^3	%MAR
B81B-00234	10.13	8.06	C	2.150	21.2	3.013	29.8
B81B-00240	38.98	22.79	C	4.445	11.4	7.455	19.1
B81B-00246	36.26	20.80	C	3.616	10.0	6.406	17.7
B81B-00251	1.34	0.98	D	0.094	7.0	0.206	15.4
B81B-00269	1.95	1.95	B	0.465	23.9	0.675	34.6
B81D-00272	91.27	57.51	C	13.288	14.6	20.084	22.0
B81D-00277	25.28	18.90	D	1.053	4.2	3.276	13.0
B81D-00280	18.51	13.95	B	3.647	19.7	5.417	29.3
B81D-00296	10.53	8.85	B	2.637	25.0	3.645	34.6
B81E-00213	17.28	11.31	C	0.302	1.7	1.392	8.1
B81F-00189	4.74	4.08	C	0.062	1.3	0.337	7.1
B81F-00203	3.74	3.08	C	0.071	1.9	0.328	8.8
B81F-00228	3.53	2.87	B	0.030	0.8	0.322	9.1
B81F-00232	2.75	2.54	B	0.094	3.4	0.347	12.8
B81G-00164	16.72	14.30	D	0.072	0.4	1.110	6.6
B81H-00162	0.64	0.59	C	0.012	1.9	0.063	9.8
B81H-00171	25.84	22.60	D	0.254	1.0	1.671	6.5
B81J-00187	2.53	2.53	C	0.014	0.5	0.247	9.8
B82A-00168	31.12	25.07	C	4.339	13.9	7.564	24.3
B82B-00173	23.13	15.76	D	1.377	6.0	2.848	12.3
B82D-00154	40.53	32.96	D	3.527	8.7	7.025	17.3
B82D-00163	4.90	4.29	C	0.818	16.7	1.261	25.8
B82D-00166	42.25	27.77	D	1.776	4.2	4.296	10.2
B82E-00149	4.51	4.02	B	0.126	2.8	0.624	13.9
B82E-00150	3.48	3.08	C	0.037	1.1	0.558	16.0
B82F-00128	32.13	30.26	C	1.595	5.0	4.962	15.4
B82F-00137	13.64	12.42	D	0.063	0.5	1.319	9.7
B82F-00141	7.32	7.19	C	0.115	1.6	0.935	12.8
B82H-00127	6.91	4.42	C	0.067	1.0	0.730	10.6
B82H-00139	3.10	3.10	B	0.021	0.7	0.463	14.9
B82H-00157	11.72	9.21	B	0.202	1.7	1.683	14.4
B82J-00197	0.66	0.64	B	0.023	3.5	0.091	13.8

1 Present Day

LINKS OF ECOSYSTEM GOODS, SERVICES AND ATTRIBUTES TO AN IMPROVED REC

All biophysical nodes where improvements are required were assessed to determine how the Ecosystem Goods, Services and Attributes (EGSA) will respond to this improvement. The relevant nodes and key responses are:

- *EWR 4: The REC should result in higher flows, more frequent flushing of riffles and thus an increase in in-stream habitat conditions. This could positively impact the aesthetic qualities of the river and may have some importance for recreational utilisation. Malaria may be reduced*

as flows will be increased and potentially has a positive impact for people in the reserve. Acceptable perennial flows are advantageous for eco-tourism regarding the aesthetic qualities.

- *EWR 7: The REC should result in higher flows, more frequent flushing of riffles and thus an increase in in-stream habitat conditions and could positively impact the aesthetic qualities of the river and have some importance for recreational utilisation. Malaria may be reduced and this has potentially positive impact for people in the reserve. Acceptable perennial flows are advantageous for eco-tourism regarding the aesthetic qualities.*
- *B81A-00242: This reach is exclusively rural, with no towns or villages noted. The REC will result in the restoration of large wetland areas through the removal of forestry from wetland and riparian areas. This will improve habitat diversity, flood attenuation and most importantly streamflow and water provision to downstream reaches and have a net positive benefit for ecosystems services. The indigenous species has no/limited utilization potential (no angling) and hence the primary utilization of the fish resource is recreational fishing of the alien trout. An ecological improvement towards the REC may therefore require eradication/decrease of trout and hence a decrease in the utilization potential of the reach.*
- *B81E-00213 – Upper area: The reach is rural in nature with the upper half being commercial farmlands; highly developed with many small dams and weirs. A general improvement of the area through attaining the REC would probably lead to higher aesthetic values being attached to the area and this may have some impact on recreational activities. Legally compliant forestry practices will improve habitat diversity, flood attenuation and most importantly streamflow and water provision to downstream reaches. All of these improvements would potentially have a net positive benefit for ecosystems services and downstream users. An increase in the fish stock may increase the availability of fish for utilization and an improvement in irrigation practices (including return flows and abstractions) should result in an improvement in overall water quality.*
- *B81E-00213 – Lower area: The general improvement of the area through attaining the REC would probably lead to higher aesthetic values being attached to the area and this may have some impact on recreational activities. Management of nutrient levels and water abstraction will improve the present state of water quality with net positive results downstream to users. An improvement in EC for fish will increase the availability of fish for utilization. Vegetation use and removal are dominant and it is unlikely to manage these in a way that will improve the PES and as such little positive impact would be expected.*

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TERMINOLOGY AND ACRONYMS

AEC	*Alternative Ecological Categories*
ASPT	*Average Score Per Taxon*
CD: RDM	*Chief Directorate: Resource Directed Measures*
DEM	*Digital Elevation Model*
DRM	*Desktop Reserve Model*
DWA	*Department of Water Affairs*
EC	*Ecological Category*
EcoSpecs	*Ecological Specifications*
EGSA	*Ecosystem Goods, Services and Attributes*
EI	*Ecological Importance*
EIS	*Ecological Importance and Sensitivity*
ES	*Ecological Sensitivity*
EWR	*Ecological Water Requirement*
FD	*Fast Deep fish habitat*
FROC	*Frequency of Occurrence*
FS	*Fast Shallow fish habitat*
GAI	*Geomorphological Driver Assessment Index*
GIS	*Geographical Information System*
gz	*Geomorphological zone*
IEI	*Integrated Environmental Importance*
IFR	*Instream Flow Requirements*
IUA	*Integrated Unit of Analysis*
KNP	*Kruger National Park*
LL	*Large limnophilics*
LR	*Large rheophilics*
LSR	*Large semi-rheophilics*
MAR	*Mean Annual Runoff*
MCM	*Million Cubic Meters*
MIRAI	*Macro Invertebrate Response Assessment Index*
NFEPA	*National Freshwater Ecosystem Priority Areas*
NGI	*National Geo-Spatial Information*
nMAR	*Natural MAR*
PAI	*Physico-chemical Driver Assessment Index*
PD	*Present Day*
PES	*Present Ecological State*
PESEIS	*Present Ecological State and Ecological Importance -Ecological Sensitivity*
pMAR	*Present MAR*
PSP	*Professional Service Provider*
Quat	*Quaternary catchment*
RDRM	*Revised Desktop Reserve Model*
REC	*Recommended Ecological Category*
RQO	*Resource Quality Objective*
RU	*Resource Units*
SASS	*South African Scoring System*
SI	*Socio-cultural Importance*
SL	*Small limnophilics*
SPATSIM	*Spatial and Time Series Information Modelling*
SQ	*Sub-quaternary (may also be termed a quinary)*
SR	*Small rheophilics*
SRTM	*Shuttle Remote Topography Mission*
SSR	*Small semi-rheophilics*
TPCs	*Thresholds of Potential Concern*

WMA	*Water Management Area*
WMS	*Water Management System*
WRC	*Water Research Commission*
WRCS	*Water Resources Classification System*
WRUI	*Water Resource Use Importance*

1 INTRODUCTION

1.1 BACKGROUND

The Chief Directorate: Resource Directed Measures (CD: RDM) of the Department of Water Affairs (DWA) initiated a study during 2012 for the provision of professional services to undertake the implementation of the Water Resources Classification System (WRCS) and determination of the Resource Quality Objectives (RQOs) for significant water resources in the Letaba catchment. Rivers for Africa was appointed as the Professional Service Provider (PSP) to undertake this study (DWA, 2013a). The study area is the catchment of the Letaba River, Water Management Area (WMA) 2, and illustrated in Figure 1.1.

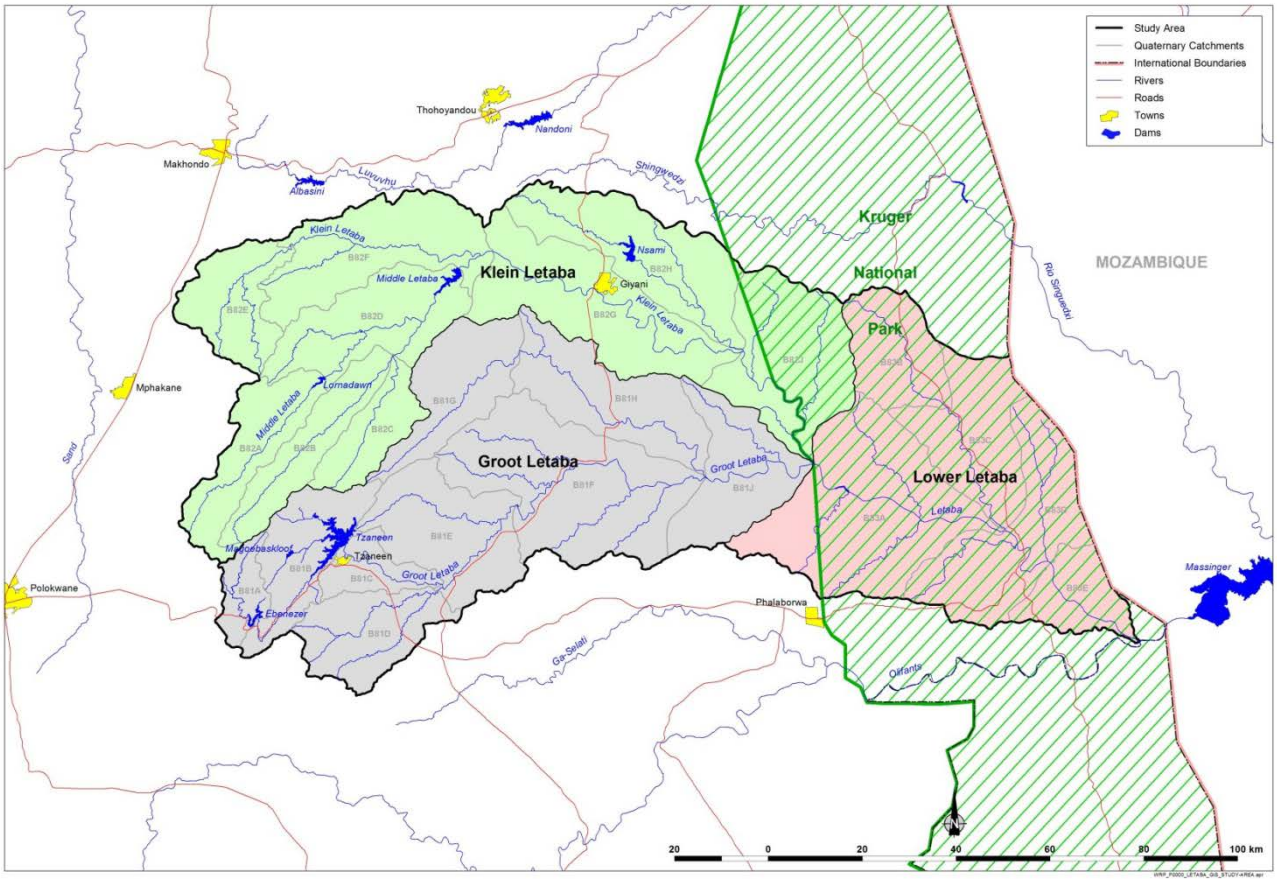

Figure 1.1 Study area: Letaba River Catchment (DWA, 2013a)

During 1994, an Instream Flow Requirements (IFR) study was undertaken for the Letaba River. This was one of the first IFR studies ever undertaken by DWA and the first IFR study where hydraulics was considered. This study was refined during 1996. The focus of these studies was downstream of Tzaneen Dam. A Comprehensive Reserve study was then undertaken and finalised in 2006. This study included seven EWR sites of which five were in the main river, one in the Letsitele and one in the Middle Letaba River. This EWR study included a scenario phase and the output of this study was that a Scenario 6.2 was selected as the Reserve (DWA, 2012).

It was recognised that the hydrology used for the 2006 Ecological Water Requirement (EWR) study was out-dated. Reserve results are generated as an EWR rule which is a flow duration table. The natural simulated hydrology is used to generate the final output. If the hydrology changes, then the final EWR output is invalid, especially if changes are significant. Therefore, the basis of the EWRs (dry and wet drought and maintenance EWRs) has to be used to generate new EWR rules based

on the original habitat requirements. The problem is further exacerbated as the EWR data and the scenarios that were developed towards the end of the 2006 study were not stored in the incorrect format within the Spatial and Time Series Information Modelling (SPATSIM) framework and therefore adjustments and changes required for future scenario evaluation cannot be made (DWA, 2012). The existing results therefore have been converted within SPATSIM if possible. Additional work and monitoring have taken place specifically focussed on EWR 3 (Letaba River close to Die Eiland Resort) and on EWR 7 in the Kruger National Park (KNP). Due to the higher confidence in these sites, they should act as drivers for decision-making on scenarios.

1.2 INTEGRATED STEP 3: QUANTIFY EWRS AND CHANGES IN NON-WATER QUALITY ECOSYSTEM SERVICES

In summary, this task consists of the EcoClassification and EWR determination at various biophysical nodes in the system. This task consists of the following subtasks:

- **Task D3.1. Setting up the system model and provision of natural and present day data**
  As indicated in the section above, the hydrology has been revised as part of the Development of the Reconciliation Strategy for the Luvuvhu and Letaba Water Supply System and will be used for the EWR assessment.
- **Task D3.2. EWRs for key biophysical nodes**
  EWRs were set at seven EWR sites (key biophysical nodes) during the comprehensive 2006 study. These EWRs had to be revised based on the new hydrology during this study.
- **Task D3.3. EWRs for desktop biophysical nodes.**
  As the comprehensive 2006 study only addressed the EWRs at the EWR sites, EWRs must now be estimated at desktop biophysical nodes which are representative of the whole catchment.
- **Task D3.4. Consequences of Ecosystem Goods, Services and Attributes (EGSA) at sites where the Recommended Ecological Category (REC) is an improvement of the Present Ecological State (PES)**
  During Task D1, the REC for all the biophysical nodes was established. The Ecosystem Services were also identified at these sites. At sites where the REC is set to improve the PES, the links (response) to the identified Services are identified.
- **Task D3.5. EWR report**
  This report.

This task provides the information for the next step, i.e. Step D4: Identification and evaluation of operational scenarios to identify consequences.

1.3 REPORT STRUCTURE

The report outline is provided below.

Chapter 1: Introduction

This Chapter provides general background to the project Task.

Chapter 2: Summary of EWR results at EWR sites (Key biophysical nodes)

The Chapter summarises certain aspects of the 2006 Reserve study undertaken by Pulles Howard & de Lange Inc. undertaken during April 2003 and March 2006. The focus of this Chapter is on the Resource Units and EWR sites selected during the 2006 study.

Chapter 3: EcoClassification results at EWR sites

EcoClassification results per EWR site are provided comparing the 2006 Reserve results with 2013 results achieved by using updated data and current EcoClassification models.

Chapter 4: EWR results at EWR sites

The focus of this chapter is on the revision of the EWR results. The updated results were generated by using the measured hydraulic cross-sections and hydraulic modelling data at EWR sites and the updated hydrology to populate the Revised Desktop Reserve Model (RDRM) (Hughes et al., 2012) in SPATSIM. The results for the low flows are provided per EWR site and the high flows are summarised for all the EWR sites. A summary of the results compared to the natural MAR (NMAR) is also provided.

Chapter 5: Desktop biophysical nodes: Resource Units, locality and EcoClassification

The Sub-Quaternary river reaches (SQs) forms the basis of the PES (11) (DWA, 2013b) assessment and are therefore surrogates for desktop level Resource Units. Desktop biophysical nodes are listed and a summary of results for the desktop biophysical nodes are provided.

Chapter 6: Desktop biophysical nodes: Approach to estimating EWRs and results

This chapter provides the general approach used during this study to estimate the EWRs at the biophysical nodes using the Revised Desktop Reserve Model (RDRM) which includes the links and relationships between hydrology, hydraulics and ecological response.

Chapter 7: Link of EGSA to improved Ecological Category

All biophysical nodes where improvements are required were assessed to determine how the Ecosystem Goods, Services and Attributes (EGSA) will respond to this improvement. The results are summarised in this Chapter.

Chapter 8: References

Appendix A: 2006 EcoClassification Results

The EcoClassification Results of the 2006 Reserve study is summarised in this Appendix.

Appendix B: 2006 EWR results

A summary of the EWR requirements as well as the high flows determined during the 2006 Reserve study is summarised in this Appendix.

Appendix C: EWR results as RDRM output

The Revised Desktop Reserve Model outputs for every EWR site are provided.

2 SUMMARY OF EWR RESULTS AT EWR SITES (KEY BIOPHYSICAL NODES)

2.1 LETABA CATCHMENT RESERVE DETERMINATION STUDY

Due to the conflicting water uses and the need for compulsory licences in order to achieve resource protection and equity needs, the CD: RDM commissioned The LETABA CATCHMENT RESERVE DETERMINATION STUDY during 2003. The study will be referred to in this document as the 2006 comprehensive study. Pulles Howard & de Lange Inc. undertook the study and it was conducted over a three-year period between April 2003 and March 2006.

This study followed comprehensive methods for EcoClassification as well as for Ecological Water Requirement determination and was based on the generic 8-step process (DWAF, 1999). The focus of the study was on the Groot Letaba River and its major tributaries the Klein Letaba, Middle Letaba, Letsitele and Molototsi rivers. The overall objectives of this study as outlined in DWAF (2006a) were as follows:

- **Groundwater Scoping:** *Clarifying the need for a groundwater study, based on a review of available information, focusing on the significance of groundwater to wetlands and surface flows, and the importance of groundwater to current and potential users in the catchment.*
- **Wetlands Scoping:** *Clarifying the need for a wetland study, based on a review of available information, focussing on the ecological importance of wetlands in the catchment, and the links between wetlands, rivers and groundwater;*
- **Determine the Present Ecological State (PES)***: Defining reference conditions and classifying each Resource Unit in which EWR sites were selected, in terms of the PES of the main ecological drivers and ecological responses and integrating the PES results of individual ecological components into an overall EcoStatus.*
- **Recommended Ecological Category (REC) and Alternative Ecological Categories (AEC):** *To recommend an Ecological Category (EC) and alternative categories, based on the results of the PES, and assess the trends (changes) that were likely to take place, the Ecological Importance and Sensitivity (EIS), Socio-cultural Importance (SI), as well as an assessment of practicality of improving ecological conditions.*
- **Ecological Water Requirements:** *Recommending and motivating specific low and high flows for maintaining ecological conditions within a specific ecological category, and presenting the results in the form of assurance rules for each selected EWR site for each month of the year and for each EC assessed.*
- **Ecological Reserve:** *Developing various operational flow scenarios; describing their ecological and socio-economic consequences, and recommending a scenario that minimizes impacts on users and the ecosystem.*
- **Monitoring:** *Assessing the suitability of available data for defining baseline conditions for Ecological Reserve monitoring in the Letaba River; recommending additional baseline data requirements, if needed; and defining Ecological Specifications (EcoSpecs) and associated Thresholds of Potential Concern (TPCs) for each monitoring site.*
- **Capacity Building:** *Training historically disadvantaged individuals in specific aspects of assessing EWR.*

2.2 RESOURCE UNITS

A summary of the Resource Units (RUs) defined during the 2006 study (DWAF, 2004) are provided in Table 2.1.

Table 2.1 Description and rationale of the Resource Units

RU	EcoRegion Level 2	Geomorphic zone[1]	Land cover	Rationale	Delineation	Quat[2]
GROOT LETABA RIVER						
RU A	*9.02 (80%)* *4.02 (20%)*	*Mountain stream (10%)* *Foothills (cobble bed) (40%)* *Rejuvenated Bedrock Fall (20%)* *Rejuvenated Foothills (30%)*	*Forestry, citrus farming and irrigated agriculture.*	*The upper Letaba River catchment is highly afforested and the catchment above Ebenezer Dam, which includes the Dap Naude Dam, is small. There are three weirs between Ebenezer and Tzaneen Dam but due to the short length of this RU (30 km), and the many similar structures in the Groot Letaba River, these weirs were not considered important enough to subdivide this RU. The Tzaneen Dam due to its large size and being instream makes a logical end point to this RU.*	*Groot Letaba River from the source above Dap Naude Dam, to Ebenezer Dam and down to Tzaneen Dam.*	*B81A and B81B*
RU B	*4.02 (10%)* *3.01 (30%)* *3.02 (10%)* *3.03 (50%)*	*Rejuvenated Foothills (100%)*	*Extensive citrus and banana plantations.*	*This RU is divided at the upper section by the Tzaneen Dam and the lower end by the Prieska weir. The majority of this section of the Letaba River lies in one EcoRegion and one geomorphology zone. The EcoRegions are too small to warrant its own RU. The water quality in this section of the river is driven by the flow releases from Tzaneen Dam and the irrigation usage from the four weirs.*	*Groot Letaba River from the Tzaneen Dam to Prieska Weir.*	*B81C B81E B81F*
RU C	*3.03 (50%)*	*Rejuvenated Foothills (100%)*	*Extensive citrus and banana plantations. Cattle farming and settlements.*	*This section of the river is approximately 40 km to the confluence with the Klein Letaba at the Kruger National Park (KNP) and consists of one weir namely the Nondweni weir. This section of the river system consists of complex operational rules and is driven by irrigation demands downstream as well as KNP releases. The majority of this section of the Letaba River lies in one EcoRegion and one geomorphology zone.*	*Groot Letaba from Prieska weir to the confluence with Klein Letaba River.*	*B81F*
RU D	*3.03 (50%)* *3.05 (35%)* *2.06 (10%)* *12.01 (5%)*	*Rejuvenated Foothills (90%)* *Gorge (10%)*	*Some cattle farming and settlements before the border with KNP.*	*Approximately 95% of this RU lies in one geomorphological zone and there are four EcoRegions. The Habitat Integrity is the same for this whole area, and for reasons of practicality, only one RU was delineated. The water quality does not change in this section of the Letaba River as there are no major anthropogenic influences.*	*Groot Letaba River from the confluence with the Klein Letaba River to the confluence with the Olifants River.*	*B81J*
KLEIN LETABA RIVER						

RU	EcoRegion Level 2	Geomorphic zone[1]	Land cover	Rationale	Delineation	Quat[2]
RU E	3.02 (60%) 3.03 (40%)	Rejuvenated Bedrock Fall (5%) Rejuvenated Foothills (95%)	Upper reach: Cattle farming, and settlements. Subsistence farming. Middle reach: Commercial irrigated agriculture from Middle Letaba. Lower reach: Largely natural.	The Klein Letaba River has various geomorphological zones and two EcoRegions. The instream habitat integrity is the same for this whole area, and for reasons of practicality, only one RU was delineated for the Klein Letaba River. The water quality does not change in this section of the Klein Letaba River as there are no major anthropogenic influences. The Middle Letaba Dam is located on the Middle Letaba River about 7 km upstream of the confluence of the Middle and Klein Letaba rivers.	Head waters of the Klein Letaba to the confluence with the Groot Letaba River.	B82A-G B82J
LETSITELE RIVER						
RU F	9.02 (20%) 3.01 (80%)	Rejuvenated Bedrock Fall (10%) Rejuvenated Foothills (90%)	Upper reach: Forestry and agricultural estates. Middle and lower reaches: Extensive commercial citrus and fruit farming, rural settlements and communal lands.	The Letsitele River has various geomorphological zones and two EcoRegions. The instream and riparian habitat integrity also has two regions. The water quality does change in the Letsitele from the upper catchment due to the dense settlements in the lower catchment. Only one RU was delineated for the Letsitele River.	Head waters, of the Letsitele down to the confluence with the Groot Letaba River.	B81D
MOLOTOTSI RIVER						
RU G	4.02 (10%) 3.02 (50%) 3.03 (40%)	Rejuvenated Bedrock Fall (5%) Rejuvenated Foothills (95%)	Rural settlements, rural cattle farming and agriculture.	The Molototsi River has various geomorphological zones and three EcoRegions. The instream and riparian habitat integrity also has only two regions. The water quality does change in the Molototsi River from the upper catchment to the confluence with the Groot Letaba River. The river is highly seasonal with long periods of no flow in the winter months. Only one RU was delineated for the Molototsi River.	Head waters, of the Molototsi down to the confluence with the Groot Letaba River.	B81G B81H
THABINA RIVER						
RU H	10.1 (5%) 3.01 (95%)	Mountain stream (5%) Rejuvenated Bedrock Fall (10%) Rejuvenated Foothills (85%)	Upper reach: Nature reserve. Downstream of Thabina Dam: Agricultural plots, villages and informal cattle farming.	The Thabina River consists mainly of one EcoRegion, is a relative short river that is a tributary of the Letsitele River. The instream and riparian habitat integrity also has only two regions. The water quality is not expected to change below the Thabina Dam due to only seepage flow and spilling floodwaters is released from the dam. Only one RU was delineated for the Thabina River.	Upper of the Thabina River (or head waters – above the Thabina Dam) down to the confluence with the Letsitele River.	B81D

1 Geomorphological zonation according to Rowntree and Wadeson (1999) is provided in the table. However six longitudinal zones were identified along the Groot Letaba main stem channel. Zones 1, 4 and 5 were further sub-divided in to two sub-categories (a and b) due to major slope differences and/or tributary junctions. A further two zones were identified in the Klein Letaba. Refer to DWAF (2004) for more detail.
2 Quaternary catchment

2.3 EWR SITES

2.3.1 Selection of EWR sites

Seven EWR sites were selected during 2003 (DWAF, 2004) and are listed in Table 2.2 and their location within WMA 2 is provided in Figure 2.2.

Table 2.2 Details of the EWR sites selected during 2003 in WMA 2

EWR Site number	EWR Site name	River	Co-ordinates		RU
			Latitude	Longitude	
EWR 1	Appel	Groot Letaba	-23.91769	30.05083	A
EWR 2	Letsitele Tank	Letsitele	-23.88806	30.36125	F
EWR 3	Hans Marensky	Groot Letaba	-23.64939	30.66064	C
EWR 4	Letaba Ranch	Groot Letaba	-23.67753	31.09864	E
EWR 5	Klein Letaba	Klein Letaba	-23.25081	30.49572	B
EWR 6	Lonely Bull	Groot Letaba	-23.75264	31.40731	D
EWR 7	Letaba Bridge	Groot Letaba	-23.80983	31.59081	D

Reasoning for excluding EWR sites from certain river reaches were mainly based on the scale or level of resolution required and are provided below:

- *Molototsi River: Due to its highly seasonal nature and the lack of adequate monitoring data. The influence of this river on the Groot Letaba was seen at EWR 4.*
- *Middle Letaba River: EWR 5 (Klein Letaba) was, selected to be directly downstream of the confluence of Middle and Klein Letaba Rivers. Furthermore the Middle Letaba Dam (used for irrigation and domestic water supply) did not release water downstream into the river.*
- *Ntsami River: Due to its contribution to the MAR of the Letaba River being small in comparison to the other tributaries.*
- *Thabina River: Due to its contribution to the Mean Annual Runoff (MAR) of the Letaba River being small in comparison to the other tributaries. An EWR site was chosen in the Letsitele River (EWR 2), of which the Thabina River is the major tributary.*

2.3.2 Description of the EWR sites

A description of the EWR sites are provided below based on information from DWAF (2004) and DWAF (2013a).

Table 2.3 Characteristics and view of EWR 1

Site information	Detail	Illustration
EWR site	EWR 1	
Name	Appel	
River	Groot Letaba River	
Co-ordinates	S 23.91769 E 30.05083	
RU	MRU A	
IUA[1]	IUA 1	
SQ[2] Reach	B81B-00264	
IEI[3] rating	Very high (4)	
WRUI[4] rating	Very high (4)	
Hotspot rating	Very high (4)	

Site information	Detail	Illustration
EWR site advantages: ▪ *Single channel characterised by a pool rapid channel type with floodplain terraces on the right bank.* ▪ *All habitat types present and limited flood damage in terms of the structure of the terraces and vegetation structure.* ▪ *Few urban rural settlements, one water quality sampling point near EWR site.*		**EWR site disadvantages:** ▪ *Flow regulation from Ebenezer Dam and instream weirs.* ▪ *Highly afforested with exotic pine and eucalyptus.* ▪ *Active channel has narrowed due to flow modification and led to vegetation encroachment.* ▪ *Vegetation encroachment due to exotic giant reed Arunda donax. Large boulders complicate low flow modelling; turbulence at low flows - difficult to survey accurate water stage.* ▪ *Dense vegetation on both banks influences overall flow resistance at high flows.* ▪ *Potential water quality impacts due to cultivated agriculture (bananas and citrus) and afforestation.*

1 Integrated Unit of Analysis *2 Sub-quaternary*
3 Integrated Environmental Importance *4 Water Resource Use Importance*

Table 2.4 Characteristics and view of EWR 2

Site information	Detail	Illustration
EWR site	*EWR 2*	
Name	*Letsitele Tank*	
River	*Letsitele*	
Co-ordinates	*S 23.88806 E 30.36125*	
MRU	*MRU F*	
IUA	*IUA 2*	
SQ Reach	*B81D-00271*	
IEI rating	*High (3)*	
WRUI rating	*High (3)*	
Hotspot rating	*High (3)*	
EWR site advantages: ▪ *One single channel characterised by an incised pool-riffle channel pattern.* ▪ *Good diverse habitats present.* ▪ *Weir upstream for flow and water quality records.*		**EWR site advantages:** ▪ *Backwater effect of the Groot Letaba during high flow conditions.* ▪ *Vegetation heavily impacted by over-grazing and trampling.* ▪ *River channel at this site is largely degraded due to erosion and local sources of water quality pollution.* ▪ *Water quality is impacted by upstream development dense rural/informal settlements as well as sewage effluent causing eutrophication.*

Table 2.5 Characteristics and view of EWR 3

Site information	Detail	Illustration
EWR site	*EWR 3*	
Name	*Prieska*	
River	*Groot Letaba*	
Co-ordinates	*S 23.64939 E 30.66064*	
MRU	*MRU C*	
IUA	*IUA 4*	
SQ Reach	*B81F-00200*	
IEI rating	*Very high (4)*	
WRUI rating	*High (3)*	
Hotspot rating	*Very high (4)*	

Site information	Detail	Illustration
EWR site advantages: ▪ *Characterised by a bedrock pool-rapid channel type with small gravels, cobbles and sand bars amongst the exposed bedrock. Steep banks with no benches or terraces.* ▪ *Location of nearby rated weir for the measurement of high flows and flood discharges when high flows prohibit access to the river for manual flow gauging.* ▪ *Good diversity of habitat.* ▪ *Water quality monitoring points at the Junction weir.*		**EWR site disadvantages:** ▪ *Extensive bedrock influence and large roughness elements are inundated at medium to high flows, multiple channels with complex flow patterns and non-uniform flow at low to medium flows. Difficult to measure medium to high flows using manual flow gauging. The short riffle feature at the site becomes drowned-out at reasonably low flows.* ▪ *The 2000 floods scoured the macro-channel floor. The many weirs and dams in this section of the river have caused enhanced sedimentation and accumulation of finer material in some sections of the river. . Vegetation encroachment, channel narrowing, sediment trapped in weirs.* ▪ *Large-scale removal of vegetation along the top of the left bank (for irrigation farming) may impact bank stability and vegetation recruitment lower down on the macro-channel banks. Alien invasion vegetation also occurring on the upper banks of the river.* ▪ *Water quality impacts due to intense irrigated agriculture and the use of fertilizers and pesticides. The large volume of water that is captured in weirs also results in algal blooms and elevated chlorophyll levels.*

Table 2.6 Characteristics and view of EWR 4

Site information	Detail	Illustration
EWR site	*EWR 4*	
Name	*Letaba Ranch*	
River	*Groot Letaba*	
Co-ordinates	*S 23.67753 E 31.09864*	
MRU	*MRU E*	
IUA	*IUA 4*	
SQ Reach	*B81J-00219*	
IEI rating	*Very high (4)*	
WRUI rating	*High (3)*	
Hotspot rating	*Very high (4)*	
EWR site advantages: ▪ *Characterised by a single active channel with an extensive, largely non-vegetated seasonal bar on the left bank. The right bank is dominated by a high ephemeral lateral terrace.* ▪ *Good diversity of habitat.* ▪ *Letaba Ranch weir, upstream of the site for flow records.* ▪ *Water quality monitoring points at Nondweni weir and in Letaba Ranch upstream of EWR site.*		**EWR site disadvantages:** ▪ *Two channels with two different water levels, downstream bedrock sections have non-uniform flow, islands, irregular shapes, potential for non-horizontal water profile at low flows, close to a bend.* ▪ *Some vegetation encroachment and loss of bedrock-influenced channel patterns has occurred.* ▪ *Marginal vegetation limited due to 2000 floods. Flow regulation has resulted in a reduction in wetted area, in depth, velocity over riffles and variation of water level.* ▪ *Naturally dynamic state form periods of vegetated to non-vegetated along the macro-channel floor. Lower riparian zone has a substantial loss cover and abundance along the flood terraces due to the 2000 floods.* ▪ *Dense rural settlements, agriculture encroachment into the riparian vegetation and irrigated agriculture results in water quality problems.*

Table 2.7 Characteristics and view of EWR 5

Site information	Detail	Illustration
EWR site	EWR 5	
Name	Klein Letaba	
River	Klein Letaba	
Co-ordinates	S 23.25081 E 30.49572	
MRU	MRU B	
IUA	IUA 9	
SQ Reach	B82G-00135	
IEI rating	High (3)	
WRUI rating	Very high (4)	
Hotspot rating	Very high (4)	

EWR site advantages:

- *Reach largely unmodified, limited exposure to direct human changes.*
- *Good marginal vegetation and deep slow habitat as well as pools. The pools will be used as refugia during droughts.*
- *Terraces on both banks, sandy active channel and seasonal mid-channel bar composed of sand, armoured by gravels and cobbles.*
- *Upper riparian zone not altered by floods and flow changes. Marginal vegetation is naturally dynamic. Alien vegetation not an issue at this stage.*
- *Water quality monitoring points at Tabaan in Klein Letaba upstream of EWR site and settlements with limited subsistence below confluence with Middle Letaba.*

EWR site disadvantages:

- *Sand bed channel, dynamic system with sand bars and islands with vegetation that complicate hydraulic modelling. No gauging station close to the site for flow records. Not very good cross section for flow measurement.*
- *Flow has been altered due to the building of the middle Letaba Dam. Rapid vegetation encroachment on to the macro-channel floor due to reduced flows and floods downstream of this impoundment. The lower riparian zone has a substantial loss of cover and abundance along the flood terraces due to the 2000 floods. Vegetation removal for fire wood and agricultural encroachment a problem.*
- *No boulders and limited stones in current data with a very limited velocity range. Marginal vegetation limited. Fast-deep habitat missing but this will be available during high flows.*

Table 2.8 Characteristics and view of EWR 6

Site information	Detail	Illustration
EWR site	EWR 6	
Name	Lonely Bull	
River	Groot Letaba	
Co-ordinates	S 23.75264 E 31.40731	
MRU	MRU D	
IUA	IUA 11	
SQ Reach	B83A-00235	
IEI rating	Very high (4)	
WRUI rating	High (3)	
Hotspot rating	Very high (4)	

Site information	Detail	Illustration
EWR site advantages: ▪ *Wide macro-channel with two active channels. Bedrock outcrops occur on the macro channel floor and terraces on the right bank.* ▪ *The dynamics of vegetation change appear to be largely natural. Upper riparian zone not altered by floods and flow changes.* ▪ *Enhanced sedimentation has caused some channel pattern changes, but the 2000 floods have reversed many of these.* ▪ *Good habitat diversity.* ▪ *No major impacts in water quality in the KNP.*		**EWR site disadvantages:** ▪ *A pool on the left side, a riffle channel on the right side, reversed flow between, different water stages across EWR cross-section. No working gauging weirs, presence of crocodiles and hippos make measurement of high flows difficult.* ▪ *Reduction in frequency, magnitude and duration of moderate and large floods and severe reduction in low flows and increase in zero flow periods (which inhibits marginal vegetation establishment and therefore prevents active channel stabilisation).* ▪ *Lower riparian zone has a substantial loss cover and abundance along the flood terraces due to the 2000 floods.* ▪ *Stones in current and riffle habitat limited.* ▪ *Crocodiles and hippos present as well as other large terrestrial mammals.* ▪ *Limited historical water quality data.*

Table 2.9 Characteristics and view of EWR 7

Site information	Detail	Illustration
EWR site	*EWR 7*	
Name	*Letaba Bridge*	
River	*Groot Letaba*	
Co-ordinates	*S 23.80983 E 31.59081*	
MRU	*MRU D*	
IUA	*IUA 11*	
SQ Reach	*B83D-00255*	
IEI rating	*High (3)*	
WRUI rating	*High (3)*	
Hotspot rating	*High (3)*	
EWR site advantages: ▪ *Uniform flow conditions over a wide range of discharges. Bed composed predominantly of sand and gravels with imbedded larger material (cobbles), resulting in reasonably uniform flow resistance as a function of stage.* ▪ *The dynamics of vegetation change appear to be largely natural.* ▪ *Diverse habitat with a deep pool that will act as refugia during droughts.* ▪ *Good habitat diversity.* ▪ *No major impacts in water quality in the KNP.*		**EWR site disadvantages:** ▪ *Mobile bed material results in changes to the channel morphology over time. Difficult to measure medium to high flows using manual flow gauging due to the wide channel. A small riffle feature (containing gravels) is a temporary feature and becomes drowned-out at low flows.* ▪ *Reduction in frequency, magnitude and duration of moderate and large floods and severe reduction in low flows and increase in zero flow periods.* ▪ *The lower riparian zone has a substantial loss of cover and abundance along the flood terraces due to the 2000 floods. Flow pattern changes have resulted in encroachment into the lower riparian zone.* ▪ *Stones in current and riffle habitat limited.* ▪ *Limited historical water quality data.* ▪ *Crocodiles and hippos present as well as other large terrestrial mammals.*

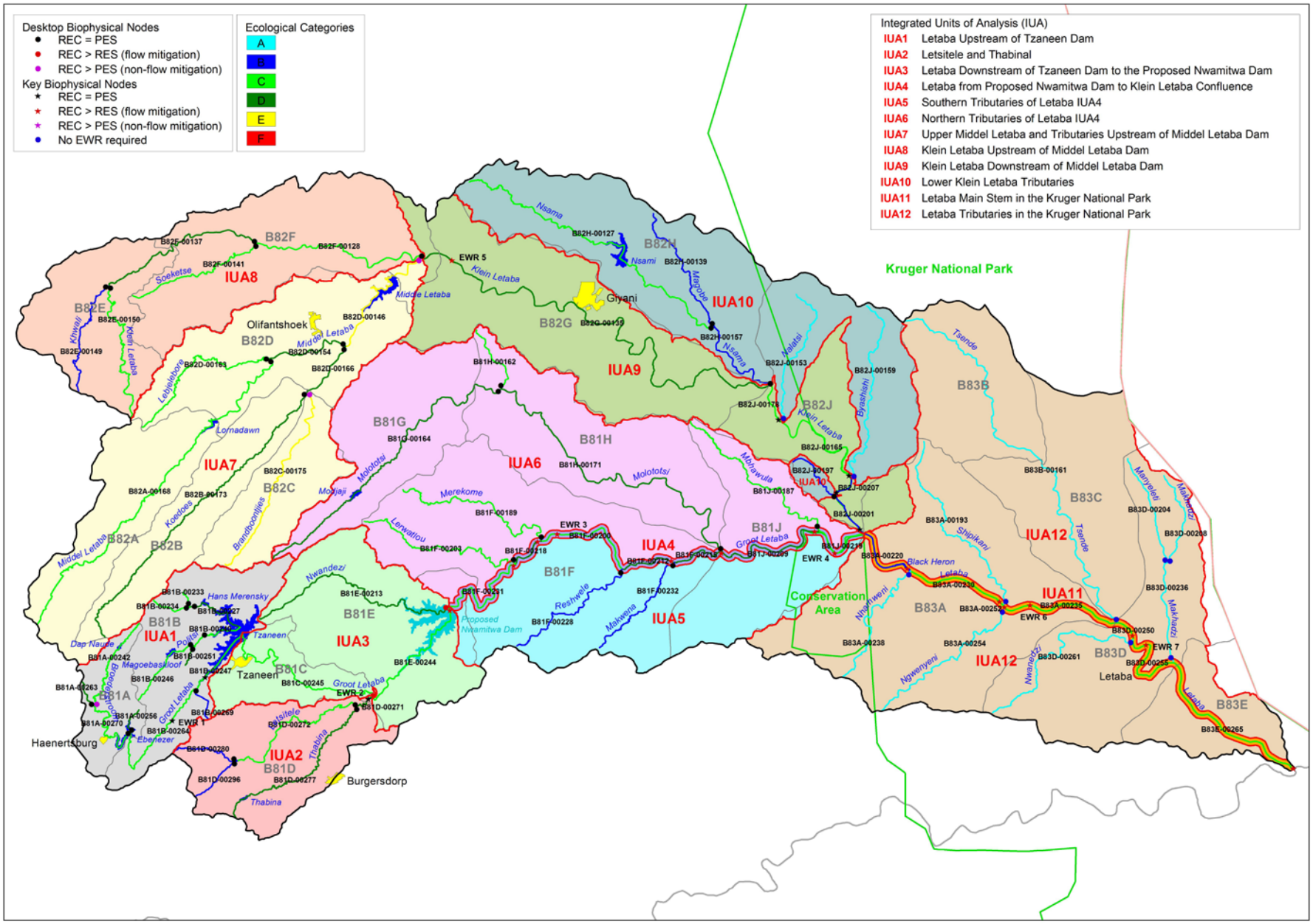

Figure 2.1 Locality of the chosen EWR sites in the Letaba catchment

3 ECOCLASSIFICATION RESULTS AT EWR SITES

A summary of the EcoClassification results (DWAF, 2006b) are provided in Appendix A. The current suite of EcoClassification models (Kleynhans and Louw, 2007) were not available during 2004 when the EcoClassification results were generated. The updated EcoStatus models (Kleynhans and Louw, 2007) were populated with the 2004 data, the PESEIS 2011 data (DWA 2013b) (referred to as PES (11)) and any additional data that may be readily available. The information is summarised in Table 3.1 to Table 3.6. Most of the changes from 2004 to 2013 are due to new or updated EcoStatus models that do not necessarily indicate a change in PES. Table 3.8~~Table 3.~~7 illustrates the PES EcoStatus for 2004 (Level IV), 2011 (desktop level) and 2013 (Level IV). Table 3.7~~Table 3.8~~ shows a summary table for the 2013 PES which is the data used for scenario evaluation.

3.1 EWR 1 APPEL PES

Table 3.1 EWR 1: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*B*	*B*	*2004 assessment data was converted to populate the Physico-chemical Driver Assessment Index (PAI) model.*
Geomorphology	*C/D*	*C/D*	*No EC change.*
Fish	*C*	*C*	*Estimated to be in a lower C due to esp. impact of alien predatory species and flow modification. PES (11): Instream = C.*
Invertebrates	*C/D*	*C*	*Slight increase – potentially related to better water quality.*
Riparian vegetation	*C*	*C*	▪ *Channel has narrowed and vegetation encroached, likely due to reduced low flows and mostly an expansion of marginal and lower zone vegetation.* ▪ *Marginal and lower zone vegetation were scoured by 2000 floods.* ▪ *Invasion by alien vegetation was high, especially Arundo donax and forestry species.* ▪ *Impacts due to forestry were "Serious".* ▪ *Vegetation removal was "Moderate".*
EcoStatus	*C*	*C*	*The updated EcoStatus model resulted in the same EcoStatus category.*

3.2 EWR 3 PRIESKA PES

Table 3.2 EWR 3: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*C*	*B/C*	*2004 assessment data was converted to populate the PAI model. Changes were due to different model applications.*
Geomorphology	*C (63%)*	*D (56%)*	*The new Geomorphological Driver Assessment Index (GAI) model scores reduced sediment supply and reduced flood flows more severely than the previous model, hence the change in EC. The D EC is a more accurate representation of the geomorphology of this reach.*
Fish	*C*	*C*	*Desktop PES (11): Instream = D. Fish however estimated to be in similar condition as described in 2004, except for Barbus eutaenia possibly still being present (sampled in upstream reach in 2012/3).*
Invertebrates	*D*	*C*	*Increase of PES score due to refinement of the Macro Invertebrate Response Assessment Index (MIRAI).*
Riparian vegetation	*D*	*C/D*	▪ *Channel has narrowed and vegetation encroached, likely due to reduced low flows and moderate floods.* ▪ *Marginal and lower zone vegetation were scoured by 2000 floods.* ▪ *Woody bank species notably reduced by agricultural encroachment.* ▪ *Vegetation removal was "Moderate".*
EcoStatus	*C/D*	*C*	*The updated EcoStatus models for all components resulted in*

Component	PES (04)	PES (13)	Comment
			different categories therefore resulting in a different EcoStatus category.

3.3 EWR 4 LETABA RANCH PES

Table 3.3 EWR 4: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*B/C-C*	*B/C*	*2004 assessment data was converted to populate the PAI model.*
Geomorphology	*C/D (61%)*	*C/D (59%)*	*No EC change.*
Fish	*C (67.81%)*	*C (67.81%)*	*Desktop PES (11): Instream = C.*
Invertebrates	*D (55.3%)*	*C (63.3%)*	*Increase of PES score due to refinement of the MIRAI - less emphasis on bedrock habitats and very high flows. Lower South African Scoring System (SASS) scores, but Average Score Per Taxon (ASPT) scores similar to natural conditions.*
Riparian vegetation	*D*	*C*	▪ *Dynamic reach with notable vegetation changes over time.* ▪ *Channel has narrowed, likely due to reduced low flows and moderate floods.* ▪ *Mostly an expansion of marginal and lower zone vegetation, upper zone vegetation has been stable over time.* ▪ *Lower zone vegetation cover notably reduced.* ▪ *Woody bank species composition and structure close to reference.*
EcoStatus	*C/D*	*C*	*The updated EcoStatus models for all components resulted in different categories therefore resulting in a different EcoStatus category.*

3.4 EWR 7 LETABA BRIDGE PES

Table 3.4 EWR 7: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*B - C*	*B*	*2004 assessment data was converted to populate the PAI model.*
Geomorphology	*C (77%)*	*C (66%)*	*No EC change, but the new GAI model scores reduced sediment supply and reduced flood flows more severely than the previous model, hence the reduced score.*
Fish	*C (69.09%)*	*C (65.07%)*	*Desktop PES (11): Instream = C.*
Invertebrates	*D (53.6%)*	*C (67.1%)*	*Increase of PES score due to refinement of the MIRAI - less emphasis on bedrock habitats and very high flows. Lower SASS scores, but higher ASPT scores relating to natural conditions.*
Riparian vegetation	*C*	*C*	▪ *Stable reach with small vegetation changes over time.* ▪ *Reduced low flows and moderate floods.* ▪ *Lower zone vegetation cover notably reduced.* ▪ *Woody bank species composition and structure close to reference.* ▪ *Species richness and composition close to reference.*
EcoStatus	*C*	*C*	*Although there were minor changes in some of the components, the EcoStatus remained in a C EC.*

3.5 EWR 2 LETSITELE PES

Table 3.5 EWR 2: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*C/D - D*	*C*	*2004 assessment data was used to populate the PAI model; integrated water quality was 72.4% (C category). A check was run using Water Management System (WMS) data up to 2013; to ensure that the same category would be attained. Although the category is still a C, an adjustment was made to 69.0%.*

Component	PES (04)	PES (13)	Comment
Geomorphology	*D/E*	*D*	*The new GAI model scores reduced sediment supply and reduced flood flows more severely than the previous model, and down weights riparian vegetation condition and morphological dynamics relative to the old model. These differences in weighting, and refined data availability (PES (11) data suggests moderate impacts only), account for the change in EC.*
Fish	*C*	*C/D*	*Water quality potentially deteriorated. Desktop PES (11): Instream = D.*
Invertebrates	*D (48.1%)*	*C (63.8%)*	*Increase of PES score due to refinement of the MIRAI - habitat evaluated - better than initial assessment.*
Riparian vegetation	*D/E*	*D*	▪ *Channel has narrowed and vegetation encroached, likely due to reduced low flows and mostly an expansion of marginal and lower zone vegetation.* ▪ *Marginal and lower zone vegetation were scoured by 2000 floods.* ▪ *Woody bank species dominated by a few large individuals with an absence of recruitment and younger individuals.* ▪ *Vegetation clearing evident.* ▪ *Invasion by alien vegetation was "Large".* ▪ *Vegetation removal was "Large".* ▪ *Channel remains narrowed and encroached and impacted by urbanisation.*
EcoStatus	*D*	*D*	*Although there were changes in some of the components, the EcoStatus remained in a D EC.*

3.6 EWR 5 KLEIN LETABA PES

Table 3.6 EWR 5: PES using the updated EcoStatus suite of models

Component	PES (04)	PES (13)	Comment
Physico chemical	*B/C - C*	*B/C*	*2004 assessment data was used to populate the PAI model; integrated water quality was 77.6% (B/C category). A check was run using WMS data up to 2013; to ensure that the same category would be attained.*
Geomorphology	*C (63%)*	*C (60%)*	*No EC change, but the new GAI model scores reduced sediment supply and reduced flood flows more severely than the previous model, hence the reduced score.*
Fish	*C*	*C*	*Slightly lower in category based on expected present status of fish assemblage. Desktop PES (11): Instream = D.*
Invertebrates	*D*	*C/D*	*Increase of PES score due to refinement of the MIRAI - habitat evaluated - better than initial assessment.*
Riparian vegetation	*B/C*	*C*	▪ *Channel has narrowed, likely due to reduced low flows and moderate floods.* ▪ *Mostly an expansion of marginal and lower zone vegetation, upper zone vegetation has been stable over time.* ▪ *Lower zone vegetation cover notably reduced.* ▪ *Woody bank species composition and structure close to reference with some targeted woody removal.* ▪ *Marginal and lower zone vegetation scoured by 2000 floods* ▪ *Alien tree invasion small.*
EcoStatus	*C*	*C*	*Although there were changes in some of the components, the EcoStatus remained in a C EC.*

3.7 PES ECOSTATUS SUMMARY (2004, 2011, 2013)

The table below compares the PES EcoStatus determined during the different studies.

Table 3.7 Comparison of PES EcoStatus

EWR sites	PES (04)	PES (11)	PES (13)
EWR 1	**C**	**C**	**C**
EWR 3	**C/D**	**C**	**C**
EWR 4	**C/D**	**C**	**C**

EWR 7	C	C	C
EWR 2	D	D	D
EWR 5	C	D	C

Table 3.8 Summary of 2013 PES (Level IV) results

Component	EWR 1	EWR 3	EWR 4	EWR 7	EWR 2	EWR 5
Physico chemical	B	B/C	B/C	B	C	B/C
Geomorphology	C/D	D	C/D	C	D	C/D
Fish	C	C	C	C	C/D	C
Invertebrates	C	C	C	C	C	C/D
Riparian vegetation	C	C/D	C	C	D	C
EcoStatus	C	C	C	C	D	C

4 EWR RESULTS AT EWR SITES

4.1 2006 EWR RESULTS

As indicated in the inception report, the EWRs undertaken during 2004 (DWAF, 2006b) were not stored in the SPATSIM format and it will therefore not be possible to use the results for scenario evaluation. Furthermore, the hydrology has changed therefore the EWR rules will have to be recreated using the new hydrology as well as accommodating some of the basic changes in methods since 2006. The basic requirements for setting flows during the 2006 study were extracted from the report (DWAF, 2006b) and were used as a guideline for recreating flows. These results are summarised in Appendix B of this report.

The major changes in the results were due to the change in present day (PD) hydrology. When determining the EWRs to maintain the PES, the EWRs should not be higher than the present day flow as that would generally imply an improvement. Therefore, wherever the 2006 EWRs were higher than present day hydrology, adjustments were required.

4.2 REVISION OF EWR RESULTS

The results were generated using the measured hydraulic cross-sections and hydraulic modelling at EWR sites where the raw hydraulic cross-sectional data was available. These results and the updated hydrology were used to populate the Revised Desktop Reserve Model (RDRM) (Hughes et al., 2012) in SPATSIM. The model output for every EWR site is attached as Appendix C. The results for the low flows are provided below per EWR site (Table 4.1 to Table 4.6) and the high flows are summarised in Table 4.7 for all the EWR sites. Note that the high flows (floods) were not adjusted and were added to the revised low EWR flows. A summary of the results compared to the natural MAR (NMAR) is provided in Table 4.8. Note that EWR 6 was not used in the revision of EWRs as it is in the same RU as EWR 7 and the results at EWR 7 are of higher confidence than EWR 6.

Table 4.1 EWR 1 Appel: Low flow EWR results for PES: C

Months	Drought flows: 90% (m^3/s)	Maintenance flows: 70% (m^3/s)
OCTOBER	*0.116*	*0.141*
NOVEMBER	*0.115*	*0.149*
DECEMBER	*0.130*	*0.170*
JANUARY	*0.149*	*0.211*
FEBRUARY	*0.158*	*0.244*
MARCH	*0.182*	*0.263*
APRIL	*0.178*	*0.278*
MAY	*0.179*	*0.265*
JUNE	*0.173*	*0.257*
JULY	*0.169*	*0.235*
AUGUST	*0.152*	*0.203*
SEPTEMBER	*0.126*	*0.162*

Table 4.2 EWR 2 Letsitele Tank: Low flow EWR results for PES: C

Months	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)
OCTOBER	0.055	0.114
NOVEMBER	0.063	0.172
DECEMBER	0.101	0.279
JANUARY	0.150	0.456
FEBRUARY	0.179	0.497
MARCH	0.200	0.571
APRIL	0.160	0.490
MAY	0.183	0.479
JUNE	0.142	0.353
JULY	0.115	0.236
AUGUST	0.087	0.177
SEPTEMBER	0.069	0.129

Table 4.3 EWR 3 Prieska: Low flow EWR results for PES (C) and REC (B/C)

Months	PES		REC	
	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)
OCTOBER	0.139	0.201	0.168	0.232
NOVEMBER	0.145	0.238	0.175	0.272
DECEMBER	0.166	0.345	0.198	0.385
JANUARY	0.195	0.455	0.231	0.500
FEBRUARY	0.206	0.620	0.243	0.672
MARCH	0.215	0.724	0.252	0.780
APRIL	0.223	0.703	0.262	0.758
MAY	0.216	0.656	0.254	0.709
JUNE	0.204	0.552	0.240	0.601
JULY	0.194	0.440	0.229	0.484
AUGUST	0.173	0.322	0.206	0.361
SEPTEMBER	0.149	0.238	0.179	0.272

Table 4.4 EWR 4 Letaba Ranch: Low flow EWR results for PES (C) and REC (B/C)

	PES		REC	
Months	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)
OCTOBER	0.042	0.192	0.223	0.525
NOVEMBER	0.046	0.211	0.228	0.564
DECEMBER	0.060	0.262	0.236	0.657
JANUARY	0.080	0.305	0.230	0.727
FEBRUARY	0.087	0.368	0.228	0.818
MARCH	0.096	0.410	0.209	0.875
APRIL	0.092	0.401	0.253	0.872
MAY	0.093	0.378	0.224	0.836
JUNE	0.085	0.340	0.226	0.781
JULY	0.077	0.296	0.232	0.714
AUGUST	0.062	0.249	0.236	0.633
SEPTEMBER	0.048	0.211	0.230	0.563

Table 4.5 EWR 5 Klein Letaba: Low flow EWR results for PES: C

Months	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)
OCTOBER	0.022	0.038
NOVEMBER	0.030	0.047
DECEMBER	0.036	0.056
JANUARY	0.036	0.074
FEBRUARY	0.041	0.088
MARCH	0.047	0.085
APRIL	0.043	0.079
MAY	0.040	0.068
JUNE	0.039	0.064
JULY	0.042	0.061
AUGUST	0.039	0.054
SEPTEMBER	0.033	0.045

Table 4.6 EWR 7 Letaba Bridge: Low flow EWR results for PES (B/C) and REC (B)

Months	PES		REC	
	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)	Drought flows: 90% (m^3/s)	Maintenance flows: 60% (m^3/s)
OCTOBER	0.566	0.598	0.610	0.643
NOVEMBER	0.586	0.696	0.634	0.748
DECEMBER	0.662	0.951	0.723	1.018
JANUARY	0.755	1.299	0.837	1.386
FEBRUARY	0.805	1.473	0.890	1.570
MARCH	0.861	1.572	0.948	1.675
APRIL	0.786	1.662	0.880	1.769
MAY	0.781	1.478	0.871	1.576
JUNE	0.752	1.221	0.833	1.304
JULY	0.722	1.022	0.796	1.092
AUGUST	0.675	0.840	0.739	0.900
SEPTEMBER	0.598	0.685	0.649	0.735

Table 4.7 High flow EWR results the EWR sites

Flood Class (m^3/s)	Macro-invertebrates	Fish	Vegetation	Geomorphology	FINAL[1]	Months	Daily average (m^3/s)	Duration (days)
EWR 1: APPEL PES: C ECOSTATUS								
CLASS I (1.2 - 2.5 m^3/s)		12			2	Mar, Nov	2	2
CLASS II (2 - 5 m^3/s)	2			6	6	Nov, Dec, Jan, Feb, Mar	3.5	3
CLASS III (4.5 - 10.5 m^3/s)		1	1	2	2	Dec, Apr	8	4
CLASS IV (20 - 28 m^3/s)			1	1:2	1	Feb	20	6
EWR 3 PRIESKA PES ECOSTATUS								
CLASS I (6 - 10 m^3/s)	6	6			6	Nov, Dec, Jan, Feb, Mar, Apr	7	2
CLASS II (12 - 18 m^3/s)	2	1	3		3	Dec, Jan Mar	14	3
CLASS III (50 - 90 m^3/s)			1		1	Feb	70	4

Flood Class (m^3/s)	Macro-invertebrates	Fish	Vegetation	Geomorphology	FINAL[1]	Months	Daily average (m^3/s)	Duration (days)
CLASS IV (150 - 220 m^3/s)			1:2	1:2	1:2*	Mar	160	6
*Included as a flood of 6 days.								
EWR 3 PRIESKA REC ECOSTATUS C								
CLASS I (6 - 10 m^3/s)		8	8		8	Oct, Nov, 2x[Dec], Jan, Feb, Mar, Apr	7	2
CLASS II (12 - 18 m^3/s)	3	1	3		3	Dec, Jan Mar	14	3
CLASS III (50 - 90 m^3/s)		1	1		1	Feb	70	4
CLASS IV (150 - 220 m^3/s)			1:2	1:2	1:2	Mar	160	6
EWR 4: LETABA RANCH PES ECOSTATUS								
CLASS I (4 - 8 m^3/s)		5			5	Jan, Mar, Apr, Nov, Dec	6	3
CLASS II (10 - 22 m^3/s)	2	1	4		4	Jan, Apr, Nov, Dec	15	4
CLASS III (60 - 180 m^3/s)			1	1	1	Mar	60	6
CLASS IV (250 - 420 m^3/s)			1	1:2	1	Feb	150	6
CLASS V (650 - 1000 m^3/s			1:10		1:10			
EWR 4: LETABA RANCH REC ECOSTATUS								
CLASS I (4 - 8 m^3/s)		7			4	Jan, Apr, Nov, Dec	6	3
CLASS II (10 - 22 m^3/s)	3	1	6		6	Jan, Apr, Nov, Dec	15	4
CLASS III (60 - 180 m^3/s)			2	1	2	Dec, Jan	60	6
CLASS IV (250 - 420 m^3/s)			2	1:2	2	Feb, Mar	150	6
EWR 5: KLEIN LETABA PES AND REC ECOSTATUS C								
CLASS I (8 - 12 m^3/s)	3	1	6		6	Nov, Dec, Jan, Feb, Mar, Apr	8	2
CLASS II (14 - 25 m^3/s)		2	3	2	3	Nov, Feb, Apr	12	3
CLASS III (60 - 126 m^3/s)			1	1:2	1	Mar	60	4
CLASS IV (175 - 480 m^3/s)			1:10		1:10		150	5
EWR 7: LETABA BRIDGE PES ECOSTATUS C								
CLASS I (5 - 8 m^3/s)		7			5	3x[Dec], Jan, Apr	6	3
CLASS II (10 - 30 m^3/s)	2	2	5	3	5	Oct, Nov, Dec, Jan, Apr	15	4
CLASS III (80 - 160 m^3/s)			2*	1	2	Feb	120	6
CLASS IV (300 - 550 m^3/s)			1*	1:?	1	Feb		8
* This only happened twice a year in four years in a twenty year record - therefore only one was allocated.								
EWR 7: LETABA BRIDGE REC ECOSTATUS C								
CLASS I (5 - 8 m^3/s)		8			2		6	3
CLASS II (10 - 30 m^3/s)	3	2	6	4	6		15	4
CLASS III (80 - 160 m^3/s)			3	1	1		120	6
CLASS IV (300 - 550 m^3/s)			1	1:2	1:5			8

1 * Final refers to the agreed on number of events considering the individual requirements for each component.

Table 4.8 Summary of PES results as a percentage of the natural MAR (nMAR)

				Long term mean					
EWR site	PES	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	High flows (MCM)	High flows (%nMAR)	Total flows (MCM)	Total (%nMAR)
EWR 1	C	99.84	53.1	10.807	10.8	9.2	9.215	19.998	20
EWR 2	C	116.55	76.42	17.865	15.3	9.799	8.4	27.664	23.7
EWR 3	C	394.91	181.98	23.72	6	22.235	5.6	45.955	11.6
EWR 4	D	441.39	217.92	52.057	11.8	56.547	12.8	108.604	24.6
EWR 5	C	124.18	67.08	4.831	3.9	15.036	12.1	19.867	16
EWR 7	B/C	646.28	360.69	47.772	7.4	60.983	9.4	108.755	16.8

Table 4.9 Summary of REC results as a percentage of the natural MAR (nMAR)

				Long term mean					
EWR site	REC	nMAR (MCM)	pMAR (MCM)	Low flows (MCM)	Low flows (%nMAR)	High flows (MCM)	High flows (%nMAR)	Total flows (MCM)	Total (%nMAR)
EWR 3	B/C	394.91	181.98	31.544	8	27.04	6.8	58.584	14.8
EWR 4	B/C	441.39	217.92	39.887	9	44.857	10.2	84.744	19.2
EWR 7	B	646.28	360.69	50.173	7.8	65.165	10	115.338	17.8

4.3 EXTRAPOLATED EWRS

Additional to the six EWR sites, 18 biophysical nodes will have a flow requirement which is extrapolated from the EWR at the EWR sites. The EWR sites and its requirements therefore act as surrogates for these nodes. Therefore, if the system is managed for the EWR sites, these 18 biophysical nodes will be catered for. The nodes are listed in Table 4.10 and due to the higher confidence than desktop level, these nodes are also key biophysical nodes.

Table 4.10 Biophysical nodes

Node name	River	Extrapolated from
B81B-00247	Great Letaba	EWR 1
EWR 1	Great Letaba	
B81C-00245	Great Letaba	EWR 3
EWR 2	Letsitele	
B81E-00244	Great Letaba	EWR 3
EWR 3	Great Letaba	
B81F-00212	Great Letaba	EWR 3/4
B81F-00215	Great Letaba	EWR 3/4
B81F-00218	Great Letaba	EWR 3/4
B81F-00231	Great Letaba	EWR 3/4
B81J-00209	Great Letaba	EWR 4
EWR 4	Great Letaba	
EWR 5	Little Letaba	
B82J-00165	Little Letaba	EWR 5
B82J-00178	Little Letaba	EWR 5
B82J-00201	Little Letaba	EWR 5

Node name	River	Extrapolated from
B82J-00207	Little Letaba	EWR 5
B83A-00220	Letaba	EWR 4/7
B83A-00230	Letaba	EWR 7
EWR 6	Letaba	EWR 7
B83A-00252	Letaba	EWR 7
B83D-00250	Letaba	EWR 7
EWR 7	Letaba	
B83E-00265	Letaba	EWR 7

5 DESKTOP BIOPHYSICAL NODES: RESOURCE UNITS, LOCALITY AND ECOCLASSIFICATION

5.1 DESKTOP RESOURCE UNITS

The Sub-Quaternary river reaches (SQs) as indicated in http://www.dwa.gov.za/iwqs/gis_data /river/rivs500k.html and http://www.dwa.gov.za/iwqs/gis_data/river/River_Report_01.pdf, forms the basis of the PES (11) (DWA 2013b) assessment. A SQ changes when a significant tributary joins it. This means that a SQ may potentially be subdivided into various EcoRegions, geomorphic zones (slope zones) resource units (natural or management), etc. Such subdivisions are not addressed on a desktop level, and may be required when higher confidence assessments are done. The version of the 1:500 000 coverage that was used for the PES (11) (DWA, 2013b), was a version used by the National Freshwater Ecosystem Priority Areas (NFEPA) project in 2009 (Nel et al., 2011).

The SQs at desktop levels are therefore surrogates for desktop level Resource Units. These SQs are illustrated in Figure 2.1.

5.2 DESKTOP BIOPHYSICAL NODES

A desktop biophysical node represents a point at the end of the SQ for all SQs which do not contain key biophysical nodes. These desktop biophysical nodes are represented in Figure 2.1. A table with all the nodes and their coordinates, as well as providing the IUA in which they are situated, are provided in Table 5.1. The red font in the first column represents key biophysical nodes.

Table 5.1 List of all nodes and coordinates

SQ/Node Number	Latitude	Longitude	IUA
B81A-00242	-23.894766	29.929583	IUA 1
B81A-00256	-23.931493	29.986368	IUA 1
B81A-00263	-23.895447	29.926083	IUA 1
B81A-00270	-23.936362	29.980707	IUA 1
B81B-00233	-23.750399	30.078479	IUA 1
B81B-00234	-23.753964	30.075103	IUA 1
B81B-00246	-23.80922	30.083294	IUA 1
B81B-00251	-23.810231	30.084098	IUA 1
B81B-00269	-23.875012	30.088541	IUA 1
B81B-00227	-23.752474	30.087183	IUA 1
B81B-00240	-23.794011	30.102626	IUA 1
B81B-00247	-23.855169	30.103565	IUA 1
EWR 1	-23.91769	30.05083	IUA 1
B81D-00277	-23.903248	30.342586	IUA 2
B81D-00280	-23.976655	30.148145	IUA 2
B81D-00296	-23.980357	30.148578	IUA 2
EWR 2	-23.88806	30.36125	IUA 2
B81D-00272	-23.896817	30.340316	IUA 2

SQ/Node Number	Latitude	Longitude	IUA
B81C-00245	-23.881822	30.368689	IUA 3
B81E-00213	-23.755704	30.484794	IUA 3
B81E-00244	-23.759511	30.490076	IUA 3
EWR 3	-23.64939	30.66064	IUA 4
B81F-00212	-23.690558	30.842038	IUA 4
B81F-00215	-23.676692	30.920789	IUA 4
B81F-00218	-23.660284	30.629575	IUA 4
B81F-00231	-23.694532	30.592761	IUA 4
B81J-00209	-23.645784	31.06698	IUA 4
EWR 4	-23.67753	31.09864	IUA 4
B81F-00228	-23.70647	30.760409	IUA 5
B81F-00232	-23.692646	30.844333	IUA 5
B81F-00189	-23.656814	30.631966	IUA 6
B81F-00203	-23.690531	30.592164	IUA 6
B81G-00164	-23.441665	30.568091	IUA 6
B81H-00162	-23.433379	30.57215	IUA 6
B81H-00171	-23.674791	30.920013	IUA 6
B81J-00187	-23.638615	31.070883	IUA 6
B82A-00168	-23.396494	30.209032	IUA 7
B82B-00173	-23.444787	30.264024	IUA 7
B82C-00175	-23.444665	30.268783	IUA 7
B82D-00163	-23.393984	30.203419	IUA 7
B82D-00154	-23.373329	30.324541	IUA 7
B82D-00166	-23.379501	30.32529	IUA 7
B82D-00146	-23.250322	30.444398	IUA 7
B82E-00149	-23.286323	29.9532	IUA 8
B82E-00150	-23.286945	29.956688	IUA 8
B82F-00141	-23.226716	30.18857	IUA 8
B82F-00128	-23.245214	30.44833	IUA 8
B82F-00137	-23.224625	30.187538	IUA 8
EWR 5	-23.25081	30.49572	IUA 9
B82J-00165	-23.56419	31.122732	IUA 9
B82J-00178	-23.483144	31.009724	IUA 9
B82J-00201	-23.642554	31.138075	IUA 9
B82J-00207	-23.588957	31.101152	IUA 9
B82H-00127	-23.347941	30.906261	IUA 10
B82H-00139	-23.346229	30.907711	IUA 10
B82H-00157	-23.43102	30.996622	IUA 10
B82J-00153	-23.482271	31.016436	IUA 10
B82J-00159	-23.565796	31.127522	IUA 10

SQ/Node Number	Latitude	Longitude	IUA
B82J-00197	-23.595182	31.097251	IUA 10
B83A-00220	-23.699633	31.213023	IUA 11
B83A-00230	-23.747566	31.358652	IUA 11
EWR 6	-23.75264	31.40731	IUA 11
B83A-00252	-23.755554	31.36645	IUA 11
B83D-00250	-23.796087	31.569096	IUA 11
EWR 7	-23.80983	31.59081	IUA 11
B83E-00265	-23.988813	31.825606	IUA 11
B83A-00193	-23.749066	31.366869	IUA 12
B83A-00238	-23.704821	31.21554	IUA 12
B83A-00254	-23.759709	31.36382	IUA 12
B83B-00161	-23.773025	31.543311	IUA 12
B83D-00204	-23.687242	31.62259	IUA 12
B83D-00208	-23.687503	31.625239	IUA 12
B83D-00261	-23.806724	31.566234	IUA 12
B83D-00236	-23.828386	31.630159	IUA 12

5.3 DESKTOP ECOCLASSIFICATION

The PES (11) (DWA, 2013b) results were used to derive the Recommended Ecological Category (REC) (Table 5.2) at the desktop biophysical nodes. In cases where the importance (IEI - Integrated Environmental Importance) is high or very high, an improved REC is recommended. The estimated EWR from the RDRM is linked to the REC and these results are provided in the following chapters. It must however be noted that if the REC is not based on an improved flow regime, the EWR for the PES is used. Information is also supplied on what will be required to achieve the REC as well as whether this is attainable (Column 6 and 7 in Table 5.2.).

Table 5.2 summarises the results for the desktop biophysical nodes (DWA, 2013a) and forms the basis for the EWR estimation (see Chapter 6 and 7). Note that biophysical nodes which fall in it totality in the Kruger National Park or other protected areas are not included for EWR estimation and are excluded from the table below. If information is required on any of these nodes, please refer to DWA (2013a).

Table 5.2 Summary of results for the desktop biophysical nodes

Node name	River	PES (EC)	IEI	REC	REC Comment	Improvement attainable?	RDRM
B81A-00242	Broederstroom	C	3	B	The EIS is high and warrants improvement to a B. This would require better management of forestry especially in the riparian zone, i.e. non-flow related mitigation.	Yes.	C
B81A-00256		D	3	D			D
B81A-00263		D	2	D			D
B81A-00270	Broederstroom	C	5	C			C

Node name	River	PES (EC)	IEI	REC	REC Comment	Improvement attainable?	RDRM
B81B-00233	Mahitse	C	4	C			C
B81B-00234	Mahitse	C	3	C			C
B81B-00246	Politsi	C	5	C			C
B81B-00251		D	2	D			D
B81B-00269	Morudi	B	5	B			B
B81B-00227	Mahitse	D	3	D			D
B81B-00240	Politsi	C	3	C			C
B81D-00277	Thabina	D	3	D			D
B81D-00280	Bobs	B	5	B			B
B81D-00296	Mothlaka-Semeetse	B	5	B			B
B81D-00272	Letsitele	C	5	C			C
B81E-00213	Nwanedzi	D	3	C	Flow is mostly from abstractions, small farm dams etc. Improvement will require catchment management and operation of the system through restrictions at times. Irrigation return flows and urban runoff must be managed and this might improve water quality. Success probably dependant on addressing other non-flow related aspects as well.	Yes.	C
B81F-00189	Merekome	C	3	C			C
B81F-00203	Lerwatlou	C	3	C			C
B81F-00228	Reshwele	B	4	B			B
B81F-00232	Makwena	B	4	B			B
B81G-00164	Molototsi	D	2	D			D
B81H-00162	Metsemola	C	3	C			C
B81H-00171	Molototsi	D	2	D			D
B81J-00187	Mbhawula	C	3	C			C
B82A-00168	Middel Letaba	C	3	C			C
B82B-00173	Koedoes	D	2	D			D
B82C-00175	Brandboontjies	E	3	D	To improve this to a D, some dams have to be removed, erosion as to be adjusted and water quality from irrigation return flows and urban areas to be addressed.	No, but as one cannot set flows for an E (as deemed unsustainable), the REC must be a D.	
B82D-00163	Lebjelebore	C	3	C			C
B82D-00154	Middel Letaba	D	2	D			D
B82D-00166	Mosukodutsi	D	2	D			D
B82E-00149	Khwali	B	5	B			B
B82E-00150	Little Letaba	C	3	C			C
B82F-00141	Soeketse	C	3	C			C
B82F-00128	Little Letaba	C	3	C			C
B82F-00137	Little Letaba	D	2	D			D
B82H-00127	Nsama	C	3	C			C

Node name	River	PES (EC)	IEI	REC	REC Comment	Improvement attainable?	RDRM
B82H-00139	Magobe	B	4	B			B
B82H-00157	Nsama	B	4	B			B
B82J-00197	Ka-Malilibone	B	4	B			B

6 DESKTOP BIOPHYSICAL NODES: APPROACH TO ESTIMATING EWRS AND RESULTS

6.1 BACKGROUND

The Desktop Reserve Model (DRM) of Hughes and Hannart (2003) has been extensively used over the last decade for estimating EWRs in this and other countries. The estimation of EWRs in this study makes use of a RDRM, that more explicitly includes the links and relationships between hydrology, hydraulics and ecological response. The RDRM was developed under a Water Research Commission (WRC) project, and is documented in Hughes et al. (2012) and Hughes et al. (in press).

6.2 APPROACH

6.2.1 Biophysical nodes and associated information provided

The SQ catchments requiring Desktop EWR assessments were provided by Rivers for Africa, together with the PES and REC. So-called 'biophysical nodes' are located at the SQ catchment outlets, and of the 38 nodes requiring Desktop EWRs, only one node[1] has an improved REC relative to the PES. The SQs are labelled according to their quaternary and NFEPA[2] codes. Also provided (of relevance to Desktop EWR estimation) included a broad assessment of the relative importance of the fundamental drivers[3] that influence the overall SQ PES, and the numerical rating[4] for flow modification activities. The PES, relative assessment of driver impacts, and rating of flow modification activities are from the national desktop Present Ecological Status, Ecological Importance and Ecological Sensitivity (DWA, 2013b).

6.2.2 SPATSIM setup

THE RDRM runs within the Spatial and Time Series Information Modelling (SPATSIM) software. A new SPATSIM application was setup for the Letaba River catchment, with Geographical Information System (GIS) coverages for the SQ catchments, rivers, major dams, biophysical nodes and EWR sites (refer to Figure 6.1). In Figure 6.1 the SQ catchments associated with biophysical nodes (requiring Desktop EWRs) are outlined darker (and labelled using the NFEPA numerical codes), and nodes are located at catchment outlets.

In this SPATSIM application, the biophysical nodes are labelled using the NFEPA code unique to each SQ catchment. For example, biophysical node B81A-00242 is labelled 242. The RDRM application setup is readily transferable to other computers running SPATSIM.

1 B81E-00213.
2 National Freshwater Ecosystem Priority Areas Project (http://bgis.sanbi.org/nfepa/project.asp). The numerical NFEPA codes are unique to each SQ at a national level.
3 Including hydrological (i.e. flow-related), water quality, and non-flow related impacts.
4 Scale 0 to 5 for change from reference, where 0 is none, 3 is moderate and 5 is critical.

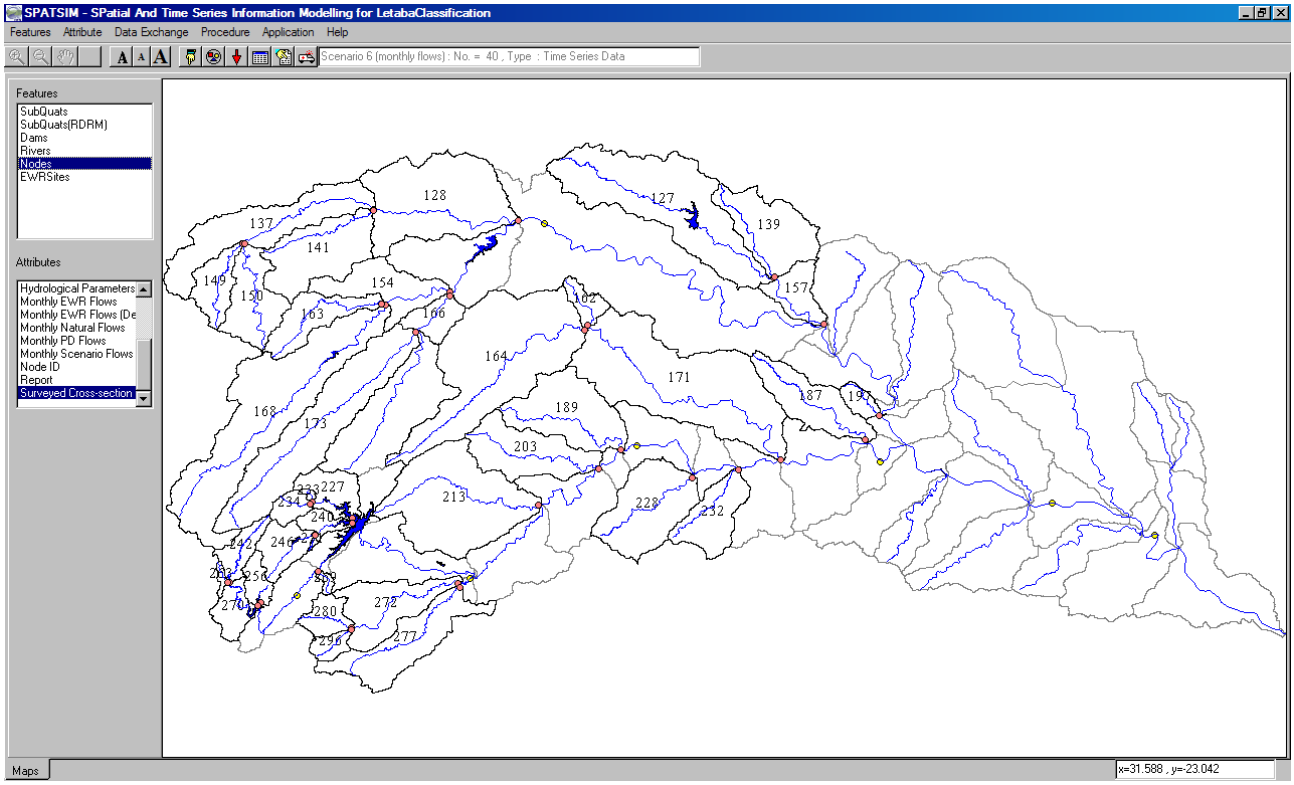

Figure 6.1 The Letaba River Catchment Classification Project visual setup in SPATSIM, showing the SQ catchments, rivers, major dams, biophysical nodes (light red) and EWR sites (yellow).

6.2.3 Data requirements and assessment

The RDRM, run as a Desktop Application[5], has the following minimum data requirements:

- *Hydrology[6]*
  - *Timeseries of monthly natural flows.*
  - *Baseflow separation parameters (refer to Hughes et al., 2002).*
  - *Percentage point on the low flow-temporal exceedance for the maximum low flow.*
- *Hydraulics*
  - *Flood region.*
  - *Valley slope.*
  - *Geomorphological zone (Gz).*
  - *Catchment area.*
- *Ecology*
  - *Seasonal perenniality, viz. whether the EWR should have wet, wet and dry, or neither seasons perennial.*
  - *The stress index value (in the range 0 to 10) corresponding to the threshold discharge for the onset of fast flows (i.e. velocities ≥ 0.3 m/s).*
  - *The relative weighting of stress index-discharges for three velocity-depth classes (viz. fast-shallow, fast-intermediate, and fast-deep flows - refer to Table 6.1).*

Default parameter values were used for the following variables:

- *Hydrology*

5 It can also be applied at higher levels of Reserve determination (e.g. Rapid III, Intermediate and Comprehensive), with the use of additional information, such as, for example, surveyed cross-sectional river profiles and modelled rating relationships.

6 Provided by WRP Consulting Engineers (Pty) Ltd.

- *Percentage point (20%) on the low flow-temporal exceedance.*
- *Regionalised baseflow separation parameters.*
- *The (three) high flow EWR parameters.*

- *Ecology*
  - *The low and high flow stress index shifts (from natural) for the categories (A to D).*

In addition to the monthly natural flows, time series of PD flows were also modelled and provided (refer to footnote 6). The remaining parameters required for Desktop assessment were determined as follows:

- *Hydraulics*
  - *Valley slopes were determined using the Shuttle Remote Topography Mission[7] (SRTM) 90m Digital Elevation Model (DEM). The 1;500000 rivers coverage published by the Department of Water Affairs (DWA)[8] was re-digitised for the Letaba River Catchment using the SRTM DEM. The reason for this is to ensure that the rivers coverage corresponds to the lowest elevations in the underlying DEM, which is in-turn used to provide elevations for vertices along the river lines, and hence valley slopes. The national 25 m DEM (available from National Geo-Spatial Information (NGI), Department of Rural Development and Land Reform) was investigated, but there were data gaps in the coverage. The SRTM DEM was pre-processed[9] and drainage lines (corresponding in position to the 1:500,000 DWA rivers coverage) were digitised for the sqs requiring Desktop EWR estimation. Valley slopes were computed[10] for the rivers coverage, and due to the resolution of the underlying DEM, average slopes[11, 12] were computed upstream of the SQ catchment outlets.*
  - *The classified Gzs8 at a national level are derived directly from valley slopes, and are subject to the resolution issues associated with the 1:500,000 rivers coverage-DEM, discussed above. The GZs corresponding to the 2 km-averaged valley slopes (at the SQ catchment outlets) were determined using the gradient-Gz classification of Rountree and Wadeson (1999)[13].*
- *Ecology*
  - *For each of the SQ catchments (requiring EWR estimates), the fish species present were classified[14] into the presence or absence of six broad guilds which differ in size (small or large) and their preference for fast-flowing water (i.e. Rheophiles, Semi-rheophiles and limnophiles)[15]. Stress-index parameter values required in the RDRM were then determined for the six broad fish guilds, and are given in Table 6.1.*
  - *The need for seasonal perenniality can be inferred from the presence/absence of the fish guilds in Table 6.1. For example, if rheophilics are present, both (wet and dry seasons must be perennial; for semi-rheophilics, the wet season must be perennial; and limnophilics do not require either seasons to be perennial.*

7 http://www2.jpl.nasa.gov/srtm/
8 http://www.dwaf.gov.za/iwqs/gis_data/
9 Sinks filled and/or channels deepened
10 At the (approximately) 90 to 127 m spatial coverage of the SRTM DEM.
11 Over 2km; artificially impounded water bodies were excluded from the average slope calculations, using the DWA (major) dams GIS coverage which was verified and refined using Google Earth imagery.
12 Dams were excluded from the average slope calculations, using the DWA (major) dams coverage which was verified and refined using Google Earth imagery.
13 This results in Gzs in the hydraulic component of the RDRM that are compatible with the valley slopes from which they are derived, and no corrections are necessary.
14 By Dr P. Kotze.
15 A rheophile is an organism that requires fast-flowing water, whereas limnophiles do not.

Table 6.1 Stress-index parameter values for fish guilds used in the RDRM

Fish Guild	Wet season[1] stress-index				Dry season[1] stress-index			
	Fast threshold	Relative weight			Fast threshold	Relative weight		
		FS	FI[2]	FD		FS	FI	FD
Large rheophylics (LR)	*10*	*1*	*2*	*2*	*10*	*1*	*2*	*2*
Small rheophilics (SR)	*10*	*1*	*1*	*1*	*10*	*1*	*1*	*1*
Large semi-rheophilics (LSR)	*9*	*1*	*2*	*2*	*4*	*1*	*1*	*1*
Small semi-rheophilics (SSR)	*9*	*1*	*1*	*1*	*3*	*1*	*1*	*1*
Large limnophilics (LL)	*5*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
Small limnophilics (SL)	*4*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
None	*4*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

1 Critical period (i.e. month) *2 Fast Intermediate*

6.2.4 Modelling

The modelled Present Day (PD) hydrological time series, together with a broad assessment of the relative impacts of the drivers, PES and hydrological modification activity ratings (from the national PES-EIS project – DWA, 2013b) were used to provide an indication of whether the PD hydrology could be meaningfully used to inform the EWR requirements. For all biophysical nodes assessed, the EWR requirements were constrained to PD flows.

For three of the nodes (viz. B81F-00232, B81H-00162 and B82J-00197) the RDRM could not be used[16], and the DRM was applied.

6.3 RESULTS

The EWR results are provided in the following formats as text files named according to the biophysical node:

- *Time series of average monthly EWR flows (in 10^6 m^3) for the period 1920 to 2010 (provided electronically).*
- *Assurance rules for EWR low flows and total flows (in 10^6 m^3) (provided electronically).*
- *RDRM generated reports (Appendix C).*

A summary of low and high flow EWR requirements, including the naturalised and PD MAR is provided in Table 6.2.

Table 6.2 Summary of Desktop EWRs for the biophysical nodes in the Letaba River Catchment

Node	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
	Natural	PD		Low flows		Total flows		
				10^6 m^3	%MAR	10^6 m^3	%MAR	
B81A-00242	*23.83*	*15.16*	*C*	*3.310*	*13.9*	*5.215*	*21.9*	*RDRM*
B81A-00256	*16.34*	*12.18*	*D*	*2.499*	*15.3*	*3.573*	*21.9*	*RDRM*
B81A-00263	*5.75*	*4.00*	*D*	*0.867*	*15.1*	*1.258*	*21.9*	*RDRM*
B81A-00270	*44.47*	*29.99*	*C*	*8.447*	*19.0*	*12.043*	*27.1*	*RDRM*

16 Since the discharge at which fast flow commences is higher than the naturalised baseflow in the wet season. This is a limiting condition for use of the existing version of the RDRM.

Node	MAR (10^6 m^3)		REC	Long-term requirements				Desktop method
	Natural	PD		Low flows		Total flows		
				10^6 m^3	%MAR	10^6 m^3	%MAR	
B81B-00227	13.60	10.77	D	2.006	14.8	3.005	22.1	RDRM
B81B-00233	2.69	2.08	C	0.500	18.6	0.738	27.4	RDRM
B81B-00234	10.13	8.06	C	2.150	21.2	3.013	29.8	RDRM
B81B-00240	38.98	22.79	C	4.445	11.4	7.455	19.1	RDRM
B81B-00246	36.26	20.80	C	3.616	10.0	6.406	17.7	RDRM
B81B-00251	1.34	0.98	D	0.094	7.0	0.206	15.4	RDRM
B81B-00269	1.95	1.95	B	0.465	23.9	0.675	34.6	RDRM
B81D-00272	91.27	57.51	C	13.288	14.6	20.084	22.0	RDRM
B81D-00277	25.28	18.90	D	1.053	4.2	3.276	13.0	RDRM
B81D-00280	18.51	13.95	B	3.647	19.7	5.417	29.3	RDRM
B81D-00296	10.53	8.85	B	2.637	25.0	3.645	34.6	RDRM
B81E-00213	17.28	11.31	C	0.302	1.7	1.392	8.1	RDRM
B81F-00189	4.74	4.08	C	0.062	1.3	0.337	7.1	RDRM
B81F-00203	3.74	3.08	C	0.071	1.9	0.328	8.8	RDRM
B81F-00228	3.53	2.87	B	0.030	0.8	0.322	9.1	RDRM
B81F-00232	2.75	2.54	B	0.094	3.4	0.347	12.8	DRM
B81G-00164	16.72	14.30	D	0.072	0.4	1.110	6.6	RDRM
B81H-00162	0.64	0.59	C	0.012	1.9	0.063	9.8	DRM
B81H-00171	25.84	22.60	D	0.254	1.0	1.671	6.5	RDRM
B81J-00187	2.53	2.53	C	0.014	0.5	0.247	9.8	RDRM
B82A-00168	31.12	25.07	C	4.339	13.9	7.564	24.3	RDRM
B82B-00173	23.13	15.76	D	1.377	6.0	2.848	12.3	RDRM
B82D-00154	40.53	32.96	D	3.527	8.7	7.025	17.3	RDRM
B82D-00163	4.90	4.29	C	0.818	16.7	1.261	25.8	RDRM
B82D-00166	42.25	27.77	D	1.776	4.2	4.296	10.2	RDRM
B82E-00149	4.51	4.02	B	0.126	2.8	0.624	13.9	RDRM
B82E-00150	3.48	3.08	C	0.037	1.1	0.558	16.0	RDRM
B82F-00128	32.13	30.26	C	1.595	5.0	4.962	15.4	RDRM
B82F-00137	13.64	12.42	D	0.063	0.5	1.319	9.7	RDRM
B82F-00141	7.32	7.19	C	0.115	1.6	0.935	12.8	RDRM
B82H-00127	6.91	4.42	C	0.067	1.0	0.730	10.6	RDRM
B82H-00139	3.10	3.10	B	0.021	0.7	0.463	14.9	RDRM
B82H-00157	11.72	9.21	B	0.202	1.7	1.683	14.4	RDRM
B82J-00197	0.66	0.64	B	0.023	3.5	0.091	13.8	DRM

7 LINK OF EGSA TO IMPROVED ECOLOGICAL CATEGORY

All biophysical nodes where improvements are required were assessed to determine how the EGSAs will respond to this improvement. The results are summarised below.

7.1 EWR 4

This site is in a nature reserve and as such the utilisation of provisioning services is very limited, however regulating services remain of some importance.

From a geomorphological perspective the REC should result in higher flows, more frequent flushing of riffles and thus an increase in in-stream habitat conditions. This could positively impact the aesthetic qualities of the river and this may have some importance for recreational utilisation. Malaria may be reduced as flows will be increased and as such habitat reduced. This potentially has a positive impact for people in the reserve.

High level of tourism is present in this reach. Acceptable perennial flows are advantageous for eco-tourism regarding the aesthetic qualities. A healthy ecosystem will support a more diverse biota which is also beneficial for tourist experiences.

7.2 EWR 7

This site is in the Kruger National Park and as such the utilisation of provisioning services is very limited, however regulating services remain of some importance.

From a geomorphological perspective the REC should result in higher flows, more frequent flushing of riffles and thus an increase in in-stream habitat conditions. This could positively impact the aesthetic qualities of the river and this may have some importance for recreational utilisation. Malaria may be reduced as flows will be increased and as such habitat reduced. This potentially has a positive impact for people in the reserve.

As a high level of tourism is present in this reach acceptable perennial flows are advantageous for eco-tourism regarding the aesthetic qualities. A healthy ecosystem will support a more diverse biota which is also beneficial for tourist experiences.

7.3 B81A-00242

This is approximately 15 km stretch of river that is exclusively rural, with no towns or villages noted. Near total dominant land-use is formal plantation forestry, including associated infrastructure (buildings, roads and small dams). Recreational utilisation is probably of relatively high importance, including fishing and hiking although the use of botanical species is likely to be limited. This SQ is largely impacted by encroaching forestry and alien vegetation within the riparian zone. Removal of forestry species from wetland and riparian areas and improving buffers where possible will improve riparian zone continuity and reduce wetland/riparian modification. However as utilisation of botanical species is low this will probably not result in major benefits.

Management of nutrient levels (from irrigation and settlements) and water abstraction (lower flows exacerbate water quality issues) will improve the present state of water quality; probably to a B EC. This would have potentially positive impacts for downstream users who depend on the river for direct abstraction.

From the perspective of fish, due to the presence of the aggressive predatory alien trout in this reach, it is estimated that most indigenous species may be eradicated. The indigenous species has no/limited utilization potential (no angling) and hence the primary utilization of the fish resource is recreational fishing of the alien trout. An ecological improvement towards the REC may therefore require eradication/decrease of trout and hence a decrease in the utilization potential of the reach.

Flood attenuation and sediment trapping should improve in the medium term and this would be a net benefit as floodplain and wetland sections will be restored. The valley bottom wetlands, including some floodplain sections, have historically been converted to forestry. The REC will result in the restoration of large wetland areas through the removal of forestry from wetland and riparian areas. This will improve habitat diversity, flood attenuation and most importantly streamflow and water provision to downstream reaches. Again this would potentially have a net positive benefit for ecosystems services.

The general improvement of the area through attaining the REC would probably lead to higher aesthetic values being attached to the area and this may have some impact on recreational utilisation but the impact on fishing as a recreational activity would probably be seen overall as negative as a key recreational fishing species could be negatively impacted.

7.4 B81E-00213: UPPER AREA

This is approximately 37 km stretch of river which is rural in nature with the upper half being commercial farmlands. The river is highly developed with many small dams and weirs.

Riparian vegetation will improve mainly if non-flow related impacts are addressed such as forestry (same comment as in Section 7.3 is applicable) and commercial farming activities. However utilisation of these species is probably low.

Although this area was not identified as a water quality hotspot an improvement in irrigation practices (including return flows and abstractions) should result in an improvement in overall water quality.

As flood attenuation and sediment trapping should improve in the medium term, small floodplain sections will be restored. Valley bottom wetlands (some wetlands and the riparian zone) have historically been converted to forestry. To achieve the REC, forestry should be set back from riparian and wetland areas in order to be legally compliant. This will improve habitat diversity, flood attenuation and most importantly streamflow and water provision to downstream reaches. All of these improvements would potentially have a net positive benefit for ecosystems services and downstream users.

An improvement in EC for fish will be associated with an increase in Frequency of Occurrence (FROC) of most fish species. One can therefore expect that an increase in the fish stock may increase the availability of fish for utilization.

A general improvement of the area through attaining the REC would probably lead to higher aesthetic values being attached to the area and this may have some impact on recreational activities.

7.5 B81E-00213: LOWER AREA

There is a considerable presence of townships in the lower half of the SQ - extending 16 km along the northern bank of the river including the Maleketla Townships, as well as extending 9 km along the northern bank of the river covering the Mamitwa Township. There is limited evidence of subsistence agriculture and formal agriculture is undertaken on a 16 km stretch of the river along the south bank, and both sides of the river for an additional 9 km on the lower reaches of the river.

Improved flows will improve riparian vegetation slightly (only marginal and lower zones) but non-flow related impacts are the major determinants of the PES for riparian vegetation. Since vegetation use and removal are dominant it is unlikely to manage these in a way that will improve the PES and as such little positive impact would be expected.

Management of nutrient levels (from irrigation and settlements) and water abstraction (i.e. lower flows exacerbate water quality issues) will improve the present state of water quality with net positive results downstream to users.

An improvement in EC for fish would probably be associated with an increase in FROC of most fish species and this will increase the availability of fish for utilization.

Attaining the REC would have a limited impact in the geomorphology. Some improvement of the instream habitat could be expected however. No/few wetlands in this lower, more arid reach are present and therefore no impacts on wetlands are expected from attaining the REC.

The general improvement of the area through attaining the REC would probably lead to higher aesthetic values being attached to the area and this may have some impact on recreational activities.

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9 APPENDIX A: 2006 ECOCLASSIFICATION RESULTS

Table 9.1 Summary of the EcoClassification results

EWR 1: APPEL

EIS: MODERATE
Highest scoring metrics were intolerance of instream biota to no flow and physico-chemical changes; species/taxon richness was high for a transitional zone, diversity of habitat types which included pools, rapids, runs, riffles, overhanging vegetation, waterfalls and cascades.

PES: C
The main flow related impacts are related to the various dams and weirs causing flow alteration and resulting in:
- *Lower base flows and reduction in magnitude and frequency of moderate flows.*
- *Change in water temperature due to dam releases.*
- *Habitat fragmentation affecting fish recruitment and distribution.*
- *Reduced habitat availability and decreased diversity and abundance of macro-invertebrate taxa with preferences for fast flowing and moderately fast flowing water.*
- *Reduced base flows resulting in vegetation encroachment.*

Non-flow related impacts include encroachment of alien invasive plants.

REC: C
EIS was MODERATE and the REC was set to maintain the PES.

Component	PES & REC
Hydrology	C
Physico chemical	B
Geomorphology	C
Fish	C
Invertebrates	C/D
Riparian vegetation	C
EcoStatus	C

EWR 2: LETSITELE

EIS: MODERATE
Highest scoring metrics were species richness (25 fish species expected) and the presence of four flow-dependent fish species. Letsitele River provides an important refuge for the Letaba River during low flow conditions.

PES: D
The main flow related impacts are related to the various farm dams and abstraction irrigation causing flow alteration and resulting in:
- *Lower base flows resulting in zero flow and reduction in floods.*
- *Deteriorated water quality due to increased nutrients caused by irrigation.*
- *Habitat fragmentation affecting fish recruitment and distribution.*
- *Reduction in macro-invertebrate species diversity caused by nutrient enrichment and associated benthic algal growth which limits habitats.*

Non-flow related impacts e.g. land-use changes, severe erosion, encroachment of alien invasive vegetation and vegetation removal impact the reach considerably.

REC: D
EIS was MODERATE and the REC was set to maintain the PES however geomorphology and riparian vegetation had to improve from a D/E to a Category D.

Component	PES & REC
Hydrology	C
Physico chemical	C/D
Geomorphology	D
Fish	C
Invertebrates	D
Riparian vegetation	D
EcoStatus	D

EWR 3: PRIESKA

EIS: HIGH
High diversity of habitats, the presence of the endangered crocodile (Crocodylus niloticus), the expected presence of two flow-dependent fish species (Chiloglanis pretoriae, Barbus eutaenia), provision of refugia and the high number of fish species expected (29 species).

PES: C/D
The main flow related impacts are related to river regulation (i.e. Tzaneen Dam), large instream irrigation dams and intense irrigation causing flow alteration and resulting in:
- *Change in low flows and periods of zero flow.*
- *Reduction in frequency, magnitude and duration of moderate and large floods and reduction in low flows resulting in decreased removal and scouring of sediment and vegetation from the bed of the macro-channel and less vegetation encroachment of the active channels and continual changes in riparian vegetation.*
- *Deteriorated water quality due to nutrient return flows from intensive irrigation, changes in water temperature and dissolved oxygen due to high percentage of surface area impounded by weirs.*
- *Habitat fragmentation affecting fish recruitment and distribution as well as migration.*
- *Reduced macro-invertebrate species diversity and abundance with preference for fast flowing water, reduced habitat availability.*

Non-flow related impacts include mainly pesticide use, agriculture and alien vegetation invasion.

REC: C
Improvement of PES due to **HIGH** *EIS rating. Improvement was based on improved low flows and floods which are now attainable due to the prospect of a new dam in the system with the aim of supplying EWRs as well as increasing the dam wall at Tzaneen Dam. Other improvements include better water quality, regularly maintained channel and re-established marginal and riparian vegetation.*

Component	PES	REC
Hydrology	D	C
Physico chemical	C	B
Geomorphology	C	B/C
Fish	C	B/C
Invertebrates	D	C
Riparian vegetation	D	C
EcoStatus	C/D	C

EWR 4: LETABA RANCH

HIGH

Presence of rare and endangered species such as the crocodile (C. niloticus) and the white backed night heron (Gorsachius leuconotus), diversity of habitats and the proximity of the Kruger National Park (rated as national as there are no fences).

PES: C/D

The main flow related impacts are related to river regulation (i.e. Tzaneen Dam) and instream dams as well as irrigation causing flow alteration and resulting in:

- *Lower base flows and absence of medium sized floods.*
- *Deteriorated water quality due to increased nutrients, turbidity and temperature.*
- *Reduction in middle order floods leading to loss of cover, abundance and structure in the lower riparian zone.*
- *Habitat fragmentation affecting fish recruitment and distribution as well as migration.*
- *Reduced macro-invertebrate species diversity and abundance with preference for fast flowing water, reduced habitat availability.*

Non-flow related impacts are presence of alien fish species.

REC: C

Improvement of PES due to **HIGH** *EIS rating. Improvement was based on improved low flows and floods which are now attainable due to the prospect of a new dam in the system with the aim of supplying EWRs as well as increasing the dam wall at Tzaneen Dam. Other improvements include improved water quality, a change in channel pattern and an increase in instream habitat diversity.*

Component	PES	REC
Hydrology	D	C
Physico chemical	B/C	B
Geomorphology	C/D	C
Fish	C	B/C
Invertebrates	D	C
Riparian vegetation	D	C/D
EcoStatus	C/D	C

EWR 5: KLEIN LETABA

EIC: MODERATE

Diversity of habitats, the presence of rare and endangered white-backed night heron (G. leuconotus), the saddle-billed stork (Ephippiorhynchus senegalensis) and osprey (Pandion haliaetus) as well as high diversity of riparian zone types.

PES: C

The main flow related impacts are related to river regulation (i.e. Middle Letaba Dam) and instream dams as well as irrigation causing flow alteration and resulting in:

- *Reduced flows especially base flows.*
- *Deteriorated water quality due to increased nutrients.*
- *Loss of cover, abundance and structure in the lower riparian zone.*
- *Habitat fragmentation affecting fish recruitment and distribution as well as migration.*
- *Reduction in fast and moderate flowing water reducing macro-invertebrate species abundance with preference for shallow flowing water, reduced cobble and fringing vegetation habitat availability.*

Some non-flow related impacts occur, particularly vegetation removal (chopping of mid-sized and larger trees) and subsistence agriculture. Exotic fish species occur.

REC: C

EIS was MODERATE and the REC was set to maintain the PES.

Component	PES & REC
Hydrology	D
Physico chemical	B/C
Geomorphology	C
Fish	C
Invertebrates	D
Riparian vegetation	B/C
EcoStatus	C

EWR 6: LONELY BULL

EIS: HIGH
Presence of rare and endangered species such as the crocodile (C. niloticus), white backed night heron (G. leuconotus), and saddle billed stork. Species/taxon richness; large pools are important refugia as the river stops flowing. Important conservation area – Kruger National Park.

PES: C
The main flow related impacts are related to river regulation (i.e. instream dams within KNP and rest of reach) causing flow alteration and resulting in:
- *Reduced low flows and short duration of high flows, increase in zero flow periods and reduction in frequency, magnitude and duration of moderate and large floods.*
- *Decreased removal and scouring of sediment from the bed of the macro-channel.*
- *Increased water temperature and decreased oxygen.*
- *Loss of cover and abundance in the lower riparian zone.*
- *Habitat loss. Zero flow prevents fish movement.*
- *Reduced abundance and number of taxa with preference for very fast and moderate flowing water and reduced habitat availability.*

REC: B
Improvement of PES due to **HIGH** *EIS rating. Improvement was based on restoration of low flows, no zero flows and improved water quality.*

Component	PES	REC
Hydrology	D	C
Physico chemical	C	B
Geomorphology	C	C
Fish	C	B
Invertebrates	D	C
Riparian vegetation	C	B
EcoStatus	C	B

EWR 7: LETABA BRIDGE

EIS: HIGH
Presence of rare and endangered species such as the crocodile (C. niloticus), white backed night heron (G. leuconotus), saddle billed stork, and Pels fishing owl. Species/taxon richness; large pools are important refugia as the river stops flowing. Important conservation area – Kruger National Park.

PES: C
The main flow related impacts are related to river regulation (i.e. instream dams within KNP and rest of reach) causing flow alteration and resulting in:
- *Reduced low flows, increase in zero flow periods and reduction in frequency, magnitude and duration of moderate and large floods.*
- *Decreased removal and scouring of sediment from the bed of the macro-channel.*
- *Increased water temperature and decreased oxygen.*
- *Loss of cover and abundance in the lower riparian zone.*
- *Habitat loss. Zero flow prevents fish movement.*
- *Reduced abundance and number of taxa with preference for very fast and moderate flowing water and reduced habitat availability.*

Non-flow related impacts include overgrazing, deforestation and urban runoff causing erosion and sedimentation input into rivers. Leaching of fertilizers into the river has enriched the water unnaturally with additional nutrients.

REC: B
Improvement of PES due to **HIGH** *EIS rating. Improvement was based on less low flows, no zero flows, general increase in marginal vegetation, an improvement of fish migratory routes, an improvement in water quality, more diversity of instream habitats and a deeper, more defined active channel.*

Component	PES	REC
Hydrology	D	C
Physico chemical	C	B
Geomorphology	C	B
Fish	C	B
Invertebrates	D	C
Riparian vegetation	C	B
EcoStatus	C	B

10 APPENDIX B: 2006 EWR RESULTS

10.1.1 Baseline low flow EWR requirements

A summary of the EWR requirements (DWAF, 2006b) are provided in Table 10.1.

Table 10.1 Summary of the EWR requirements

Duration	Flow (m^3/s)	Motivation
EWR 1: APPEL		**PES/REC: C** **Fish: C** **Macro-invertebrates: C/D**
		DRY SEASON
0%	*0*	**Fish:** *Zero breeding capability and very limited extremely fast shallow (FS) habitat remaining.*
5%	*0.125*	**Fish:** *Mountain stream, providing limited fast shallow habitat for survival of Barbus eutaenia and other rheophilic species.*
10%	*0.15*	**Invertebrates:** *There is enough stones-in-current habitat with fast enough velocities (0.3 m/s) and depth (>10 cm) to ensure the survival of the highly flow dependent mayfly Tricorythus sp., which was selected as an indicator species for the rheophilic macro-invertebrate community.*
30%	*0.225*	**Invertebrates:** *The river has enough flow to ensure a healthy population of the mayfly, Tricorythus sp.*
		WET SEASON
0%	*0.12*	**Fish:** *Zero breeding capability and very limited extremely FS habitat remaining.*
5%	*0.18*	**Fish:** *Mountain stream, providing limited fast shallow habitat for survival of B. eutaenia and other rheophilic species.*
20%	*0.26*	**Fish:** *Providing habitat for gonadal development and fast deep (FD) habitats and cover including inundated margins which provide for juvenile development.*
EWR 2: LETSITELE		**PES/REC: D** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
10%	*0.03*	**Invertebrates:** *There is enough stones-in-current habitat with fast enough velocities (0.3 m/s) and depth (>10 cm) to ensure the survival of the highly flow dependent mayfly Tricorythus sp., which was selected as an indicator species for the rheophilic macro-invertebrate community. This should be for a duration of not less than 10%. Higher drought flows are required in the summer months to ensure sustainability and gender equity in the Tricorythus population.*
30%	*0.29*	**Fish:** *Providing limited fast deep habitat but abundant FS cover. Improved marginal cover leading to some gonad development.*
		WET SEASON
0%	*0*	**Fish:** *Good velocities but depths remain very shallow for B. eutaenia.*
5%	*0.29*	**Fish:** *Providing limited FD habitat but abundant FS cover. Improved marginal cover leading to some gonad development.*
30%	*1.15*	**Fish:** *Providing good habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development.*
EWR 3: PRIESKA		**PES: C/D** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
0%	*0*	**Fish:** *No FD and FS habitats occur.*
10%	*0.05*	**Fish:** *FS habitat very limited but with velocities acceptable to maintain Chiloglanis pretoriae.*
40%	*0.13*	**Fish:** *Providing limited FD habitat but abundant FS cover. Improved marginal cover leading to some gonad development.*
		WET SEASON
0%	*0.13*	**Fish:** *Moderate FS habitats with good velocities to maintain C. pretoriae population in healthy conditions.*
20%	*0.25*	**Fish:** *Providing no FD habitat but abundant FS cover. Improved marginal cover leading to some gonad development.*
40%	*0.52*	**Fish:** *Providing good habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 3: PRIESKA		**REC: C** **Fish: B/C** **Macro-invertebrates: C**

Duration	Flow (m^3/s)	Motivation
		DRY SEASON
5%	*0.05*	**Fish:** *FS habitat very limited but with velocities acceptable to maintain C. pretoriae.*
10%	*0.13*	**Fish:** *FS habitat very limited but with velocities acceptable to maintain C. pretoriae.*
40%	*0.25*	**Fish:** *providing limited FD habitat but abundant FS cover. Improved marginal cover leading to some gonad development.*
		WET SEASON
5%	*0.13*	**Fish:** *Moderate FS habitats with good velocities to maintain C. pretoriae population in healthy conditions.*
10%	*0.25*	**Fish:** *Providing good habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development for indicator and other species.*
40%	*0.75*	**Fish:** *Providing good habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 4: LETABA RANCH		**PES: C/D** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
0%	*0.03*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. pretoriae.*
10%	*0.06*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. pretoriae.*
30%	*0.18*	**Fish:** *Providing limited fast deep habitat but abundant fast shallow cover. Improved marginal cover leading to some gonad development.*
		WET SEASON
0%	*0.07*	**Fish:** *Moderate FS habitats with velocities to maintain C. pretoriae populations in healthy condition.*
25%	*0.63*	**Fish:** *Providing good habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 4: LETABA RANCH		**REC: C** **Fish: B/C** **Macro-invertebrates: C**
		DRY SEASON
0%	*0.03*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. pretoriae.*
5%	*0.06*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. pretoriae.*
25%	*0.25*	**Fish:** *FD and FS providing moderate habitat for recruitment and survival. FD habitats and inundated margins available for juvenile development for indicator and other species.*
		WET SEASON
0%	*0.08*	**Fish:** *Moderate FS habitats with velocities to maintain C. pretoriae populations in healthy condition.*
10%	*0.18*	**Fish:** *Providing no FD habitat but abundant FS cover. Improved marginal cover leading to limited gonad development.*
20%	*0.63*	**Fish:** *Abundant FD and FS providing good habitat for recruitment and survival. Frequency of occurrence improving. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 5: KLEIN LETABA		**PES: C** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
0%	*0*	**Fish:** *No FD and FS habitats occur.*
10%	*0.019*	**Inverts:** *There is enough flow to ensure that the downstream riffle is covered (does not stop flowing).*
50%	*0.15*	**Inverts:** *The discharge over the riffle would be sufficient to provide a range of depths and velocities.*
		WET SEASON
0%	*0.019*	**Fish:** *No FD and FS habitats occur.*
10%	*0.026*	**Inverts:** *There is enough flow over the riffle to ensure that there is small range of velocities.*
50%	*0.335*	**Inverts:** *The discharge over the riffle would be sufficient to provide a range of depths and velocities.*
EWR 6: LONELY BULL		**PES: C** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
0%	*0*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain Chiloglanis engiops.*

Duration	Flow (m^3/s)	Motivation
10%	*0.14*	**Fish:** *Providing no FD habitat but some FS cover. Frequency of occurrence in drought conditions for C. engiops remains stable.*
35%	*0.45*	**Fish:** *FD and FS providing moderate habitat for recruitment and survival. FS habitats are deep enough to provide for juvenile development of indicator and other species.*
		WET SEASON
0%	*0.24*	**Fish:** *Moderate FS sandy habitats with velocities to maintain C. engiops populations.*
10%	*0.45*	**Fish:** *Providing some FD habitat but abundant FS cover. Improved water column cover leading to limited gonad development.*
40%	*0.625*	**Fish:** *Abundant FD and FS providing good habitat for recruitment and survival. Frequency of occurrence improving. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 6: LONELY BULL		**REC: B** **Fish: B** **Macro-invertebrates: C**
		DRY SEASON
0%	*0*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. engiops.*
5%	*0.14*	**Fish:** *Providing no FD habitat but some FS cover. Frequency of occurrence in drought conditions for C. engiops remains stable.*
30%	*0.625*	**Fish:** *FD and FS providing good habitat for recruitment and survival. FS habitats are deep enough to provide for juvenile development of indicator and other species.*
		WET SEASON
0%	*0.24*	**Fish:** *Moderate FS sandy habitats with velocities to maintain C. engiops populations.*
10%	*0.625*	**Fish:** *Providing some FD habitat but abundant FS cover. Improved water column cover leading to limited gonad development.*
40%	*2*	**Fish:** *Abundant FD and FS providing good habitat for recruitment and survival. Frequency of occurrence improving. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 7: LETABA BRIDGE		**PES: C** **Fish: C** **Macro-invertebrates: D**
		DRY SEASON
5%	*0.15*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. engiops.*
10%	*0.25*	**Fish:** *Providing no FD habitat but some FS cover. Frequency of occurrence in drought conditions for C. engiops remains stable.*
35%	*2.5*	**Fish:** *FD and FS providing moderate habitat for recruitment and survival. FS habitats are deep enough to provide for juvenile development of indicator and other species.*
		WET SEASON
5%	*0.25*	**Fish:** *Moderate FS sandy habitats with velocities to maintain C. engiops populations.*
10%	*0.5*	**Fish:** *Providing no FD habitat but abundant fast shallow cover. Improved water column cover leading to limited gonad development.*
35%	*3*	**Fish:** *Abundant FD and FS providing good habitat for recruitment and survival. Frequency of occurrence improving. FD habitats and inundated margins available for juvenile development for indicator and other species.*
EWR 7: LETABA BRIDGE		**REC: B** **Fish: B** **Macro-invertebrates: C**
		DRY SEASON
5%	*0.15*	**Fish:** *FS habitat very limited but with velocities still acceptable to maintain C. engiops.*
10%	*0.5*	**Fish:** *Providing no FD habitat but some FS cover. Frequency of occurrence in drought conditions for C. engiops remains stable.*
35%	*3.5*	**Fish:** *FD and FS providing good habitat for recruitment and survival. FS habitats are deep enough to provide for juvenile development of indicator and other species*
		WET SEASON
0%	*0.25*	**Fish:** *Moderate FS sandy habitats with velocities to maintain C. engiops populations.*
10%	*2*	**Fish:** *Providing some FD habitat but abundant fast shallow cover. Improved water column cover leading to limited gonad development.*
40%	*4*	**Fish:** *Abundant FD and FS providing good habitat for recruitment and survival. Frequency of occurrence improving. FD habitats and inundated margins available for juvenile development for indicator and other species.*

10.1.2 High flows

A summary of the high flows (DWAF, 2006b) are provided in Table 10.2.

Table 10.2 Summary of the high flows

Flood Class (m^3/s)	Macro-invertebrates	Fish	Vegetation	Geomorphology	FINAL[1]	Months	Daily average	Duration
EWR 1: APPEL PES: C ECOSTATUS								
CLASS I (1.2 - 2.5 m^3/s)		12			2	Mar, Nov	2	2
CLASS II (2 - 5 m^3/s)	2			6	6	Nov, Dec, Jan, Feb, Mar	3.5	3
CLASS III (4.5 - 10.5 m^3/s)		1	1	2	2	Dec, Apr	8	4
CLASS IV (20 - 28 m^3/s)			1	1:2	1	Feb	20	6
EWR 2: LETSITELE PES: D ECOSTATUS								
CLASS I (2.5 - 4 m^3/s)	3	8		15	10	Nov, 2x[Dec – Mar], Apr	3.5	2
CLASS II (3.5 - 6 m^3/s)		1			1	De c	4.5	2
CLASS III (15 m^3/s)				2	2	Feb, Dec	15	3
EWR 3 PRIESKA PES ECOSTATUS C/D								
CLASS I (6 - 10 m^3/s)	6	6			6	Nov, Dec, Jan, Feb, Mar, Apr	7	2
CLASS II (12 - 18 m^3/s)	2	1	3		3	Dec, Jan Mar	14	3
CLASS III (50 - 90 m^3/s)			1		1	Feb	70	4
CLASS IV (150 - 220 m^3/s)			1:2	1:2	1:2*	Mar	160	6
*Included as a flood of 6 days.								
EWR 3 PRIESKA REC ECOSTATUS C								
CLASS I (6 - 10 m^3/s)		8	8		8	Oct, Nov, 2x[Dec], Jan, Feb, Mar, Apr	7	2
CLASS II (12 - 18 m^3/s)	3	1	3		3	Dec, Jan Mar	14	3
CLASS III (50 - 90 m^3/s)		1	1		1	Feb	70	4
CLASS IV (150 - 220 m^3/s)			1:2	1:2	1:2	Mar	160	6
EWR 4: LETABA RANCH PES ECOSTATUS C/D								
CLASS I (4 - 8 m^3/s)		5			5	Jan, Mar, Apr, Nov, Dec	6	3
CLASS II (10 - 22 m^3/s)	2	1	4		4	Jan, Apr, Nov, Dec	15	4
CLASS III (60 - 180 m^3/s)			1	1	1	Mar	60	6
CLASS IV (250 - 420 m^3/s)			1	1:2	1	Feb	150	6
CLASS V (650 - 1000 m^3/s			1:10		1:10			
EWR 4: LETABA RANCH REC ECOSTATUS C								
CLASS I (4 - 8 m^3/s)		7			4	Jan, Apr, Nov, Dec	6	3
CLASS II (10 - 22 m^3/s)	3	1	6		6	Jan, Apr, Nov, Dec	15	4
CLASS III (60 - 180 m^3/s)			2	1	2	Dec, Jan	60	6
CLASS IV (250 - 420 m^3/s)			2	1:2	2	Feb, Mar	150	6
EWR 5: KLEIN LETABA PES AND REC ECOSTATUS C								
CLASS I (8 - 12 m^3/s)	3	1	6		6	Nov, Dec, Jan, Feb, Mar, Apr	8	2

Flood Class (m^3/s)	Macro-invertebrates	Fish	Vegetation	Geomorphology	FINAL[1]	Months	Daily average	Duration
CLASS II (14 - 25 m^3/s)		2	3	2	3	Nov, Feb, Apr	12	3
CLASS III (60 - 126 m^3/s)			1	1:2	1	Mar	60	4
CLASS IV (175 - 480 m^3/s)			1:10		1:10		150	5
EWR 6: LONELY BULL PES ECOSTATUS C								
CLASS I (5 - 8 m^3/s)		5			2	Dec, Apr	6	3
CLASS II (10 - 27 m^3/s)	2	2	5	3	5	Oct, Nov, Dec, Jan, Apr	15	4
CLASS III (80 - 150 m^3/s)			2*	1	1	Jan, Mar	120	6
CLASS IV (300 m^3/s)			1*	1	1:5	Feb		8
* This only happened twice a year in four years in a twenty year record - therefore only one was allocated.								
EWR 6: LONELY BULL REC ECOSTATUS B								
CLASS I (5 - 8 m^3/s)		8			2		6	3
CLASS II (10 - 27 m^3/s)	3	2	6	4	6		15	4
CLASS III (80 - 150 m^3/s)			3	1	1		120	6
CLASS IV (300 m^3/s)			1	1	1:5			8
EWR 7: LETABA BRIDGE PES ECOSTATUS C								
CLASS I (5 - 8 m^3/s)		7			5	3x[Dec], Jan, Apr	6	3
CLASS II (10 - 30 m^3/s)	2	2	5	3	5	Oct, Nov, Dec, Jan, Apr	15	4
CLASS III (80 - 160 m^3/s)			2*	1	2	Feb	120	6
CLASS IV (300 - 550 m^3/s)			1*	1:?	1	Feb		8
* This only happened twice a year in four years in a twenty year record - therefore only one was allocated.								
EWR 7: LETABA BRIDGE REC ECOSTATUS C								
CLASS I (5 - 8 m^3/s)		8			2		6	3
CLASS II (10 - 30 m^3/s)	3	2	6	4	6		15	4
CLASS III (80 - 160 m^3/s)			3	1	1		120	6
CLASS IV (300 - 550 m^3/s)			1	1:2	1:5			8

1 Final refers to the agreed on number of events considering the individual requirements for each component.

11 APPENDIX C EWR RESULTS AS RDRM OUPUT

A report is generated as part of the RDERM to provide:

- *the hydrology summary;*
- *the parameters that were adjusted from the default;*
- *and the final output results (EWR rules) for all categories.*

This report is provided for all the EWR sites in the following sections.

11.1 EWR 1: APPEL

11.1.1 Hydrology data summary

Natural Flows:					Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV	Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)					($m^3 * 10^6$)			
0.0	99.84	60.39	3.52	0.6	0	53.1	49.44	0.82	0.93
% Zero flows	0.0				% Zero flows	0.0			
Baseflow Parameters:			A	0.96	Baseflow Parameters:			A	0.96
			B	0.44				B	0.44
BFI				0.51	BFI				0.35
Hydro Index				2.4	Hydro Index				6.6

MONTH	MEAN	SD	CV	MONTH	MEAN	SD	CV
	($m^3 * 10^6$)				($m^3 * 10^6$)		
Oct	3	0.88	0.29	Oct	1.46	2.51	1.71
Nov	3.9	1.85	0.47	Nov	1.29	1.42	1.1
Dec	6.9	5.26	0.76	Dec	3.4	6.26	1.84
Jan	12.51	10.4	0.83	Jan	6.7	8.6	1.28
Feb	18.57	19.51	1.05	Feb	10.73	16.13	1.5
Mar	18.67	19.25	1.03	Mar	12.89	16.21	1.26
Apr	12.43	10.58	0.85	Apr	6.45	9.2	1.43
May	7.35	3.26	0.44	May	3.45	2.54	0.74
Jun	5.13	1.46	0.29	Jun	1.78	1.26	0.71
Jul	4.37	1.1	0.25	Jul	1.99	2.51	1.26
Aug	3.78	0.99	0.26	Aug	1.25	1.13	0.91
Sep	3.23	0.89	0.28	Sep	1.69	1.81	1.07

Critical months:	Wet Season	Apr	Dry Season	Oct
Max. baseflows (m^3/s)	2.012		1.154	

11.1.2 Hydraulics data summary

Geomorph. Zone	4
Flood Zone	9
Max. Channel width (m)	32.5
Max. Channel Depth (m)	2.33
Max. Channel Discharge (m3/s) between 101.743 and 113.290	

11.1.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	*1.4*	*0.05*
A/B	*1.5*	*0.1*
B	*1.6*	*0.15*
B/C	*1.7*	*0.2*
C	*1.8*	*0.25*
C/D	*1.85*	*0.3*
D	*1.9*	*0.35*
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress C Category Aligned		
Table of flows (m^3/s) v stress index		
Stress	**Wet Season Flow**	**Dry Season Flow**
0	*2.048*	*1.204*
1	*1.374*	*0.964*
2	*0.888*	*0.758*
3	*0.707*	*0.44*
4	*0.606*	*0.377*
5	*0.505*	*0.314*
6	*0.404*	*0.251*
7	*0.303*	*0.188*
8	*0.202*	*0.126*
9	*0.101*	*0.063*
10	*0*	*0*

11.1.4 High flow estimation summary details

No High flows when natural high flows are < 18% of total flows							
Maximum high flows are 180% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	*13.785*	*12.863*	*11.969*	*11.104*	*10.265*	*9.452*	*8.666*
Oct	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Nov	*0.315*	*0.294*	*0.274*	*0.254*	*0.235*	*0.216*	*0.198*
Dec	*1.562*	*1.457*	*1.356*	*1.258*	*1.163*	*1.071*	*0.982*
Jan	*2.849*	*2.659*	*2.474*	*2.295*	*2.122*	*1.954*	*1.791*
Feb	*3.276*	*3.057*	*2.845*	*2.639*	*2.44*	*2.246*	*2.059*
Mar	*3.002*	*2.802*	*2.607*	*2.418*	*2.236*	*2.059*	*1.887*
Apr	*1.964*	*1.833*	*1.706*	*1.582*	*1.463*	*1.347*	*1.235*
May	*0.816*	*0.761*	*0.708*	*0.657*	*0.607*	*0.559*	*0.513*
Jun	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Jul	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Aug	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sep	*0*	*0*	*0*	*0*	*0*	*0*	*0*

11.1.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows				
Long term mean flow requirements (Mill. m^3 and %MAR)				
Category	**Low Flows**		**Total Flows**	
	Mill. m^3	**%MAR**	**Mill. m^3**	**%MAR**
A	17.978	18	30.32	30.4
A/B	15.754	15.8	27.271	27.3
B	13.823	13.8	24.54	24.6
B/C	12.172	12.2	22.114	22.1
C	10.807	10.8	19.998	20
C/D	9.871	9.9	18.334	18.4
D	9.052	9.1	16.811	16.8

11.1.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**99**
Natural Total flow duration curve (mill. m^3)										
Oct	4.458	3.752	3.485	3.142	2.895	2.718	2.516	2.166	2.021	1.548
Nov	5.734	5.06	4.551	3.866	3.575	3.13	2.821	2.484	2.043	1.449
Dec	12.796	9.436	7.74	6.402	5.65	4.804	4.118	3.346	2.824	1.607
Jan	26.995	21.004	14.67	10.598	9.195	7.352	5.76	5.082	3.618	2.237
Feb	47.665	28.564	16.725	13.462	11.92	9.14	7.341	6.264	4.556	2.794
Mar	47.039	29.53	19.439	14.682	12.035	8.698	7.42	5.936	4.675	3.02
Apr	23.806	18.462	14.266	11.896	9.325	7.21	6.22	5.498	4.625	2.668
May	12.684	10.096	8.885	7.852	6.66	5.696	5.123	4.616	4.121	2.179
Jun	7.073	6.158	5.716	5.478	5.16	4.764	4.352	3.892	3.576	1.861
Jul	5.824	5.128	4.98	4.78	4.385	4.138	3.793	3.442	3.133	1.674
Aug	4.963	4.492	4.28	4.092	3.79	3.588	3.35	2.956	2.637	1.452
Sep	4.357	3.94	3.721	3.496	3.285	3.014	2.723	2.422	2.17	1.268
Natural Baseflow flow duration curve (mill. m^3)										
Oct	3.858	3.642	3.267	3.09	2.785	2.677	2.475	2.166	1.989	1.349
Nov	4.12	3.677	3.363	3.086	2.87	2.766	2.469	2.188	1.902	1.448
Dec	4.615	4.222	3.981	3.551	3.168	3.039	2.79	2.519	2.25	1.469
Jan	7.166	5.421	4.809	4.343	3.799	3.445	3.241	3.119	2.482	1.618
Feb	11.489	7.005	5.946	4.615	4.398	4.062	3.543	3.343	2.622	1.861
Mar	12.396	7.448	6.452	5.092	4.71	4.172	3.833	3.432	3.179	1.948
Apr	9.655	7.657	6.256	5.18	4.749	4.25	3.791	3.511	3.099	2.029
May	8.633	6.644	5.76	4.965	4.576	4.167	3.871	3.465	3.105	2.009
Jun	6.147	5.586	5.009	4.598	4.352	4.047	3.588	3.355	2.979	1.861
Jul	5.68	4.938	4.49	4.293	4.113	3.777	3.455	3.161	2.92	1.674
Aug	4.891	4.336	4.184	3.855	3.66	3.474	3.116	2.845	2.594	1.452
Sep	4.238	3.916	3.597	3.408	3.21	2.992	2.723	2.422	2.08	1.268
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	2.172	1.2	1	0.856	0.746	0.664	0.603	0.559	0.528	0.507
Nov	2.195	1.323	1.007	0.869	0.746	0.67	0.614	0.553	0.512	0.507
Dec	2.497	1.582	1.338	1.067	0.897	0.808	0.718	0.648	0.598	0.567
Jan	3.393	2.272	1.801	1.473	1.186	0.99	0.885	0.822	0.695	0.625
Feb	4.911	2.884	2.198	1.493	1.335	1.147	0.926	0.824	0.679	0.67
Mar	6.084	3.419	2.458	1.932	1.58	1.34	1.095	0.946	0.861	0.784
Apr	4.07	3.433	2.58	1.965	1.624	1.349	1.117	0.945	0.832	0.772

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
May	3.842	2.871	2.382	1.865	1.578	1.338	1.102	0.96	0.847	0.771
Jun	3.029	2.199	1.843	1.575	1.414	1.222	1.035	0.893	0.8	0.702
Jul	2.925	1.929	1.618	1.446	1.331	1.145	0.982	0.87	0.804	0.673
Aug	2.595	1.657	1.435	1.226	1.117	0.997	0.852	0.772	0.71	0.596
Sep	2.187	1.38	1.124	0.977	0.881	0.759	0.665	0.61	0.559	0.525
A/B Category										
Oct	1.851	1.107	0.932	0.793	0.686	0.606	0.547	0.504	0.473	0.453
Nov	1.886	1.122	0.935	0.803	0.686	0.612	0.557	0.498	0.458	0.453
Dec	2.138	1.345	1.209	0.983	0.827	0.74	0.652	0.584	0.535	0.506
Jan	2.844	1.902	1.575	1.348	1.099	0.909	0.805	0.74	0.621	0.556
Feb	4.135	2.383	1.854	1.365	1.241	1.057	0.843	0.742	0.605	0.593
Mar	5.115	2.818	2.145	1.76	1.469	1.236	0.997	0.852	0.768	0.693
Apr	3.304	2.821	2.185	1.789	1.513	1.245	1.018	0.85	0.74	0.681
May	3.17	2.371	2.022	1.7	1.469	1.233	1.004	0.864	0.755	0.682
Jun	2.56	1.837	1.604	1.44	1.315	1.126	0.943	0.804	0.712	0.622
Jul	2.483	1.624	1.434	1.326	1.235	1.053	0.894	0.783	0.716	0.598
Aug	2.217	1.406	1.288	1.128	1.034	0.916	0.775	0.695	0.634	0.531
Sep	1.871	1.179	1.032	0.902	0.813	0.694	0.604	0.55	0.501	0.468
B Category										
Oct	1.454	1.034	0.865	0.73	0.626	0.548	0.491	0.449	0.419	0.4
Nov	1.539	1.031	0.867	0.74	0.627	0.554	0.501	0.444	0.404	0.398
Dec	1.745	1.223	1.111	0.906	0.758	0.672	0.586	0.52	0.473	0.444
Jan	2.318	1.652	1.435	1.248	1.012	0.828	0.725	0.659	0.547	0.487
Feb	3.359	1.965	1.67	1.265	1.147	0.967	0.761	0.66	0.532	0.516
Mar	4.163	2.394	1.95	1.632	1.358	1.131	0.9	0.757	0.674	0.602
Apr	2.681	2.268	1.963	1.671	1.403	1.14	0.918	0.754	0.647	0.589
May	2.583	1.996	1.825	1.577	1.36	1.129	0.906	0.767	0.663	0.593
Jun	2.086	1.598	1.459	1.335	1.215	1.03	0.851	0.714	0.624	0.542
Jul	2.025	1.443	1.311	1.229	1.14	0.962	0.806	0.696	0.628	0.523
Aug	1.809	1.272	1.182	1.042	0.951	0.834	0.697	0.618	0.558	0.466
Sep	1.521	1.084	0.954	0.832	0.745	0.63	0.542	0.489	0.443	0.411
B/C Category										
Oct	1.154	0.962	0.798	0.666	0.565	0.49	0.434	0.394	0.365	0.346
Nov	1.238	0.955	0.799	0.678	0.567	0.496	0.444	0.389	0.351	0.344
Dec	1.406	1.131	1.02	0.832	0.688	0.603	0.52	0.456	0.41	0.382
Jan	1.887	1.505	1.31	1.153	0.925	0.747	0.644	0.577	0.472	0.418
Feb	2.707	1.76	1.514	1.171	1.054	0.877	0.678	0.577	0.459	0.44
Mar	3.369	2.17	1.782	1.516	1.246	1.027	0.802	0.662	0.581	0.511
Apr	2.211	2.039	1.782	1.554	1.292	1.036	0.819	0.659	0.555	0.498
May	2.12	1.801	1.657	1.464	1.251	1.025	0.807	0.671	0.571	0.504
Jun	1.692	1.457	1.331	1.236	1.116	0.934	0.758	0.625	0.536	0.462
Jul	1.639	1.325	1.2	1.134	1.045	0.87	0.718	0.609	0.54	0.448
Aug	1.46	1.174	1.084	0.959	0.868	0.753	0.62	0.542	0.482	0.402
Sep	1.227	1.006	0.878	0.762	0.676	0.565	0.481	0.429	0.385	0.354
C Category										
Oct	1.075	0.89	0.73	0.603	0.505	0.432	0.378	0.339	0.311	0.293
Nov	1.096	0.882	0.732	0.615	0.507	0.438	0.387	0.335	0.297	0.29
Dec	1.246	1.042	0.938	0.757	0.618	0.535	0.454	0.392	0.348	0.321
Jan	1.676	1.373	1.209	1.058	0.838	0.666	0.564	0.495	0.398	0.349

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Feb	2.398	1.585	1.403	1.078	0.96	0.787	0.595	0.495	0.385	0.363
Mar	2.99	1.968	1.647	1.399	1.135	0.922	0.704	0.568	0.488	0.419
Apr	1.978	1.82	1.659	1.436	1.181	0.931	0.72	0.564	0.462	0.407
May	1.887	1.632	1.536	1.351	1.142	0.921	0.709	0.575	0.479	0.415
Jun	1.501	1.329	1.23	1.136	1.017	0.838	0.666	0.535	0.448	0.382
Jul	1.453	1.214	1.106	1.04	0.949	0.779	0.629	0.522	0.453	0.372
Aug	1.293	1.081	0.998	0.876	0.785	0.672	0.543	0.465	0.406	0.337
Sep	1.101	0.929	0.805	0.693	0.608	0.501	0.42	0.369	0.326	0.297
C/D Category										
Oct	1.002	0.827	0.677	0.556	0.464	0.395	0.344	0.307	0.281	0.264
Nov	1.02	0.82	0.678	0.568	0.466	0.401	0.353	0.304	0.267	0.261
Dec	1.157	0.968	0.87	0.7	0.569	0.49	0.413	0.355	0.314	0.288
Jan	1.54	1.275	1.123	0.98	0.773	0.611	0.514	0.447	0.357	0.312
Feb	2.202	1.471	1.306	0.999	0.887	0.722	0.542	0.446	0.345	0.322
Mar	2.748	1.829	1.531	1.298	1.048	0.847	0.641	0.511	0.437	0.371
Apr	1.785	1.696	1.544	1.334	1.092	0.855	0.656	0.508	0.411	0.359
May	1.719	1.516	1.429	1.253	1.055	0.846	0.645	0.518	0.428	0.368
Jun	1.385	1.235	1.143	1.053	0.939	0.769	0.607	0.483	0.4	0.339
Jul	1.343	1.128	1.027	0.963	0.876	0.715	0.573	0.471	0.404	0.332
Aug	1.2	1.004	0.926	0.81	0.723	0.616	0.494	0.42	0.364	0.302
Sep	1.024	0.863	0.746	0.64	0.56	0.459	0.382	0.334	0.294	0.267
D Category										
Oct	0.928	0.764	0.623	0.51	0.423	0.358	0.311	0.276	0.251	0.235
Nov	0.945	0.758	0.625	0.521	0.425	0.364	0.318	0.272	0.238	0.232
Dec	1.072	0.895	0.802	0.643	0.52	0.445	0.373	0.318	0.279	0.255
Jan	1.428	1.18	1.037	0.902	0.708	0.556	0.463	0.399	0.317	0.275
Feb	2.042	1.363	1.208	0.921	0.814	0.658	0.488	0.398	0.304	0.282
Mar	2.549	1.694	1.414	1.197	0.962	0.771	0.578	0.455	0.386	0.323
Apr	1.657	1.573	1.429	1.231	1.002	0.779	0.591	0.452	0.36	0.311
May	1.594	1.405	1.322	1.156	0.969	0.771	0.582	0.461	0.377	0.321
Jun	1.284	1.143	1.056	0.97	0.861	0.701	0.547	0.43	0.351	0.297
Jul	1.245	1.044	0.948	0.886	0.803	0.651	0.517	0.42	0.356	0.292
Aug	1.112	0.928	0.854	0.745	0.662	0.56	0.446	0.375	0.322	0.267
Sep	0.949	0.798	0.688	0.588	0.511	0.417	0.345	0.299	0.262	0.236
Category Total Flow Assurance curves (mill. m^3)										
A Category										
Oct	2.172	1.2	1	0.856	0.746	0.664	0.603	0.559	0.528	0.507
Nov	2.709	1.749	1.371	1.196	1.062	0.965	0.85	0.691	0.513	0.507
Dec	5.041	3.689	3.139	2.688	2.458	2.268	1.887	1.33	0.605	0.567
Jan	8.034	6.117	5.086	4.432	4.033	3.654	3.018	2.066	0.708	0.625
Feb	10.247	7.305	5.975	4.894	4.608	4.21	3.379	2.254	0.694	0.67
Mar	10.975	7.471	5.92	5.049	4.58	4.147	3.342	2.257	0.875	0.784
Apr	7.27	6.083	4.845	4.005	3.587	3.186	2.587	1.802	0.841	0.772
May	5.17	3.971	3.323	2.711	2.393	2.1	1.713	1.316	0.851	0.771
Jun	3.029	2.199	1.843	1.575	1.414	1.222	1.035	0.893	0.8	0.702
Jul	2.925	1.929	1.618	1.446	1.331	1.145	0.982	0.87	0.804	0.673
Aug	2.595	1.657	1.435	1.226	1.117	0.997	0.852	0.772	0.71	0.596
Sep	2.187	1.38	1.124	0.977	0.881	0.759	0.665	0.61	0.559	0.525
A/B Category										

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Oct	1.851	1.107	0.932	0.793	0.686	0.606	0.547	0.504	0.473	0.453
Nov	2.366	1.52	1.275	1.109	0.981	0.887	0.778	0.627	0.459	0.453
Dec	4.512	3.311	2.889	2.496	2.284	2.102	1.743	1.22	0.542	0.506
Jan	7.175	5.49	4.641	4.109	3.756	3.395	2.795	1.901	0.633	0.556
Feb	9.115	6.508	5.378	4.539	4.296	3.915	3.132	2.076	0.62	0.593
Mar	9.679	6.599	5.375	4.668	4.268	3.855	3.094	2.074	0.781	0.693
Apr	6.29	5.295	4.298	3.692	3.345	2.959	2.39	1.65	0.748	0.681
May	4.41	3.398	2.899	2.491	2.23	1.945	1.574	1.196	0.758	0.682
Jun	2.56	1.837	1.604	1.44	1.315	1.126	0.943	0.804	0.712	0.622
Jul	2.483	1.624	1.434	1.326	1.235	1.053	0.894	0.783	0.716	0.598
Aug	2.217	1.406	1.288	1.128	1.034	0.916	0.775	0.695	0.634	0.531
Sep	1.871	1.179	1.032	0.902	0.813	0.694	0.604	0.55	0.501	0.468
B Category										
Oct	1.454	1.034	0.865	0.73	0.626	0.548	0.491	0.449	0.419	0.4
Nov	1.986	1.4	1.183	1.025	0.9	0.81	0.706	0.563	0.406	0.398
Dec	3.953	3.053	2.675	2.314	2.113	1.94	1.601	1.112	0.479	0.444
Jan	6.348	4.99	4.287	3.817	3.484	3.141	2.576	1.738	0.558	0.487
Feb	7.992	5.804	4.95	4.219	3.99	3.627	2.89	1.901	0.545	0.516
Mar	8.409	5.912	4.956	4.339	3.963	3.569	2.851	1.895	0.687	0.602
Apr	5.46	4.57	3.93	3.442	3.107	2.735	2.195	1.499	0.655	0.589
May	3.737	2.952	2.641	2.313	2.068	1.791	1.436	1.076	0.666	0.593
Jun	2.086	1.598	1.459	1.335	1.215	1.03	0.851	0.714	0.624	0.542
Jul	2.025	1.443	1.311	1.229	1.14	0.962	0.806	0.696	0.628	0.523
Aug	1.809	1.272	1.182	1.042	0.951	0.834	0.697	0.618	0.558	0.466
Sep	1.521	1.084	0.954	0.832	0.745	0.63	0.542	0.489	0.443	0.411
B/C Category										
Oct	1.154	0.962	0.798	0.666	0.565	0.49	0.434	0.394	0.365	0.346
Nov	1.652	1.298	1.092	0.942	0.821	0.734	0.634	0.5	0.352	0.344
Dec	3.455	2.828	2.47	2.138	1.945	1.78	1.461	1.005	0.416	0.382
Jan	5.626	4.603	3.956	3.536	3.218	2.893	2.362	1.578	0.483	0.418
Feb	7.005	5.321	4.556	3.911	3.691	3.344	2.653	1.729	0.471	0.44
Mar	7.309	5.433	4.57	4.027	3.663	3.288	2.612	1.718	0.593	0.511
Apr	4.789	4.174	3.606	3.197	2.873	2.515	2.004	1.35	0.562	0.498
May	3.19	2.687	2.414	2.146	1.907	1.639	1.299	0.958	0.574	0.504
Jun	1.692	1.457	1.331	1.236	1.116	0.934	0.758	0.625	0.536	0.462
Jul	1.639	1.325	1.2	1.134	1.045	0.87	0.718	0.609	0.54	0.448
Aug	1.46	1.174	1.084	0.959	0.868	0.753	0.62	0.542	0.482	0.402
Sep	1.227	1.006	0.878	0.762	0.676	0.565	0.481	0.429	0.385	0.354
C Category										
Oct	1.075	0.89	0.73	0.603	0.505	0.432	0.378	0.339	0.311	0.293
Nov	1.479	1.199	1.003	0.859	0.742	0.658	0.563	0.438	0.298	0.29
Dec	3.14	2.611	2.278	1.965	1.78	1.622	1.324	0.899	0.354	0.321
Jan	5.133	4.236	3.655	3.261	2.958	2.65	2.152	1.421	0.408	0.349
Feb	6.372	4.877	4.216	3.611	3.398	3.068	2.421	1.56	0.396	0.363
Mar	6.632	4.985	4.225	3.72	3.369	3.013	2.378	1.543	0.499	0.419
Apr	4.361	3.794	3.345	2.955	2.643	2.299	1.815	1.203	0.469	0.407
May	2.876	2.451	2.236	1.981	1.749	1.489	1.163	0.84	0.481	0.415
Jun	1.501	1.329	1.23	1.136	1.017	0.838	0.666	0.535	0.448	0.382
Jul	1.453	1.214	1.106	1.04	0.949	0.779	0.629	0.522	0.453	0.372

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Aug	1.293	1.081	0.998	0.876	0.785	0.672	0.543	0.465	0.406	0.337
Sep	1.101	0.929	0.805	0.693	0.608	0.501	0.42	0.369	0.326	0.297
C/D Category										
Oct	1.002	0.827	0.677	0.556	0.464	0.395	0.344	0.307	0.281	0.264
Nov	1.372	1.112	0.928	0.793	0.682	0.603	0.515	0.398	0.268	0.261
Dec	2.901	2.413	2.104	1.812	1.639	1.491	1.215	0.822	0.319	0.288
Jan	4.722	3.912	3.376	3.009	2.725	2.438	1.976	1.3	0.367	0.312
Feb	5.862	4.503	3.896	3.332	3.132	2.823	2.223	1.427	0.355	0.322
Mar	6.102	4.607	3.905	3.436	3.106	2.772	2.182	1.41	0.447	0.371
Apr	3.979	3.514	3.097	2.732	2.438	2.115	1.664	1.096	0.418	0.359
May	2.63	2.271	2.073	1.834	1.614	1.369	1.064	0.762	0.43	0.368
Jun	1.385	1.235	1.143	1.053	0.939	0.769	0.607	0.483	0.4	0.339
Jul	1.343	1.128	1.027	0.963	0.876	0.715	0.573	0.471	0.404	0.332
Aug	1.2	1.004	0.926	0.81	0.723	0.616	0.494	0.42	0.364	0.302
Sep	1.024	0.863	0.746	0.64	0.56	0.459	0.382	0.334	0.294	0.267
D Category										
Oct	0.928	0.764	0.623	0.51	0.423	0.358	0.311	0.276	0.251	0.235
Nov	1.268	1.026	0.853	0.727	0.623	0.549	0.466	0.359	0.239	0.232
Dec	2.671	2.22	1.934	1.662	1.501	1.363	1.108	0.746	0.284	0.255
Jan	4.346	3.597	3.102	2.762	2.498	2.23	1.804	1.18	0.325	0.275
Feb	5.397	4.143	3.582	3.059	2.872	2.584	2.03	1.296	0.314	0.282
Mar	5.623	4.241	3.591	3.157	2.848	2.536	1.991	1.279	0.394	0.323
Apr	3.668	3.24	2.853	2.513	2.237	1.934	1.515	0.99	0.366	0.311
May	2.43	2.096	1.913	1.688	1.481	1.25	0.966	0.685	0.379	0.321
Jun	1.284	1.143	1.056	0.97	0.861	0.701	0.547	0.43	0.351	0.297
Jul	1.245	1.044	0.948	0.886	0.803	0.651	0.517	0.42	0.356	0.292
Aug	1.112	0.928	0.854	0.745	0.662	0.56	0.446	0.375	0.322	0.267
Sep	0.949	0.798	0.688	0.588	0.511	0.417	0.345	0.299	0.262	0.236

11.2 EWR 2: LETSITELE

11.2.1 Hydrology data summary

Natural Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0.0	116.55	78.3	2.88	0.67
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.42
Hydro Index				3.5

Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0	76.42	72.48	0.91	0.95
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.31
Hydro Index				6

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	3.05	1.77	0.58
Nov	5.52	4.03	0.73
Dec	10.46	9.15	0.88
Jan	19.62	20.8	1.06
Feb	25.67	30.28	1.18

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	0.87	0.87	1.01
Nov	1.99	2.47	1.24
Dec	5.45	7.86	1.44
Jan	14.11	19.2	1.36
Feb	20.94	29.44	1.41

Mar	21.46	22.99	1.07		Mar	17.22	22.51	1.31	
Apr	11.92	10.67	0.89		Apr	8.24	10	1.21	
May	6.17	3.21	0.52		May	3.03	2.46	0.81	
Jun	4.06	1.56	0.38		Jun	1.64	0.95	0.58	
Jul	3.25	1.17	0.36		Jul	1.21	0.57	0.47	
Aug	2.83	1.07	0.38		Aug	0.96	0.48	0.5	
Sep	2.55	1.09	0.43		Sep	0.76	0.46	0.6	

Critical months:	Wet Season	Mar	Dry Season	Oct	
Max. baseflows (m^3/s)	2.225		0.93		

11.2.2 Hydraulics data summary

Geomorph. Zone	4
Flood Zone	9
Max. Channel width (m)	38.74
Max. Channel Depth (m)	2.67
Max. Channel Discharge (m3/s) between 135.237 and 148.069	

11.2.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	0.55	0.01
A/B	0.58	0.02
B	0.6	0.03
B/C	0.65	0.04
C	0.7	0.06
C/D	0.75	0.08
D	0.8	0.1
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress C Category Aligned		
Table of flows (m^3/s) v stress index		
Stress	**Wet Season Flow**	**Dry Season Flow**
0	2.326	0.962
1	2.126	0.908
2	1.722	0.76
3	1.382	0.676
4	1.08	0.606
5	0.821	0.472
6	0.591	0.222
7	0.444	0.166
8	0.296	0.111
9	0.148	0.055
10	0	0

11.2.4 High flow estimation summary details

No High flows when natural high flows are < 20% of total flows							
Maximum high flows are 165% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	14.604	13.701	12.818	11.955	11.112	10.288	9.482

Oct	0	0	0	0	0	0	0
Nov	1.343	1.26	1.179	1.1	1.022	0.946	0.872
Dec	2.279	2.138	2	1.865	1.734	1.605	1.479
Jan	3.336	3.13	2.928	2.731	2.539	2.35	2.166
Feb	3.202	3.004	2.811	2.622	2.437	2.256	2.079
Mar	2.5	2.345	2.194	2.046	1.902	1.761	1.623
Apr	1.311	1.23	1.151	1.073	0.997	0.923	0.851
May	0.633	0.594	0.555	0.518	0.481	0.446	0.411
Jun	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0

11.2.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows

Long term mean flow requirements (Mill. m^3 and %MAR)

Category	Low Flows		Total Flows	
	Mill. m^3	%MAR	Mill. m^3	%MAR
A	20.716	17.8	33.593	28.8
A/B	20.101	17.2	32.183	27.6
B	19.615	16.8	30.918	26.5
B/C	18.774	16.1	29.316	25.2
C	17.865	15.3	27.664	23.7
C/D	17.135	14.7	26.207	22.5
D	16.397	14.1	24.759	21.2

11.2.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Natural Total flow duration curve (mill. m^3)										
Oct	5.069	4.132	3.6	3.214	2.705	2.354	2.029	1.634	1.422	0.759
Nov	11.375	6.84	6.165	5.202	4.725	3.86	3.284	2.344	1.865	1.01
Dec	22.786	14.926	13.206	9.6	7.575	5.944	4.828	3.862	3.046	1.472
Jan	47.618	32.53	20.208	15.414	12.48	9.05	7.482	5.968	4.046	2.655
Feb	79.518	40.112	25.814	16.998	13.08	10.504	7.279	5.892	4.192	2.508
Mar	56.06	36.64	26.479	16.958	11.33	8.528	7.162	5.346	4.065	2.711
Apr	24.076	18.934	12.871	10.6	8.625	7.29	5.767	4.658	3.285	2.752
May	10.152	7.96	6.798	6.224	5.83	5.118	4.222	3.614	2.893	2.148
Jun	6.232	5.29	4.9	4.368	3.91	3.422	3.17	2.792	1.995	1.403
Jul	5.011	4.066	3.657	3.398	3.19	2.858	2.613	2.384	1.812	1.222
Aug	4.24	3.484	3.195	2.91	2.79	2.548	2.303	2.036	1.644	0.92
Sep	4.035	3.638	3.089	2.658	2.435	2.224	1.793	1.612	1.281	0.805
Natural Baseflow flow duration curve (mill. m^3)										
Oct	3.78	3.036	2.876	2.484	2.336	2.026	1.754	1.523	1.321	0.744
Nov	4.084	3.68	3.157	2.939	2.669	2.428	1.993	1.728	1.38	0.781
Dec	5.102	4.565	3.892	3.682	3.299	2.963	2.688	2.193	1.766	0.963
Jan	9.467	7.321	5.527	4.571	4.035	3.706	3.33	2.65	2.2	1.384
Feb	15.97	9.131	6.679	5.358	4.4	4.063	3.722	3.252	2.362	1.646
Mar	13.381	9.79	7.415	5.929	4.67	4.108	3.754	3.451	2.512	1.764
Apr	11.256	8.345	6.569	5.79	4.955	4.12	3.659	3.331	2.545	1.818
May	6.957	6.121	5.726	4.764	4.151	3.745	3.549	3.093	2.45	1.733

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Jun	5.253	4.996	4.371	3.885	3.571	3.315	3.107	2.724	1.995	1.403
Jul	4.745	3.96	3.614	3.284	3.087	2.714	2.593	2.372	1.812	1.222
Aug	3.957	3.296	3.114	2.89	2.79	2.376	2.236	2.036	1.622	0.92
Sep	3.573	3.096	2.806	2.61	2.415	2.18	1.793	1.612	1.281	0.805
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	2.145	1.746	1.36	0.699	0.49	0.396	0.326	0.275	0.239	0.215
Nov	2.277	1.993	1.484	0.98	0.669	0.569	0.422	0.335	0.266	0.24
Dec	2.964	2.569	2.035	1.491	1.171	0.938	0.715	0.5	0.429	0.352
Jan	4.704	4.035	3.129	2.266	1.87	1.521	1.087	0.757	0.629	0.514
Feb	6.966	4.61	3.629	2.697	2.011	1.506	1.205	0.89	0.68	0.574
Mar	5.991	5.653	4.683	3.651	2.693	1.913	1.39	1.068	0.833	0.685
Apr	5.034	4.497	3.942	3.284	2.006	1.579	1.228	0.969	0.653	0.623
May	3.792	3.51	3.257	2.477	1.994	1.598	1.232	0.935	0.762	0.624
Jun	2.923	2.701	2.233	1.617	1.357	1.144	0.912	0.701	0.575	0.495
Jul	2.699	2.248	1.781	1.22	0.991	0.8	0.675	0.572	0.483	0.383
Aug	2.314	1.889	1.495	0.968	0.761	0.603	0.516	0.447	0.37	0.315
Sep	1.769	1.673	1.46	0.803	0.525	0.432	0.337	0.296	0.29	0.241
A/B Category										
Oct	2.102	1.723	1.313	0.616	0.469	0.373	0.303	0.252	0.216	0.192
Nov	2.238	1.962	1.425	0.903	0.642	0.54	0.396	0.309	0.241	0.215
Dec	2.915	2.528	1.962	1.4	1.127	0.895	0.679	0.466	0.393	0.318
Jan	4.641	3.97	3.035	2.166	1.805	1.456	1.04	0.711	0.581	0.467
Feb	6.868	4.536	3.534	2.606	1.943	1.443	1.157	0.841	0.631	0.524
Mar	5.936	5.539	4.57	3.555	2.606	1.83	1.335	1.011	0.774	0.625
Apr	4.972	4.425	3.841	3.188	1.935	1.512	1.177	0.916	0.601	0.566
May	3.734	3.454	3.163	2.377	1.926	1.53	1.181	0.883	0.707	0.568
Jun	2.875	2.658	2.157	1.527	1.309	1.094	0.87	0.659	0.531	0.449
Jul	2.653	2.212	1.713	1.135	0.953	0.762	0.639	0.535	0.444	0.346
Aug	2.273	1.859	1.435	0.89	0.73	0.573	0.486	0.415	0.338	0.283
Sep	1.744	1.647	1.411	0.734	0.502	0.409	0.315	0.272	0.265	0.215
B Category										
Oct	2.063	1.704	1.27	0.581	0.453	0.358	0.287	0.236	0.2	0.176
Nov	2.202	1.935	1.376	0.852	0.622	0.519	0.377	0.291	0.224	0.198
Dec	2.87	2.491	1.901	1.338	1.095	0.863	0.653	0.442	0.369	0.294
Jan	4.581	3.907	2.955	2.092	1.755	1.408	1.005	0.68	0.549	0.435
Feb	6.777	4.46	3.452	2.534	1.889	1.396	1.121	0.806	0.597	0.49
Mar	5.882	5.431	4.478	3.473	2.535	1.768	1.294	0.97	0.733	0.585
Apr	4.913	4.353	3.753	3.108	1.88	1.462	1.139	0.878	0.566	0.528
May	3.68	3.401	3.082	2.301	1.873	1.48	1.144	0.846	0.669	0.53
Jun	2.831	2.619	2.093	1.464	1.271	1.056	0.84	0.629	0.501	0.418
Jul	2.612	2.181	1.657	1.078	0.925	0.735	0.614	0.508	0.418	0.321
Aug	2.237	1.833	1.385	0.838	0.708	0.551	0.465	0.393	0.316	0.261
Sep	1.721	1.623	1.371	0.689	0.486	0.392	0.299	0.256	0.248	0.198
B/C Category										
Oct	2.021	1.674	1.162	0.55	0.42	0.323	0.252	0.2	0.162	0.138
Nov	2.159	1.891	1.283	0.777	0.582	0.475	0.337	0.25	0.184	0.157
Dec	2.816	2.436	1.791	1.245	1.033	0.8	0.596	0.387	0.312	0.239
Jan	4.51	3.819	2.829	1.983	1.667	1.317	0.933	0.608	0.473	0.36

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Feb	6.669	4.36	3.336	2.427	1.797	1.306	1.047	0.729	0.518	0.409
Mar	5.825	5.304	4.357	3.349	2.414	1.647	1.209	0.88	0.638	0.487
Apr	4.844	4.256	3.628	2.989	1.784	1.366	1.061	0.793	0.482	0.436
May	3.616	3.326	2.957	2.19	1.78	1.386	1.065	0.763	0.581	0.438
Jun	2.778	2.561	1.982	1.37	1.203	0.984	0.775	0.561	0.431	0.343
Jul	2.561	2.132	1.554	0.993	0.871	0.678	0.559	0.449	0.356	0.261
Aug	2.192	1.792	1.291	0.763	0.663	0.505	0.418	0.342	0.265	0.209
Sep	1.693	1.587	1.303	0.624	0.452	0.356	0.263	0.218	0.208	0.157
C Category										
Oct	1.98	1.642	1.062	0.53	0.401	0.305	0.234	0.183	0.146	0.122
Nov	2.1	1.843	1.199	0.734	0.552	0.446	0.312	0.228	0.164	0.138
Dec	2.74	2.368	1.683	1.177	0.974	0.746	0.551	0.348	0.271	0.202
Jan	4.398	3.689	2.681	1.877	1.564	1.221	0.859	0.543	0.403	0.294
Feb	6.497	4.188	3.176	2.299	1.685	1.212	0.963	0.648	0.438	0.328
Mar	5.716	5.081	4.163	3.169	2.254	1.529	1.111	0.779	0.536	0.384
Apr	4.727	4.099	3.456	2.831	1.677	1.269	0.976	0.706	0.414	0.356
May	3.521	3.221	2.804	2.073	1.67	1.284	0.98	0.678	0.491	0.357
Jun	2.703	2.487	1.866	1.295	1.132	0.914	0.715	0.501	0.368	0.279
Jul	2.492	2.076	1.456	0.939	0.822	0.633	0.517	0.403	0.307	0.219
Aug	2.133	1.747	1.205	0.72	0.629	0.473	0.387	0.309	0.232	0.178
Sep	1.651	1.542	1.232	0.592	0.431	0.335	0.244	0.199	0.179	0.136
C/D Category										
Oct	1.939	1.602	0.961	0.509	0.382	0.287	0.217	0.166	0.129	0.106
Nov	2.045	1.792	1.111	0.702	0.526	0.422	0.292	0.208	0.147	0.12
Dec	2.667	2.299	1.574	1.127	0.93	0.709	0.52	0.322	0.244	0.178
Jan	4.276	3.564	2.543	1.798	1.494	1.166	0.816	0.506	0.367	0.26
Feb	6.314	4.029	3.038	2.203	1.609	1.157	0.917	0.607	0.4	0.291
Mar	5.528	4.875	3.999	3.033	2.152	1.473	1.059	0.73	0.489	0.339
Apr	4.59	3.952	3.306	2.714	1.601	1.212	0.929	0.661	0.375	0.315
May	3.425	3.118	2.665	1.986	1.594	1.227	0.933	0.635	0.448	0.316
Jun	2.631	2.413	1.753	1.241	1.08	0.872	0.678	0.467	0.335	0.246
Jul	2.427	2.018	1.356	0.898	0.784	0.601	0.487	0.373	0.278	0.193
Aug	2.077	1.7	1.116	0.689	0.599	0.448	0.362	0.285	0.208	0.156
Sep	1.606	1.496	1.165	0.567	0.41	0.316	0.227	0.181	0.161	0.119
D Category										
Oct	1.898	1.543	0.86	0.489	0.363	0.269	0.199	0.149	0.113	0.089
Nov	1.995	1.736	1.019	0.674	0.501	0.399	0.271	0.189	0.129	0.102
Dec	2.598	2.224	1.461	1.081	0.886	0.674	0.489	0.295	0.218	0.153
Jan	4.142	3.436	2.404	1.722	1.425	1.114	0.773	0.469	0.331	0.226
Feb	6.116	3.872	2.9	2.109	1.535	1.105	0.871	0.566	0.361	0.254
Mar	5.316	4.67	3.835	2.9	2.057	1.416	1.007	0.681	0.443	0.294
Apr	4.435	3.805	3.157	2.598	1.527	1.156	0.882	0.616	0.336	0.273
May	3.328	3.012	2.523	1.902	1.521	1.173	0.885	0.591	0.405	0.274
Jun	2.562	2.334	1.636	1.189	1.03	0.831	0.64	0.432	0.301	0.213
Jul	2.365	1.954	1.252	0.861	0.747	0.57	0.457	0.343	0.249	0.166
Aug	2.026	1.647	1.023	0.661	0.57	0.423	0.338	0.26	0.185	0.134
Sep	1.557	1.445	1.096	0.544	0.39	0.297	0.209	0.164	0.143	0.102
Category Total Flow Assurance curves (mill. m^3)										
A Category										

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Oct	2.145	1.746	1.36	0.699	0.49	0.396	0.326	0.275	0.239	0.215
Nov	4.34	3.784	3.057	2.398	2.012	1.825	1.427	0.921	0.272	0.24
Dec	6.462	5.606	4.703	3.896	3.449	3.069	2.421	1.494	0.439	0.352
Jan	9.827	8.483	7.035	5.787	5.205	4.64	3.584	2.213	0.644	0.514
Feb	11.883	8.88	7.379	6.077	5.212	4.501	3.602	2.287	0.694	0.574
Mar	9.829	8.986	7.61	6.289	5.192	4.25	3.261	2.159	0.844	0.685
Apr	7.046	6.245	5.477	4.668	3.317	2.805	2.209	1.541	0.659	0.623
May	4.764	4.354	3.998	3.145	2.627	2.189	1.706	1.211	0.765	0.624
Jun	2.923	2.701	2.233	1.617	1.357	1.144	0.912	0.701	0.575	0.495
Jul	2.699	2.248	1.781	1.22	0.991	0.8	0.675	0.572	0.483	0.383
Aug	2.314	1.889	1.495	0.968	0.761	0.603	0.516	0.447	0.37	0.315
Sep	1.769	1.673	1.46	0.803	0.525	0.432	0.337	0.296	0.29	0.241
A/B Category										
Oct	2.102	1.723	1.313	0.616	0.469	0.373	0.303	0.252	0.216	0.192
Nov	4.173	3.642	2.9	2.233	1.902	1.718	1.339	0.859	0.247	0.215
Dec	6.197	5.378	4.465	3.657	3.265	2.894	2.279	1.398	0.403	0.318
Jan	9.446	8.143	6.7	5.47	4.935	4.383	3.383	2.077	0.596	0.467
Feb	11.481	8.542	7.052	5.777	4.946	4.252	3.406	2.152	0.645	0.524
Mar	9.537	8.666	7.316	6.03	4.95	4.023	3.09	2.034	0.785	0.625
Apr	6.86	6.064	5.281	4.486	3.165	2.662	2.097	1.452	0.607	0.566
May	4.645	4.245	3.858	3.003	2.52	2.085	1.626	1.142	0.71	0.568
Jun	2.875	2.658	2.157	1.527	1.309	1.094	0.87	0.659	0.531	0.449
Jul	2.653	2.212	1.713	1.135	0.953	0.762	0.639	0.535	0.444	0.346
Aug	2.273	1.859	1.435	0.89	0.73	0.573	0.486	0.415	0.338	0.283
Sep	1.744	1.647	1.411	0.734	0.502	0.409	0.315	0.272	0.265	0.215
B Category										
Oct	2.063	1.704	1.27	0.581	0.453	0.358	0.287	0.236	0.2	0.176
Nov	4.012	3.506	2.756	2.096	1.8	1.622	1.26	0.806	0.23	0.198
Dec	5.941	5.158	4.243	3.449	3.094	2.733	2.15	1.314	0.378	0.294
Jan	9.077	7.811	6.384	5.183	4.683	4.146	3.198	1.958	0.563	0.435
Feb	11.092	8.208	6.743	5.501	4.699	4.024	3.225	2.033	0.61	0.49
Mar	9.251	8.356	7.048	5.789	4.729	3.819	2.937	1.928	0.743	0.585
Apr	6.68	5.887	5.1	4.323	3.031	2.537	2.001	1.38	0.571	0.528
May	4.533	4.141	3.732	2.887	2.428	2	1.56	1.088	0.672	0.53
Jun	2.831	2.619	2.093	1.464	1.271	1.056	0.84	0.629	0.501	0.418
Jul	2.612	2.181	1.657	1.078	0.925	0.735	0.614	0.508	0.418	0.321
Aug	2.237	1.833	1.385	0.838	0.708	0.551	0.465	0.393	0.316	0.261
Sep	1.721	1.623	1.371	0.689	0.486	0.392	0.299	0.256	0.248	0.198
B/C Category										
Oct	2.021	1.674	1.162	0.55	0.42	0.323	0.252	0.2	0.162	0.138
Nov	3.847	3.357	2.571	1.938	1.681	1.504	1.16	0.73	0.19	0.157
Dec	5.679	4.922	3.975	3.214	2.898	2.544	1.993	1.201	0.32	0.239
Jan	8.704	7.461	6.028	4.866	4.397	3.87	2.977	1.8	0.486	0.36
Feb	10.694	7.855	6.406	5.195	4.418	3.757	3.009	1.873	0.53	0.409
Mar	8.967	8.033	6.754	5.509	4.46	3.56	2.741	1.773	0.647	0.487
Apr	6.492	5.687	4.885	4.122	2.857	2.37	1.864	1.262	0.487	0.436
May	4.411	4.016	3.563	2.736	2.298	1.87	1.453	0.989	0.583	0.438
Jun	2.778	2.561	1.982	1.37	1.203	0.984	0.775	0.561	0.431	0.343
Jul	2.561	2.132	1.554	0.993	0.871	0.678	0.559	0.449	0.356	0.261

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Aug	2.192	1.792	1.291	0.763	0.663	0.505	0.418	0.342	0.265	0.209
Sep	1.693	1.587	1.303	0.624	0.452	0.356	0.263	0.218	0.208	0.157
C Category										
Oct	1.98	1.642	1.062	0.53	0.401	0.305	0.234	0.183	0.146	0.122
Nov	3.669	3.206	2.396	1.813	1.574	1.401	1.078	0.674	0.169	0.138
Dec	5.402	4.68	3.713	3.008	2.707	2.367	1.849	1.105	0.279	0.202
Jan	8.296	7.073	5.653	4.556	4.102	3.594	2.759	1.651	0.415	0.294
Feb	10.238	7.436	6.03	4.871	4.121	3.491	2.787	1.711	0.449	0.328
Mar	8.637	7.616	6.39	5.177	4.156	3.308	2.535	1.609	0.545	0.384
Apr	6.258	5.428	4.623	3.884	2.674	2.202	1.723	1.141	0.419	0.356
May	4.26	3.862	3.368	2.581	2.151	1.734	1.341	0.889	0.493	0.357
Jun	2.703	2.487	1.866	1.295	1.132	0.914	0.715	0.501	0.368	0.279
Jul	2.492	2.076	1.456	0.939	0.822	0.633	0.517	0.403	0.307	0.219
Aug	2.133	1.747	1.205	0.72	0.629	0.473	0.387	0.309	0.232	0.178
Sep	1.651	1.542	1.232	0.592	0.431	0.335	0.244	0.199	0.179	0.136
C/D Category										
Oct	1.939	1.602	0.961	0.509	0.382	0.287	0.217	0.166	0.129	0.106
Nov	3.498	3.054	2.219	1.701	1.472	1.307	1	0.621	0.151	0.12
Dec	5.132	4.439	3.453	2.822	2.534	2.21	1.722	1.022	0.252	0.178
Jan	7.884	6.697	5.296	4.279	3.843	3.363	2.575	1.531	0.378	0.26
Feb	9.777	7.037	5.68	4.584	3.864	3.266	2.606	1.592	0.41	0.291
Mar	8.232	7.223	6.061	4.892	3.913	3.119	2.377	1.499	0.498	0.339
Apr	6.008	5.183	4.388	3.689	2.525	2.075	1.62	1.064	0.379	0.315
May	4.11	3.712	3.187	2.457	2.04	1.643	1.266	0.829	0.45	0.316
Jun	2.631	2.413	1.753	1.241	1.08	0.872	0.678	0.467	0.335	0.246
Jul	2.427	2.018	1.356	0.898	0.784	0.601	0.487	0.373	0.278	0.193
Aug	2.077	1.7	1.116	0.689	0.599	0.448	0.362	0.285	0.208	0.156
Sep	1.606	1.496	1.165	0.567	0.41	0.316	0.227	0.181	0.161	0.119
D Category										
Oct	1.898	1.543	0.86	0.489	0.363	0.269	0.199	0.149	0.113	0.089
Nov	3.334	2.899	2.041	1.594	1.372	1.214	0.924	0.569	0.133	0.102
Dec	4.869	4.197	3.194	2.642	2.365	2.058	1.597	0.941	0.225	0.153
Jan	7.468	6.324	4.94	4.009	3.59	3.14	2.395	1.414	0.341	0.226
Feb	9.309	6.644	5.335	4.304	3.614	3.049	2.428	1.473	0.371	0.254
Mar	7.808	6.834	5.735	4.614	3.679	2.934	2.222	1.39	0.451	0.294
Apr	5.742	4.94	4.153	3.497	2.378	1.952	1.519	0.987	0.34	0.273
May	3.959	3.559	3.004	2.336	1.931	1.557	1.193	0.77	0.407	0.274
Jun	2.562	2.334	1.636	1.189	1.03	0.831	0.64	0.432	0.301	0.213
Jul	2.365	1.954	1.252	0.861	0.747	0.57	0.457	0.343	0.249	0.166
Aug	2.026	1.647	1.023	0.661	0.57	0.423	0.338	0.26	0.185	0.134
Sep	1.557	1.445	1.096	0.544	0.39	0.297	0.209	0.164	0.143	0.102

11.3 EWR 3: PRIESKA

11.3.1 Hydrology data summary

Natural Flows:					Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV	Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)					($m^3 * 10^6$)			
0.0	394.91	310.58	11.52	0.79	0	181.98	275.03	1.65	1.51
% Zero flows	0.0				% Zero flows	0.0			
Baseflow Parameters:			A	0.96	Baseflow Parameters:			A	0.96
			B	0.44				B	0.44
BFI				0.46	BFI				0.25
Hydro Index				3.4	Hydro Index				11.5

MONTH	MEAN	SD	CV	MONTH	MEAN	SD	CV
	($m^3 * 10^6$)				($m^3 * 10^6$)		
Oct	10.42	3.84	0.37	Oct	1.94	1.1	0.57
Nov	15.85	9.95	0.63	Nov	2.6	3.94	1.51
Dec	29.75	26.33	0.89	Dec	8.02	18.61	2.32
Jan	57.31	61.96	1.08	Jan	27.78	51.48	1.85
Feb	88.81	126.12	1.42	Feb	59.18	119.2	2.01
Mar	75.68	102.66	1.36	Mar	49.17	98.7	2.01
Apr	42.23	42.31	1	Apr	20.55	37.46	1.82
May	22.63	10.25	0.45	May	5.25	6.21	1.18
Jun	16.22	5.22	0.32	Jun	2.57	2.83	1.1
Jul	13.72	4.17	0.3	Jul	1.81	1.58	0.87
Aug	11.92	3.69	0.31	Aug	1.46	0.87	0.59
Sep	10.39	3.39	0.33	Sep	1.65	0.68	0.41

Critical months:	Wet Season	Mar	Dry Season	Oct
Max. baseflows (m^3/s)	6.329		3.573	

11.3.2 Hydraulics data summary

Geomorph. Zone	5
Flood Zone	3
Max. Channel width (m)	65.24
Max. Channel Depth (m)	2.23
Observed Channel XS used	
Observed Rating Curve used	
(Gradients and Roughness n values calibrated)	
Max. Gradient	0.005
Min. Gradient	0.004
Gradient Shape Factor	20
Max. Mannings n	0.13
Min. Mannings n	0.06
n Shape Factor	15

11.3.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	*0.6*	*0.1*
A/B	*0.65*	*0.15*
B	*0.68*	*0.2*
B/C	*0.72*	*0.24*
C	*0.75*	*0.28*
C/D	*0.78*	*0.32*
D	*0.8*	*0.36*
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress D Category Aligned		
Table of flows (m^3/s) v stress index		
Stress	**Wet Season Flow**	**Dry Season Flow**
0	*6.454*	*3.622*
1	*5.719*	*2.612*
2	*5.139*	*2.13*
3	*4.181*	*1.871*
4	*2.034*	*1.622*
5	*1.695*	*1.293*
6	*1.356*	*1.028*
7	*1.017*	*0.771*
8	*0.678*	*0.514*
9	*0.339*	*0.257*
10	*0*	*0*

11.3.4 High flow estimation summary details

No High flows when natural high flows are < 25% of total flows							
Maximum high flows are 120% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	*39.84*	*37.829*	*35.821*	*33.814*	*31.81*	*29.807*	*27.806*
Oct	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Nov	*1.638*	*1.555*	*1.473*	*1.39*	*1.308*	*1.225*	*1.143*
Dec	*6.184*	*5.872*	*5.56*	*5.249*	*4.938*	*4.627*	*4.316*
Jan	*8.959*	*8.507*	*8.055*	*7.604*	*7.153*	*6.703*	*6.253*
Feb	*10.341*	*9.819*	*9.298*	*8.777*	*8.257*	*7.737*	*7.218*
Mar	*7.65*	*7.264*	*6.878*	*6.493*	*6.108*	*5.724*	*5.339*
Apr	*5.068*	*4.812*	*4.557*	*4.301*	*4.046*	*3.792*	*3.537*
May	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Jun	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Jul	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Aug	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sep	*0*	*0*	*0*	*0*	*0*	*0*	*0*

11.3.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows				
Long term mean flow requirements (Mill. m^3 and %MAR)				
Category	**Low Flows**		**Total Flows**	
	Mill. m^3	**%MAR**	**Mill. m^3**	**%MAR**
A	37.747	9.6	69.605	17.6
A/B	35.04	8.9	65.29	16.5
B	33.28	8.4	61.924	15.7
B/C	31.544	8	58.584	14.8
C	28.969	7.3	54.406	13.8
C/D	26.354	6.7	50.189	12.7
D	23.72	6	45.955	11.6

11.3.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**99**
Natural Total flow duration curve (mill. m^3)										
Oct	15.807	13.352	12.433	11.18	10.045	9.18	7.756	7.006	6.144	4.236
Nov	26.03	20.65	18.573	15.228	13.6	12.022	11.086	8.668	7.091	4.487
Dec	57.673	41.132	32.557	27.538	23.03	19.26	15.816	12.63	9.671	5.532
Jan	133.056	91.53	62.855	43.638	33.73	27.78	20.944	18.506	13.696	7.656
Feb	235.822	134.198	78.311	52.09	43.58	30.936	24.456	19.074	15.954	8.384
Mar	198.703	111.932	77.652	53.34	38.725	29.87	21.875	17.464	14.645	9.07
Apr	80.432	59.286	49.907	40.19	31.045	22.502	19.766	17.574	13.962	8.678
May	36.918	30.794	26.701	24.226	20.69	17.952	15.703	14.462	11.716	6.89
Jun	22.463	20.986	18.794	17.43	16.165	14.95	13.105	11.69	9.858	5.812
Jul	19.737	16.912	15.817	14.764	13.845	12.65	11.307	10.066	8.773	5.311
Aug	16.543	14.446	13.559	12.814	12.4	10.66	10.037	8.784	7.436	4.449
Sep	14.627	12.984	12.238	11.49	10.605	9.12	8.319	7.184	6.462	4.036
Natural Baseflow flow duration curve (mill. m^3)										
Oct	14.11	12.345	11.329	10.221	9.463	8.412	7.68	6.94	5.892	4.047
Nov	14.7	12.702	11.801	10.945	10.201	9.152	7.962	7.107	6.151	4.193
Dec	17.417	15.675	14.627	12.701	11.456	10.944	9.704	8.435	7.075	4.707
Jan	28.386	22.749	18.643	16.405	13.5	12.22	11.769	10.26	8.612	5.481
Feb	54.065	30.449	22.448	17.846	15.474	14.167	12.648	11.636	9.028	5.859
Mar	49.255	33.195	24.343	19.454	16.829	15.214	13.412	12.309	9.69	6.287
Apr	36.129	26.912	21.584	19.74	16.74	15.037	13.71	11.601	9.477	6.636
May	26.737	23.512	19.789	17.49	15.938	14.569	13.186	11.316	9.341	6.48
Jun	21.459	19.063	17.583	15.571	14.656	13.306	12.247	10.608	8.992	5.756
Jul	19.65	16.788	15.047	14.555	13.33	12.078	10.887	9.596	8.546	5.311
Aug	16.476	14.386	13.431	12.686	11.79	10.452	9.744	8.784	7.436	4.449
Sep	14.586	12.734	11.923	11.242	10.38	8.969	8.319	7.184	6.296	4.036
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	2.926	1.915	1.429	1.15	0.974	0.857	0.775	0.717	0.674	0.645
Nov	3.206	2.054	1.603	1.3	1.128	0.947	0.809	0.733	0.677	0.641
Dec	4.057	3.155	2.988	1.907	1.506	1.318	1.076	0.882	0.785	0.742
Jan	7.965	6.547	5.623	3.284	2.335	1.656	1.393	1.071	0.894	0.788
Feb	12.876	10.296	7.627	3.759	2.694	1.958	1.439	1.081	0.852	0.769
Mar	15.963	14.378	11.111	4.915	3.552	2.46	1.697	1.226	0.964	0.842
Apr	11.621	10.307	8.09	3.964	2.924	2.324	1.55	1.175	0.978	0.924

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
May	7.283	7.214	6.69	3.935	3.129	2.257	1.643	1.179	0.97	0.885
Jun	5.167	4.799	4.622	2.923	2.53	1.885	1.453	1.07	0.895	0.792
Jul	4.637	3.654	3.408	2.551	2.143	1.61	1.266	1.006	0.89	0.78
Aug	3.781	2.684	2.432	1.897	1.628	1.246	1.08	0.907	0.813	0.734
Sep	3.147	2.041	1.641	1.368	1.157	0.947	0.837	0.743	0.693	0.645
A/B Category										
Oct	2.77	1.797	1.327	1.057	0.887	0.773	0.695	0.638	0.597	0.568
Nov	3.037	1.93	1.48	1.2	1.035	0.86	0.727	0.654	0.6	0.566
Dec	3.846	2.973	2.709	1.772	1.395	1.212	0.978	0.791	0.698	0.655
Jan	7.576	6.212	5.041	3.075	2.192	1.536	1.28	0.969	0.799	0.697
Feb	12.258	9.808	6.789	3.523	2.544	1.832	1.331	0.984	0.763	0.682
Mar	15.23	13.817	9.475	4.684	3.367	2.311	1.573	1.118	0.865	0.747
Apr	11.121	9.817	7.213	3.695	2.753	2.18	1.421	1.066	0.875	0.818
May	6.926	6.744	5.984	3.694	2.958	2.115	1.52	1.072	0.869	0.785
Jun	4.906	4.427	4.15	2.737	2.382	1.758	1.34	0.97	0.801	0.702
Jul	4.399	3.449	3.085	2.383	2.007	1.492	1.159	0.907	0.795	0.689
Aug	3.584	2.526	2.216	1.763	1.512	1.143	0.981	0.815	0.723	0.648
Sep	2.981	1.917	1.512	1.264	1.062	0.86	0.754	0.663	0.614	0.569
B Category										
Oct	2.671	1.709	1.245	0.978	0.81	0.697	0.62	0.564	0.523	0.495
Nov	2.93	1.839	1.386	1.119	0.955	0.783	0.652	0.579	0.526	0.493
Dec	3.717	2.847	2.518	1.676	1.305	1.122	0.89	0.707	0.615	0.571
Jan	7.364	5.997	4.667	2.958	2.086	1.438	1.183	0.876	0.708	0.609
Feb	11.934	9.508	6.252	3.407	2.44	1.735	1.24	0.897	0.678	0.597
Mar	14.927	13.398	8.502	4.547	3.244	2.2	1.471	1.021	0.771	0.654
Apr	10.855	9.522	6.668	3.557	2.631	2.073	1.308	0.967	0.777	0.716
May	6.727	6.483	5.537	3.568	2.84	2.007	1.416	0.976	0.774	0.687
Jun	4.752	4.192	3.843	2.627	2.275	1.658	1.244	0.879	0.712	0.614
Jul	4.256	3.308	2.87	2.276	1.904	1.395	1.066	0.817	0.704	0.602
Aug	3.462	2.414	2.065	1.667	1.419	1.054	0.894	0.729	0.638	0.565
Sep	2.876	1.827	1.415	1.181	0.982	0.783	0.677	0.588	0.539	0.496
B/C Category										
Oct	2.573	1.622	1.163	0.899	0.732	0.622	0.544	0.489	0.449	0.421
Nov	2.825	1.748	1.292	1.038	0.875	0.705	0.577	0.505	0.453	0.42
Dec	3.589	2.715	2.322	1.58	1.214	1.031	0.802	0.622	0.531	0.488
Jan	7.157	5.762	4.276	2.84	1.98	1.34	1.087	0.783	0.618	0.522
Feb	11.62	9.173	5.696	3.291	2.335	1.639	1.149	0.81	0.593	0.513
Mar	14.624	12.924	7.528	4.409	3.121	2.089	1.369	0.923	0.676	0.561
Apr	10.578	9.189	6.098	3.419	2.508	1.965	1.196	0.868	0.68	0.613
May	6.53	6.222	5.068	3.442	2.723	1.898	1.313	0.88	0.679	0.59
Jun	4.601	3.989	3.525	2.516	2.168	1.558	1.148	0.788	0.622	0.527
Jul	4.115	3.161	2.647	2.169	1.801	1.297	0.972	0.726	0.614	0.515
Aug	3.341	2.3	1.913	1.571	1.326	0.966	0.806	0.643	0.553	0.483
Sep	2.772	1.736	1.319	1.099	0.901	0.705	0.6	0.513	0.464	0.422
C Category										
Oct	2.422	1.504	1.061	0.806	0.645	0.538	0.464	0.41	0.371	0.345
Nov	2.66	1.621	1.167	0.939	0.782	0.618	0.495	0.426	0.375	0.345
Dec	3.384	2.506	2.015	1.456	1.103	0.925	0.704	0.531	0.444	0.402
Jan	6.792	5.312	3.606	2.665	1.837	1.219	0.974	0.681	0.523	0.431

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Feb	11.047	8.463	4.734	3.106	2.185	1.513	1.04	0.714	0.504	0.425
Mar	14.027	12.017	5.84	4.178	2.936	1.94	1.245	0.815	0.577	0.466
Apr	9.979	8.473	5.079	3.212	2.337	1.822	1.067	0.759	0.577	0.507
May	6.184	5.728	4.252	3.245	2.551	1.756	1.189	0.773	0.578	0.49
Jun	4.347	3.673	2.994	2.355	2.02	1.431	1.035	0.688	0.528	0.437
Jul	3.885	2.917	2.29	2.02	1.665	1.179	0.865	0.628	0.519	0.425
Aug	3.149	2.126	1.686	1.447	1.21	0.863	0.708	0.55	0.463	0.397
Sep	2.61	1.61	1.191	0.998	0.807	0.618	0.517	0.433	0.385	0.346
C/D Category										
Oct	2.27	1.386	0.958	0.713	0.558	0.455	0.383	0.332	0.294	0.268
Nov	2.495	1.491	1.049	0.841	0.689	0.531	0.413	0.346	0.298	0.269
Dec	3.174	2.285	1.762	1.331	0.993	0.819	0.606	0.44	0.357	0.316
Jan	6.387	4.812	3.085	2.49	1.694	1.099	0.862	0.58	0.427	0.341
Feb	10.395	7.632	4.018	2.922	2.035	1.387	0.931	0.617	0.415	0.338
Mar	13.212	11.001	5.218	3.947	2.75	1.791	1.121	0.707	0.477	0.37
Apr	9.235	7.659	4.294	3.005	2.167	1.678	0.937	0.65	0.474	0.401
May	5.804	5.17	3.62	3.048	2.38	1.613	1.066	0.667	0.478	0.389
Jun	4.077	3.328	2.58	2.195	1.871	1.303	0.922	0.588	0.434	0.347
Jul	3.644	2.654	1.995	1.871	1.529	1.06	0.758	0.529	0.424	0.335
Aug	2.953	1.945	1.492	1.323	1.094	0.76	0.609	0.458	0.374	0.312
Sep	2.448	1.482	1.071	0.896	0.713	0.531	0.433	0.353	0.307	0.271
D Category										
Oct	2.119	1.267	0.856	0.62	0.471	0.371	0.302	0.253	0.217	0.192
Nov	2.329	1.359	0.939	0.743	0.596	0.444	0.331	0.267	0.221	0.194
Dec	2.956	2.038	1.58	1.207	0.882	0.713	0.509	0.349	0.27	0.23
Jan	5.918	4.177	2.762	2.315	1.551	0.979	0.749	0.478	0.332	0.25
Feb	9.616	6.515	3.634	2.738	1.885	1.261	0.823	0.52	0.326	0.251
Mar	12.225	8.97	4.939	3.717	2.565	1.642	0.997	0.599	0.378	0.275
Apr	8.366	6.59	3.83	2.797	1.996	1.535	0.808	0.541	0.371	0.295
May	5.376	4.469	3.242	2.85	2.209	1.471	0.942	0.56	0.377	0.289
Jun	3.787	2.916	2.316	2.034	1.723	1.176	0.809	0.488	0.34	0.256
Jul	3.391	2.352	1.787	1.722	1.393	0.942	0.651	0.431	0.329	0.246
Aug	2.753	1.75	1.339	1.199	0.978	0.657	0.511	0.365	0.284	0.227
Sep	2.285	1.351	0.96	0.795	0.619	0.444	0.35	0.273	0.228	0.195
Category Total Flow Assurance curves (mill. m^3)										
A Category										
Oct	2.926	1.915	1.429	1.15	0.974	0.857	0.775	0.717	0.674	0.645
Nov	5.134	3.908	3.384	3.009	2.765	2.479	2.035	1.448	0.685	0.641
Dec	11.337	10.157	9.713	8.358	7.687	7.1	5.705	3.581	0.814	0.742
Jan	18.513	16.691	15.365	12.629	11.289	10.033	8.099	4.981	0.936	0.788
Feb	25.051	22.005	18.873	14.547	13.03	11.627	9.18	5.594	0.9	0.769
Mar	24.97	23.041	19.43	12.896	11.198	9.613	7.424	4.564	1	0.842
Apr	17.588	16.046	13.601	9.251	7.989	7.062	5.343	3.387	1.001	0.924
May	7.283	7.214	6.69	3.935	3.129	2.257	1.643	1.179	0.97	0.885
Jun	5.167	4.799	4.622	2.923	2.53	1.885	1.453	1.07	0.895	0.792
Jul	4.637	3.654	3.408	2.551	2.143	1.61	1.266	1.006	0.89	0.78
Aug	3.781	2.684	2.432	1.897	1.628	1.246	1.08	0.907	0.813	0.734
Sep	3.147	2.041	1.641	1.368	1.157	0.947	0.837	0.743	0.693	0.645
A/B Category										

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Oct	2.77	1.797	1.327	1.057	0.887	0.773	0.695	0.638	0.597	0.568
Nov	4.868	3.691	3.171	2.822	2.589	2.314	1.892	1.333	0.607	0.566
Dec	10.76	9.622	9.095	7.898	7.264	6.703	5.373	3.354	0.725	0.655
Jan	17.592	15.844	14.292	11.95	10.694	9.49	7.648	4.682	0.838	0.697
Feb	23.819	20.926	17.467	13.767	12.358	11.013	8.681	5.27	0.808	0.682
Mar	23.783	22.042	17.375	12.262	10.627	9.103	7.011	4.288	0.899	0.747
Apr	16.787	15.266	12.446	8.715	7.563	6.68	5.023	3.166	0.897	0.818
May	6.926	6.744	5.984	3.694	2.958	2.115	1.52	1.072	0.869	0.785
Jun	4.906	4.427	4.15	2.737	2.382	1.758	1.34	0.97	0.801	0.702
Jul	4.399	3.449	3.085	2.383	2.007	1.492	1.159	0.907	0.795	0.689
Aug	3.584	2.526	2.216	1.763	1.512	1.143	0.981	0.815	0.723	0.648
Sep	2.981	1.917	1.512	1.264	1.062	0.86	0.754	0.663	0.614	0.569
B Category										
Oct	2.671	1.709	1.245	0.978	0.81	0.697	0.62	0.564	0.523	0.495
Nov	4.664	3.507	2.987	2.655	2.427	2.159	1.754	1.222	0.533	0.493
Dec	10.263	9.142	8.565	7.476	6.862	6.321	5.052	3.133	0.64	0.571
Jan	16.848	15.117	13.427	11.36	10.137	8.97	7.213	4.392	0.746	0.609
Feb	22.881	20.036	16.364	13.106	11.733	10.429	8.2	4.955	0.721	0.597
Mar	23.026	21.186	15.982	11.722	10.119	8.631	6.62	4.022	0.803	0.654
Apr	16.22	14.681	11.624	8.311	7.185	6.333	4.719	2.956	0.799	0.716
May	6.727	6.483	5.537	3.568	2.84	2.007	1.416	0.976	0.774	0.687
Jun	4.752	4.192	3.843	2.627	2.275	1.658	1.244	0.879	0.712	0.614
Jul	4.256	3.308	2.87	2.276	1.904	1.395	1.066	0.817	0.704	0.602
Aug	3.462	2.414	2.065	1.667	1.419	1.054	0.894	0.729	0.638	0.565
Sep	2.876	1.827	1.415	1.181	0.982	0.783	0.677	0.588	0.539	0.496
B/C Category										
Oct	2.573	1.622	1.163	0.899	0.732	0.622	0.544	0.489	0.449	0.421
Nov	4.461	3.322	2.803	2.488	2.265	2.005	1.617	1.111	0.459	0.42
Dec	9.769	8.658	8.03	7.056	6.46	5.939	4.731	2.913	0.556	0.488
Jan	16.11	14.372	12.546	10.772	9.58	8.449	6.779	4.102	0.653	0.522
Feb	21.954	19.111	15.241	12.447	11.108	9.846	7.719	4.641	0.634	0.513
Mar	22.269	20.276	14.589	11.182	9.611	8.16	6.229	3.757	0.706	0.561
Apr	15.642	14.059	10.776	7.906	6.807	5.987	4.416	2.745	0.7	0.613
May	6.53	6.222	5.068	3.442	2.723	1.898	1.313	0.88	0.679	0.59
Jun	4.601	3.989	3.525	2.516	2.168	1.558	1.148	0.788	0.622	0.527
Jul	4.115	3.161	2.647	2.169	1.801	1.297	0.972	0.726	0.614	0.515
Aug	3.341	2.3	1.913	1.571	1.326	0.966	0.806	0.643	0.553	0.483
Sep	2.772	1.736	1.319	1.099	0.901	0.705	0.6	0.513	0.464	0.422
C Category										
Oct	2.422	1.504	1.061	0.806	0.645	0.538	0.464	0.41	0.371	0.345
Nov	4.2	3.101	2.589	2.304	2.089	1.841	1.474	0.996	0.382	0.345
Dec	9.198	8.097	7.385	6.607	6.038	5.542	4.4	2.686	0.467	0.402
Jan	15.214	13.411	11.385	10.127	8.986	7.908	6.329	3.803	0.556	0.431
Feb	20.768	17.812	13.713	11.72	10.437	9.233	7.221	4.317	0.543	0.425
Mar	21.219	18.933	12.482	10.55	9.041	7.651	5.817	3.481	0.605	0.466
Apr	14.744	13.054	9.479	7.433	6.382	5.605	4.096	2.525	0.596	0.507
May	6.184	5.728	4.252	3.245	2.551	1.756	1.189	0.773	0.578	0.49
Jun	4.347	3.673	2.994	2.355	2.02	1.431	1.035	0.688	0.528	0.437
Jul	3.885	2.917	2.29	2.02	1.665	1.179	0.865	0.628	0.519	0.425

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Aug	3.149	2.126	1.686	1.447	1.21	0.863	0.708	0.55	0.463	0.397
Sep	2.61	1.61	1.191	0.998	0.807	0.618	0.517	0.433	0.385	0.346
C/D Category										
Oct	2.27	1.386	0.958	0.713	0.558	0.455	0.383	0.332	0.294	0.268
Nov	3.937	2.879	2.382	2.119	1.914	1.677	1.33	0.881	0.304	0.269
Dec	8.621	7.524	6.794	6.158	5.617	5.145	4.07	2.459	0.378	0.316
Jan	14.278	12.401	10.374	9.482	8.393	7.366	5.879	3.505	0.458	0.341
Feb	19.505	16.392	12.432	10.993	9.768	8.621	6.723	3.993	0.451	0.338
Mar	19.951	17.482	11.442	9.918	8.471	7.142	5.406	3.205	0.504	0.37
Apr	13.699	11.952	8.418	6.96	5.956	5.224	3.776	2.305	0.492	0.401
May	5.804	5.17	3.62	3.048	2.38	1.613	1.066	0.667	0.478	0.389
Jun	4.077	3.328	2.58	2.195	1.871	1.303	0.922	0.588	0.434	0.347
Jul	3.644	2.654	1.995	1.871	1.529	1.06	0.758	0.529	0.424	0.335
Aug	2.953	1.945	1.492	1.323	1.094	0.76	0.609	0.458	0.374	0.312
Sep	2.448	1.482	1.071	0.896	0.713	0.531	0.433	0.353	0.307	0.271
D Category										
Oct	2.119	1.267	0.856	0.62	0.471	0.371	0.302	0.253	0.217	0.192
Nov	3.675	2.654	2.182	1.935	1.739	1.513	1.187	0.766	0.226	0.194
Dec	8.038	6.925	6.274	5.709	5.196	4.749	3.739	2.233	0.29	0.23
Jan	13.28	11.257	9.562	8.838	7.801	6.825	5.43	3.207	0.361	0.25
Feb	18.113	14.688	11.483	10.267	9.099	8.01	6.226	3.67	0.359	0.251
Mar	18.512	15.016	10.746	9.287	7.901	6.634	4.994	2.929	0.403	0.275
Apr	12.53	10.595	7.677	6.487	5.531	4.842	3.456	2.085	0.388	0.295
May	5.376	4.469	3.242	2.85	2.209	1.471	0.942	0.56	0.377	0.289
Jun	3.787	2.916	2.316	2.034	1.723	1.176	0.809	0.488	0.34	0.256
Jul	3.391	2.352	1.787	1.722	1.393	0.942	0.651	0.431	0.329	0.246
Aug	2.753	1.75	1.339	1.199	0.978	0.657	0.511	0.365	0.284	0.227
Sep	2.285	1.351	0.96	0.795	0.619	0.444	0.35	0.273	0.228	0.195

11.4 EWR 4: LETABA RANCH

11.4.1 Hydrology data summary

Natural Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0.0	441.39	435.05	11.53	0.99
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.44
Hydro Index				4.4

Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0	217.92	403.03	1.55	1.85
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.25
Hydro Index				12.1

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	10.48	3.93	0.38
Nov	16.6	11.72	0.71
Dec	32.25	30.93	0.96
Jan	64.67	83.3	1.29
Feb	109.31	195.62	1.79

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	1.6	0.91	0.57
Nov	2.2	4.64	2.11
Dec	8.3	21.63	2.61
Jan	32.68	71.9	2.2
Feb	77.73	189.23	2.43

Mar	88.28	154.37	1.75		Mar	60.62	151.19	2.49	
Apr	44.73	51.09	1.14		Apr	22.32	46.28	2.07	
May	22.76	10.49	0.46		May	5.07	6.13	1.21	
Jun	16.23	5.24	0.32		Jun	2.43	2.67	1.1	
Jul	13.75	4.2	0.31		Jul	1.86	1.33	0.72	
Aug	11.92	3.69	0.31		Aug	1.59	0.23	0.14	
Sep	10.41	3.41	0.33		Sep	1.51	0.21	0.14	

Critical months:	Wet Season	Mar	Dry Season	Oct	
Max. baseflows (m^3/s)	6.461		3.577		

11.4.2 Hydraulics data summary

Geomorph. Zone	5
Flood Zone	9
Max. Channel width (m)	177.52
Max. Channel Depth (m)	3.38

11.4.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	0.1	0.02
A/B	0.15	0.05
B	0.2	0.1
B/C	0.3	0.15
C	0.4	0.2
C/D	0.5	0.4
D	0.6	0.6
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress A Category Aligned		
Table of flows (m^3/s) v stress index		
Stress	**Wet Season Flow**	**Dry Season Flow**
0	6.635	3.66
1	3.042	3.006
2	2.215	2.724
3	1.938	2.232
4	1.661	1.924
5	1.385	1.468
6	1.108	1.223
7	0.831	0.917
8	0.554	0.612
9	0.277	0.306
10	0	0

11.4.4 High flow estimation summary details

No High flows when natural high flows are < 20% of total flows							
Maximum high flows are 160% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	66.807	62.022	57.42	52.996	48.743	44.656	40.73
Oct	0	0	0	0	0	0	0

No High flows when natural high flows are < 20% of total flows							
Maximum high flows are 160% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Nov	2.286	2.122	1.964	1.813	1.668	1.528	1.393
Dec	11.476	10.654	9.864	9.103	8.373	7.671	6.997
Jan		13.165	12.189	11.249	10.347	9.479	8.646
Feb	16.008	14.861	13.759	12.698	11.679	10.7	9.76
Mar	13.025	12.092	11.195	10.332	9.503	8.706	7.941
Apr	7.913	7.346	6.801	6.277	5.773	5.289	4.824
May	1.919	1.782	1.649	1.522	1.4	1.283	1.17
Jun	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0

11.4.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows				
Long term mean flow requirements (Mill. m^3 and %MAR)				
Category	**Low Flows**		**Total Flows**	
	Mill. m^3	**%MAR**	**Mill. m^3**	**%MAR**
A	52.057	11.8	108.604	24.6
A/B	48.141	10.9	100.638	22.8
B	43.391	9.8	91.993	20.8
B/C	39.887	9	84.744	19.2
C	36.629	8.3	77.886	17.6
C/D	26.642	6	64.44	14.6
D	17.34	3.9	51.816	11.7

11.4.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**99**
Natural Total flow duration curve (mill. m^3)										
Oct	16.448	13.352	12.457	11.342	10.045	9.18	7.756	7.006	6.144	4.236
Nov	28.063	21.974	18.6	15.504	13.835	12.34	11.158	8.668	7.091	4.497
Dec	63.429	43.002	35.938	29.78	25.325	19.592	15.888	12.682	9.68	5.542
Jan	152.541	101.168	67.429	46.104	35.63	28.474	21.974	18.84	13.696	8.184
Feb	286.945	143.83	91.771	58.092	44.61	32.696	24.582	19.076	15.956	8.384
Mar	226.581	120.224	84.283	53.362	40.995	30.102	21.882	17.472	14.645	9.079
Apr	84.171	60.166	51.492	40.216	31.065	22.618	19.773	17.576	13.962	8.678
May	36.947	30.818	26.753	24.238	20.7	17.972	15.703	14.462	11.716	6.89
Jun	22.535	21.042	18.818	17.448	16.195	14.956	13.105	11.69	9.858	5.812
Jul	19.815	16.938	15.833	14.786	13.865	12.662	11.324	10.068	8.773	5.311
Aug	16.543	14.446	13.559	12.814	12.4	10.66	10.037	8.784	7.436	4.449
Sep	14.679	13.024	12.238	11.49	10.605	9.12	8.319	7.184	6.462	4.036
Natural Baseflow flow duration curve (mill. m^3)										
Oct	14.11	12.348	11.357	10.221	9.576	8.412	7.691	6.94	5.892	4.047
Nov	14.756	12.978	11.904	10.979	10.529	9.156	7.97	7.107	6.162	4.193
Dec	17.736	16.069	14.871	12.704	11.539	11.002	10.024	8.638	7.232	4.709
Jan	30.113	23.294	18.965	17.018	14.016	12.428	11.955	10.397	8.743	5.481
Feb	58.73	32.733	23.653	18.554	16.196	14.495	12.819	12.013	9.116	5.972

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Mar	50.871	35.333	26.732	19.562	17.223	15.605	13.529	12.374	9.696	6.612
Apr	39.584	28.489	23.53	20.711	17.057	15.509	13.769	11.65	9.55	6.936
May	27.054	24.407	20.707	18.335	15.997	14.816	13.407	11.405	9.363	6.769
Jun	21.783	19.324	17.734	15.894	14.895	13.378	12.434	10.79	9.059	5.764
Jul	19.681	16.85	15.286	14.652	13.505	12.091	10.887	9.646	8.629	5.311
Aug	16.476	14.386	13.431	12.686	11.79	10.514	9.744	8.784	7.436	4.449
Sep	14.613	12.735	11.923	11.242	10.445	8.986	8.319	7.184	6.462	4.036
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	7.368	5.483	3.896	3.095	2.362	1.813	1.41	1.117	0.907	0.769
Nov	7.511	5.522	4.026	3.187	2.495	1.871	1.417	1.114	0.896	0.768
Dec	8.975	6.783	4.903	3.735	2.864	2.218	1.636	1.217	0.944	0.812
Jan	12.867	8.882	5.932	4.655	3.421	2.418	1.748	1.219	0.902	0.801
Feb	20.413	9.661	6.061	4.603	3.491	2.426	1.609	1.063	0.807	0.7
Mar	14.127	10.678	7.03	5.347	4.095	2.81	1.776	1.124	0.803	0.687
Apr	13.758	9.732	6.468	5.609	4.025	2.726	2.048	1.202	1.004	0.922
May	12.071	8.979	6.185	4.957	3.855	2.716	1.893	1.186	0.866	0.821
Jun	9.978	7.512	5.403	4.324	3.466	2.486	1.716	1.172	0.852	0.748
Jul	9.502	7.015	5.094	4.165	3.264	2.383	1.7	1.225	0.913	0.808
Aug	8.386	6.223	4.599	3.717	2.91	2.146	1.618	1.216	0.944	0.814
Sep	7.367	5.47	4.034	3.231	2.49	1.869	1.435	1.118	0.9	0.745
A/B Category										
Oct	7.08	5.295	3.766	2.953	2.235	1.698	1.303	1.016	0.81	0.676
Nov	7.235	5.291	3.839	3.05	2.366	1.755	1.311	1.015	0.802	0.676
Dec	8.579	6.39	4.654	3.58	2.723	2.091	1.523	1.112	0.847	0.717
Jan	11.809	7.941	5.584	4.482	3.271	2.288	1.637	1.12	0.811	0.709
Feb	18.473	7.847	5.641	4.442	3.353	2.311	1.514	0.981	0.727	0.622
Mar	11.279	8.093	6.43	5.167	3.944	2.687	1.676	1.039	0.725	0.611
Apr	12.097	8.199	6.032	5.392	3.864	2.602	1.914	1.108	0.894	0.817
May	11.211	8.004	5.806	4.78	3.702	2.589	1.779	1.094	0.781	0.729
Jun	9.437	6.936	5.102	4.159	3.319	2.361	1.611	1.078	0.767	0.664
Jul	9.051	6.58	4.831	4.001	3.116	2.253	1.587	1.123	0.821	0.714
Aug	8.048	5.918	4.376	3.563	2.768	2.02	1.505	1.111	0.847	0.718
Sep	7.102	5.246	3.847	3.092	2.361	1.754	1.329	1.019	0.806	0.657
B Category										
Oct	6.515	4.929	3.573	2.752	2.066	1.552	1.174	0.9	0.703	0.575
Nov	6.74	4.944	3.601	2.848	2.192	1.608	1.184	0.901	0.697	0.577
Dec	7.921	5.919	4.334	3.35	2.53	1.926	1.384	0.991	0.739	0.615
Jan	10.331	7.15	5.129	4.215	3.057	2.118	1.501	1.006	0.713	0.611
Feb	15.867	6.658	5.075	4.19	3.15	2.153	1.395	0.888	0.641	0.54
Mar	7.779	7.038	5.772	4.882	3.714	2.515	1.55	0.942	0.643	0.534
Apr	9.975	7.121	5.459	5.062	3.627	2.431	1.75	1.001	0.775	0.706
May	9.989	7.202	5.31	4.504	3.477	2.414	1.637	0.988	0.691	0.632
Jun	8.605	6.36	4.718	3.907	3.108	2.193	1.481	0.97	0.676	0.575
Jul	8.319	6.082	4.492	3.752	2.908	2.083	1.448	1.005	0.721	0.615
Aug	7.464	5.508	4.089	3.334	2.574	1.858	1.367	0.99	0.74	0.616
Sep	6.622	4.903	3.608	2.888	2.187	1.607	1.2	0.904	0.701	0.562
B/C Category										
Oct	5.961	4.495	3.38	2.552	1.897	1.407	1.046	0.784	0.596	0.474

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Nov	6.214	4.564	3.395	2.644	2.018	1.461	1.057	0.786	0.592	0.478
Dec	7.288	5.439	4.084	3.118	2.338	1.761	1.246	0.871	0.631	0.513
Jan	9.396	6.468	4.823	3.946	2.844	1.947	1.365	0.893	0.616	0.514
Feb	14.357	5.911	4.755	3.937	2.946	1.996	1.276	0.795	0.556	0.459
Mar	6.689	5.99	5.445	4.597	3.485	2.343	1.424	0.846	0.56	0.457
Apr	8.943	6.311	5.124	4.732	3.391	2.26	1.58	0.894	0.656	0.595
May	9.117	6.51	4.992	4.228	3.252	2.239	1.495	0.883	0.6	0.536
Jun	7.894	5.811	4.442	3.654	2.897	2.025	1.351	0.862	0.586	0.486
Jul	7.646	5.582	4.231	3.501	2.699	1.913	1.31	0.887	0.621	0.515
Aug	6.875	5.074	3.854	3.102	2.379	1.696	1.229	0.87	0.633	0.513
Sep	6.106	4.527	3.402	2.682	2.013	1.46	1.072	0.79	0.596	0.467
C Category										
Oct	5.608	4.063	3.165	2.352	1.728	1.261	0.918	0.668	0.489	0.372
Nov	5.747	4.172	3.183	2.44	1.844	1.314	0.929	0.672	0.487	0.379
Dec	6.731	4.976	3.83	2.886	2.145	1.596	1.107	0.75	0.523	0.411
Jan	8.598	5.93	4.528	3.678	2.63	1.776	1.229	0.78	0.518	0.416
Feb	13.101	5.54	4.465	3.684	2.743	1.839	1.157	0.702	0.47	0.378
Mar	5.822	5.597	5.117	4.312	3.256	2.171	1.299	0.749	0.478	0.38
Apr	8.091	5.801	4.811	4.401	3.154	2.09	1.421	0.787	0.541	0.484
May	8.369	5.972	4.688	3.951	3.027	2.064	1.354	0.778	0.51	0.439
Jun	7.276	5.321	4.169	3.401	2.686	1.857	1.221	0.754	0.495	0.397
Jul	7.057	5.108	3.97	3.251	2.491	1.743	1.171	0.77	0.521	0.416
Aug	6.354	4.641	3.615	2.871	2.184	1.534	1.091	0.749	0.526	0.41
Sep	5.649	4.139	3.19	2.476	1.84	1.313	0.944	0.675	0.491	0.371
C/D Category										
Oct	3.866	3.11	2.337	1.718	1.243	0.888	0.627	0.437	0.301	0.212
Nov	4.027	3.121	2.362	1.786	1.334	0.931	0.639	0.444	0.304	0.221
Dec	4.725	3.723	2.847	2.122	1.563	1.15	0.783	0.512	0.342	0.256
Jan	6.096	4.438	3.376	2.735	1.943	1.297	0.899	0.56	0.366	0.275
Feb	9.307	4.172	3.339	2.755	2.049	1.368	0.862	0.525	0.341	0.272
Mar	4.366	4.199	3.839	3.237	2.446	1.634	0.981	0.57	0.367	0.293
Apr	5.813	4.349	3.596	3.262	2.353	1.564	1.027	0.582	0.389	0.327
May	5.914	4.467	3.499	2.949	2.26	1.538	1.003	0.576	0.379	0.311
Jun	5.119	3.981	3.105	2.523	1.992	1.369	0.901	0.545	0.358	0.277
Jul	4.957	3.821	2.952	2.403	1.833	1.268	0.842	0.539	0.364	0.271
Aug	4.456	3.472	2.685	2.111	1.593	1.1	0.769	0.511	0.346	0.253
Sep	3.957	3.096	2.367	1.813	1.331	0.93	0.651	0.446	0.308	0.221
D Category										
Oct	2.657	2.039	1.508	1.084	0.759	0.515	0.336	0.206	0.112	0.051
Nov	2.728	2.053	1.527	1.133	0.824	0.548	0.348	0.215	0.12	0.062
Dec	3.199	2.451	1.849	1.359	0.981	0.703	0.459	0.273	0.16	0.101
Jan	4.119	2.932	2.211	1.791	1.255	0.817	0.569	0.34	0.214	0.135
Feb	6.288	2.762	2.212	1.827	1.354	0.897	0.566	0.347	0.213	0.168
Mar	2.911	2.8	2.561	2.161	1.636	1.097	0.664	0.391	0.256	0.207
Apr	3.915	2.884	2.374	2.122	1.552	1.039	0.633	0.377	0.238	0.178
May	3.999	2.953	2.299	1.948	1.493	1.012	0.652	0.375	0.248	0.183
Jun	3.465	2.625	2.028	1.644	1.299	0.881	0.58	0.337	0.221	0.156
Jul	3.356	2.517	1.92	1.554	1.175	0.793	0.512	0.309	0.206	0.125
Aug	3.018	2.284	1.74	1.351	1.002	0.666	0.447	0.273	0.167	0.096

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Sep	2.681	2.036	1.53	1.151	0.822	0.547	0.358	0.218	0.125	0.071
Category Total Flow Assurance curves (mill. m^3)										
A Category										
Oct	7.368	5.483	3.896	3.095	2.362	1.813	1.41	1.117	0.907	0.769
Nov	10.818	8.304	6.492	5.506	4.777	4.008	3.127	2.112	0.906	0.768
Dec	25.579	20.755	17.287	15.379	14.324	12.949	10.227	6.225	0.998	0.812
Jan	33.385	26.147	21.235	19.044	17.583	15.677	12.363	7.407	0.967	0.801
Feb	43.574	29.15	23.335	20.845	19.477	17.394	13.592	8.048	0.881	0.7
Mar	32.972	26.535	21.086	18.562	17.103	14.988	11.525	6.808	0.864	0.687
Apr	25.206	19.365	15.007	13.638	11.928	10.125	7.971	4.655	1.041	0.922
May	14.847	11.316	8.256	6.904	5.771	4.511	3.329	2.023	0.875	0.821
Jun	9.978	7.512	5.403	4.324	3.466	2.486	1.716	1.172	0.852	0.748
Jul	9.502	7.015	5.094	4.165	3.264	2.383	1.7	1.225	0.913	0.808
Aug	8.386	6.223	4.599	3.717	2.91	2.146	1.618	1.216	0.944	0.814
Sep	7.367	5.47	4.034	3.231	2.49	1.869	1.435	1.118	0.9	0.745
A/B Category										
Oct	7.08	5.295	3.766	2.953	2.235	1.698	1.303	1.016	0.81	0.676
Nov	10.305	7.874	6.129	5.203	4.485	3.739	2.899	1.941	0.811	0.676
Dec	23.994	19.361	16.151	14.39	13.363	12.053	9.498	5.762	0.896	0.717
Jan	30.858	23.969	19.791	17.84	16.419	14.598	11.493	6.865	0.872	0.709
Feb	39.975	25.941	21.678	19.521	18.194	16.206	12.639	7.466	0.796	0.622
Mar	28.774	22.814	19.479	17.436	16.019	13.993	10.727	6.316	0.781	0.611
Apr	22.726	17.143	13.959	12.846	11.2	9.471	7.413	4.314	0.928	0.817
May	13.788	10.173	7.728	6.588	5.481	4.254	3.112	1.871	0.789	0.729
Jun	9.437	6.936	5.102	4.159	3.319	2.361	1.611	1.078	0.767	0.664
Jul	9.051	6.58	4.831	4.001	3.116	2.253	1.587	1.123	0.821	0.714
Aug	8.048	5.918	4.376	3.563	2.768	2.02	1.505	1.111	0.847	0.718
Sep	7.102	5.246	3.847	3.092	2.361	1.754	1.329	1.019	0.806	0.657
B Category										
Oct	6.515	4.929	3.573	2.752	2.066	1.552	1.174	0.9	0.703	0.575
Nov	9.582	7.335	5.721	4.841	4.153	3.445	2.654	1.758	0.706	0.577
Dec	22.192	17.928	14.978	13.357	12.381	11.149	8.768	5.296	0.785	0.615
Jan	27.966	21.99	18.282	16.581	15.23	13.514	10.625	6.325	0.77	0.611
Feb	35.774	23.409	19.922	18.15	16.89	15.018	11.694	6.892	0.705	0.54
Mar	23.976	20.668	17.853	16.241	14.894	12.982	9.93	5.828	0.695	0.534
Apr	19.815	15.401	12.798	11.963	10.419	8.79	6.841	3.969	0.806	0.706
May	12.376	9.21	7.09	6.178	5.124	3.956	2.872	1.708	0.698	0.632
Jun	8.605	6.36	4.718	3.907	3.108	2.193	1.481	0.97	0.676	0.575
Jul	8.319	6.082	4.492	3.752	2.908	2.083	1.448	1.005	0.721	0.615
Aug	7.464	5.508	4.089	3.334	2.574	1.858	1.367	0.99	0.74	0.616
Sep	6.622	4.903	3.608	2.888	2.187	1.607	1.2	0.904	0.701	0.562
B/C Category										
Oct	5.961	4.495	3.38	2.552	1.897	1.407	1.046	0.784	0.596	0.474
Nov	8.837	6.771	5.351	4.483	3.828	3.156	2.414	1.578	0.6	0.478
Dec	20.46	16.522	13.907	12.354	11.429	10.273	8.06	4.844	0.673	0.513
Jan	25.672	20.164	16.963	15.36	14.078	12.465	9.786	5.802	0.668	0.514
Feb	32.73	21.371	18.458	16.821	15.628	13.869	10.782	6.337	0.614	0.459
Mar	21.639	18.569	16.594	15.08	13.803	12.004	9.158	5.355	0.608	0.457
Apr	18.024	13.953	11.898	11.1	9.659	8.13	6.284	3.633	0.685	0.595

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
May	11.319	8.363	6.635	5.772	4.772	3.662	2.635	1.547	0.607	0.536
Jun	7.894	5.811	4.442	3.654	2.897	2.025	1.351	0.862	0.586	0.486
Jul	7.646	5.582	4.231	3.501	2.699	1.913	1.31	0.887	0.621	0.515
Aug	6.875	5.074	3.854	3.102	2.379	1.696	1.229	0.87	0.633	0.513
Sep	6.106	4.527	3.402	2.682	2.013	1.46	1.072	0.79	0.596	0.467
C Category										
Oct	5.608	4.063	3.165	2.352	1.728	1.261	0.918	0.668	0.489	0.372
Nov	8.16	6.202	4.982	4.132	3.509	2.873	2.178	1.4	0.495	0.379
Dec	18.846	15.17	12.866	11.381	10.507	9.425	7.375	4.404	0.562	0.411
Jan	23.568	18.527	15.693	14.176	12.963	11.45	8.974	5.295	0.566	0.416
Feb	29.999	19.76	17.069	15.534	14.407	12.759	9.9	5.799	0.524	0.378
Mar	19.571	17.167	15.372	13.954	12.746	11.057	8.412	4.896	0.522	0.38
Apr	16.444	12.83	11.041	10.259	8.92	7.488	5.743	3.306	0.567	0.484
May	10.395	7.677	6.198	5.372	4.425	3.374	2.402	1.389	0.516	0.439
Jun	7.276	5.321	4.169	3.401	2.686	1.857	1.221	0.754	0.495	0.397
Jul	7.057	5.108	3.97	3.251	2.491	1.743	1.171	0.77	0.521	0.416
Aug	6.354	4.641	3.615	2.871	2.184	1.534	1.091	0.749	0.526	0.41
Sep	5.649	4.139	3.19	2.476	1.84	1.313	0.944	0.675	0.491	0.371
C/D Category										
Oct	3.866	3.11	2.337	1.718	1.243	0.888	0.627	0.437	0.301	0.212
Nov	6.238	4.981	4.011	3.336	2.86	2.36	1.783	1.11	0.311	0.221
Dec	15.824	13.062	11.125	9.905	9.223	8.322	6.525	3.859	0.377	0.256
Jan	19.811	15.978	13.605	12.352	11.409	10.16	7.995	4.696	0.41	0.275
Feb	24.789	17.2	14.886	13.612	12.734	11.373	8.872	5.194	0.391	0.272
Mar	16.963	14.798	13.234	12.07	11.141	9.775	7.498	4.369	0.408	0.293
Apr	13.465	10.788	9.304	8.628	7.635	6.51	4.986	2.89	0.414	0.327
May	7.77	6.029	4.883	4.251	3.541	2.738	1.963	1.136	0.385	0.311
Jun	5.119	3.981	3.105	2.523	1.992	1.369	0.901	0.545	0.358	0.277
Jul	4.957	3.821	2.952	2.403	1.833	1.268	0.842	0.539	0.364	0.271
Aug	4.456	3.472	2.685	2.111	1.593	1.1	0.769	0.511	0.346	0.253
Sep	3.957	3.096	2.367	1.813	1.331	0.93	0.651	0.446	0.308	0.221
D Category										
Oct	2.657	2.039	1.508	1.084	0.759	0.515	0.336	0.206	0.112	0.051
Nov	4.744	3.749	3.03	2.546	2.215	1.851	1.392	0.823	0.126	0.062
Dec	13.322	10.969	9.399	8.458	7.968	7.245	5.696	3.327	0.192	0.101
Jan	16.628	13.458	11.541	10.563	9.889	8.901	7.041	4.113	0.254	0.135
Feb	20.409	14.644	12.743	11.729	11.101	10.023	7.872	4.606	0.258	0.168
Mar	14.401	12.468	11.13	10.218	9.567	8.522	6.608	3.856	0.293	0.207
Apr	10.895	8.757	7.58	7.017	6.369	5.55	4.244	2.482	0.26	0.178
May	5.691	4.377	3.561	3.135	2.662	2.106	1.528	0.886	0.253	0.183
Jun	3.465	2.625	2.028	1.644	1.299	0.881	0.58	0.337	0.221	0.156
Jul	3.356	2.517	1.92	1.554	1.175	0.793	0.512	0.309	0.206	0.125
Aug	3.018	2.284	1.74	1.351	1.002	0.666	0.447	0.273	0.167	0.096
Sep	2.681	2.036	1.53	1.151	0.822	0.547	0.358	0.218	0.125	0.071

11.5 EWR 5: KLEIN LETABA

11.5.1 Hydrology data summary

Natural Flows:					Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV	Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)					($m^3 * 10^6$)			
0.0	124.18	200	2.12	1.61	0	67.08	187.08	0.05	2.79
% Zero flows	0.0				% Zero flows	0.0			
Baseflow Parameters:			A	0.96	Baseflow Parameters:			A	0.96
			B	0.44				B	0.44
BFI				0.42	BFI				0.2
Hydro Index				8.3	Hydro Index				30.6

MONTH	MEAN	SD	CV	MONTH	MEAN	SD	CV
	($m^3 * 10^6$)				($m^3 * 10^6$)		
Oct	3.02	1.96	0.65	Oct	0.12	0.24	1.96
Nov	4.77	6.11	1.28	Nov	0.93	2.29	2.46
Dec	7.57	12.13	1.6	Dec	2.37	7.05	2.98
Jan	24.19	63.57	2.63	Jan	15.63	59.81	3.83
Feb	31.2	96.11	3.08	Feb	23.89	95.18	3.98
Mar	25.53	76.22	2.99	Mar	18.69	69.93	3.74
Apr	9.06	17.33	1.91	Apr	4.38	16.52	3.77
May	4.38	2.96	0.68	May	0.43	1.09	2.53
Jun	3.97	2.48	0.62	Jun	0.23	0.55	2.37
Jul	3.85	2.42	0.63	Jul	0.21	0.47	2.24
Aug	3.47	2.21	0.64	Aug	0.1	0.21	2.04
Sep	3.16	2.09	0.66	Sep	0.1	0.2	2.1

Critical months:	Wet Season	Feb	Dry Season	Oct
Max. baseflows (m^3/s)	2.117		0.967	

11.5.2 Hydraulics data summary

Geomorph. Zone	5
Flood Zone	9
Max. Channel width (m)	148.4
Max. Channel Depth (m)	3.53

11.5.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	1.2	0.05
A/B	1.25	0.1
B	1.3	0.2
B/C	1.4	0.25
C	1.5	0.35
C/D	1.6	0.45
D	1.8	0.5
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress A Category Aligned		
Table of flows (m^3/s) v stress index		

Stress	Wet Season Flow	Dry Season Flow
0	2.242	1.043
1	2.04	0.829
2	1.75	0.64
3	1.436	0.444
4	1.097	0.319
5	0.844	0.223
6	0.542	0.178
7	0.234	0.134
8	0.156	0.089
9	0.078	0.045
10	0	0

11.5.4 High flow estimation summary details

No High flows when natural high flows are < 20% of total flows							
Maximum high flows are 250% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	22.905	21.032	19.259	17.581	15.993	14.492	13.074
Oct	0	0	0	0	0	0	0
Nov	2.09	1.919	1.757	1.604	1.459	1.322	1.193
Dec	5.369	4.93	4.514	4.121	3.749	3.397	3.065
Jan		4.739	4.339	3.961	3.603	3.265	2.946
Feb	6.317	5.801	5.312	4.849	4.411	3.997	3.606
Mar	3.968	3.644	3.337	3.046	2.771	2.511	2.265
Apr	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0

11.5.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows				
Long term mean flow requirements (Mill. m^3 and %MAR)				
Category	**Low Flows**		**Total Flows**	
	Mill. m^3	**%MAR**	**Mill. m^3**	**%MAR**
A	9.322	7.5	30.856	24.8
A/B	8.43	6.8	28.203	22.7
B	6.929	5.6	25.035	20.2
B/C	6.127	4.9	22.656	18.2
C	4.831	3.9	19.867	16
C/D	3.701	3	17.325	14
D	3.103	2.5	15.394	12.4

11.5.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Natural Total flow duration curve (mill. m^3)										
Oct	*6.221*	*4.694*	*3.817*	*2.974*	*2.345*	*1.958*	*1.696*	*1.386*	*1.085*	*0.56*
Nov	*9.48*	*6.23*	*4.66*	*3.752*	*3.23*	*2.704*	*1.97*	*1.416*	*1.01*	*0.51*
Dec	*16.382*	*8.372*	*5.972*	*4.938*	*4.405*	*3.51*	*2.949*	*1.864*	*1.187*	*0.699*
Jan	*53.803*	*26.258*	*10.935*	*6.664*	*5.345*	*4.28*	*3.594*	*2.802*	*1.798*	*0.904*
Feb	*69.081*	*40.794*	*20.637*	*12.138*	*6.12*	*4.438*	*3.341*	*2.686*	*2.193*	*0.821*
Mar	*40.421*	*23.57*	*13.662*	*7.818*	*5.41*	*4.14*	*3.123*	*2.52*	*2.003*	*1.033*
Apr	*14.871*	*9.54*	*7.184*	*5.616*	*4.35*	*3.382*	*2.771*	*2.294*	*1.62*	*0.981*
May	*8.615*	*6.984*	*5.192*	*4.256*	*3.545*	*2.93*	*2.535*	*2.02*	*1.524*	*0.865*
Jun	*7.956*	*6.658*	*4.723*	*3.936*	*3.105*	*2.794*	*2.338*	*1.982*	*1.449*	*0.807*
Jul	*7.806*	*6.364*	*4.797*	*3.836*	*2.785*	*2.624*	*2.257*	*1.888*	*1.444*	*0.777*
Aug	*7.162*	*5.742*	*4.303*	*3.348*	*2.53*	*2.41*	*2.019*	*1.694*	*1.308*	*0.763*
Sep	*6.658*	*4.972*	*4.13*	*2.94*	*2.31*	*2.098*	*1.75*	*1.488*	*1.145*	*0.671*
Natural Baseflow flow duration curve (mill. m^3)										
Oct	*5.6*	*4.668*	*3.73*	*2.578*	*2.16*	*1.888*	*1.561*	*1.314*	*0.94*	*0.56*
Nov	*5.814*	*4.66*	*3.603*	*2.975*	*2.439*	*2.169*	*1.682*	*1.264*	*0.916*	*0.51*
Dec	*5.831*	*4.833*	*4.289*	*3.251*	*2.699*	*2.287*	*1.777*	*1.344*	*0.962*	*0.695*
Jan	*9.909*	*7.524*	*5.076*	*3.9*	*3.301*	*2.714*	*2.253*	*1.807*	*1.142*	*0.874*
Feb	*15.421*	*9.883*	*6.233*	*4.949*	*3.496*	*3.021*	*2.506*	*2.041*	*1.296*	*0.795*
Mar	*11.976*	*9.01*	*6.618*	*4.991*	*3.705*	*2.99*	*2.571*	*2.199*	*1.384*	*0.932*
Apr	*9.307*	*7.428*	*5.562*	*4.429*	*3.587*	*2.824*	*2.361*	*2.086*	*1.375*	*0.875*
May	*8.2*	*6.219*	*4.993*	*3.79*	*3.151*	*2.581*	*2.278*	*1.94*	*1.378*	*0.798*
Jun	*7.62*	*6.121*	*4.634*	*3.563*	*2.864*	*2.5*	*2.258*	*1.877*	*1.309*	*0.77*
Jul	*7.467*	*5.78*	*4.607*	*3.544*	*2.68*	*2.442*	*2.129*	*1.821*	*1.293*	*0.759*
Aug	*6.907*	*5.665*	*4.144*	*3.191*	*2.48*	*2.275*	*2.019*	*1.648*	*1.255*	*0.757*
Sep	*6.451*	*4.881*	*4.011*	*2.912*	*2.31*	*2.09*	*1.701*	*1.45*	*1.095*	*0.671*
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	*0.943*	*0.521*	*0.379*	*0.286*	*0.224*	*0.181*	*0.152*	*0.132*	*0.118*	*0.109*
Nov	*1.115*	*0.863*	*0.703*	*0.354*	*0.269*	*0.212*	*0.164*	*0.15*	*0.15*	*0.15*
Dec	*1.28*	*0.839*	*0.652*	*0.453*	*0.352*	*0.253*	*0.189*	*0.189*	*0.188*	*0.188*
Jan	*2.46*	*1.951*	*1.358*	*0.698*	*0.478*	*0.326*	*0.256*	*0.212*	*0.186*	*0.186*
Feb	*4.427*	*3.134*	*1.99*	*0.985*	*0.482*	*0.353*	*0.269*	*0.219*	*0.188*	*0.173*
Mar	*3.345*	*2.488*	*1.663*	*1.037*	*0.506*	*0.375*	*0.286*	*0.244*	*0.244*	*0.244*
Apr	*2.071*	*2.059*	*1.644*	*0.835*	*0.449*	*0.337*	*0.265*	*0.227*	*0.217*	*0.217*
May	*1.658*	*1.481*	*1.257*	*0.658*	*0.44*	*0.304*	*0.255*	*0.224*	*0.208*	*0.207*
Jun	*1.483*	*1.194*	*0.947*	*0.561*	*0.367*	*0.28*	*0.241*	*0.208*	*0.197*	*0.197*
Jul	*1.482*	*1.147*	*0.911*	*0.527*	*0.332*	*0.275*	*0.238*	*0.217*	*0.217*	*0.217*
Aug	*1.343*	*0.923*	*0.72*	*0.415*	*0.293*	*0.246*	*0.212*	*0.202*	*0.202*	*0.202*
Sep	*1.141*	*0.693*	*0.546*	*0.372*	*0.25*	*0.204*	*0.168*	*0.167*	*0.166*	*0.166*
A/B Category										
Oct	*0.831*	*0.489*	*0.353*	*0.264*	*0.205*	*0.165*	*0.137*	*0.118*	*0.104*	*0.095*
Nov	*0.991*	*0.795*	*0.635*	*0.321*	*0.247*	*0.193*	*0.148*	*0.133*	*0.133*	*0.132*
Dec	*1.153*	*0.775*	*0.598*	*0.403*	*0.325*	*0.231*	*0.167*	*0.166*	*0.166*	*0.166*
Jan	*2.234*	*1.782*	*1.233*	*0.605*	*0.443*	*0.299*	*0.232*	*0.19*	*0.165*	*0.164*
Feb	*4.106*	*2.834*	*1.777*	*0.815*	*0.448*	*0.324*	*0.245*	*0.196*	*0.168*	*0.153*
Mar	*3.073*	*2.272*	*1.505*	*0.887*	*0.468*	*0.345*	*0.259*	*0.216*	*0.216*	*0.216*
Apr	*1.887*	*1.88*	*1.487*	*0.716*	*0.415*	*0.309*	*0.241*	*0.204*	*0.192*	*0.192*

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
May	1.486	1.358	1.142	0.572	0.407	0.279	0.231	0.201	0.183	0.183
Jun	1.326	1.097	0.863	0.492	0.34	0.256	0.218	0.187	0.174	0.174
Jul	1.323	1.055	0.832	0.464	0.306	0.251	0.216	0.192	0.192	0.191
Aug	1.196	0.852	0.661	0.372	0.27	0.224	0.191	0.179	0.179	0.178
Sep	1.011	0.642	0.503	0.335	0.23	0.185	0.151	0.147	0.147	0.146
B Category										
Oct	0.659	0.432	0.31	0.231	0.178	0.142	0.117	0.1	0.088	0.08
Nov	0.793	0.673	0.515	0.268	0.216	0.168	0.127	0.114	0.114	0.113
Dec	0.936	0.659	0.501	0.332	0.284	0.201	0.143	0.143	0.142	0.142
Jan	1.831	1.491	0.993	0.469	0.39	0.261	0.201	0.164	0.141	0.141
Feb	3.439	2.361	1.391	0.556	0.394	0.284	0.214	0.17	0.145	0.131
Mar	2.549	1.887	1.208	0.651	0.41	0.302	0.225	0.185	0.185	0.185
Apr	1.558	1.555	1.186	0.536	0.364	0.271	0.21	0.176	0.164	0.164
May	1.199	1.134	0.923	0.445	0.358	0.243	0.201	0.174	0.157	0.157
Jun	1.067	0.926	0.706	0.387	0.298	0.224	0.189	0.161	0.149	0.149
Jul	1.064	0.889	0.684	0.37	0.268	0.219	0.187	0.164	0.164	0.164
Aug	0.958	0.728	0.552	0.307	0.236	0.195	0.166	0.153	0.153	0.153
Sep	0.807	0.55	0.426	0.276	0.2	0.16	0.13	0.126	0.126	0.125
B/C Category										
Oct	0.583	0.4	0.285	0.21	0.159	0.125	0.102	0.086	0.074	0.067
Nov	0.706	0.613	0.447	0.24	0.194	0.149	0.111	0.096	0.096	0.096
Dec	0.836	0.602	0.446	0.301	0.258	0.179	0.123	0.12	0.12	0.12
Jan	1.636	1.345	0.86	0.41	0.355	0.234	0.178	0.142	0.119	0.119
Feb	3.075	2.137	1.176	0.513	0.36	0.256	0.189	0.148	0.124	0.111
Mar	2.286	1.705	1.043	0.554	0.372	0.272	0.198	0.159	0.156	0.156
Apr	1.38	1.378	1.018	0.463	0.33	0.243	0.185	0.152	0.139	0.139
May	1.072	1.005	0.8	0.391	0.326	0.218	0.177	0.151	0.133	0.133
Jun	0.95	0.828	0.617	0.34	0.27	0.2	0.167	0.14	0.126	0.126
Jul	0.947	0.798	0.601	0.327	0.242	0.195	0.165	0.14	0.139	0.139
Aug	0.852	0.659	0.49	0.275	0.212	0.173	0.145	0.13	0.129	0.129
Sep	0.717	0.499	0.382	0.244	0.18	0.142	0.113	0.106	0.106	0.106
C Category										
Oct	0.503	0.343	0.242	0.177	0.133	0.103	0.082	0.068	0.058	0.052
Nov	0.572	0.499	0.333	0.201	0.163	0.123	0.09	0.077	0.077	0.077
Dec	0.674	0.496	0.35	0.255	0.217	0.149	0.1	0.097	0.096	0.096
Jan	1.307	1.051	0.622	0.345	0.302	0.197	0.147	0.116	0.096	0.096
Feb	2.434	1.644	0.783	0.44	0.307	0.216	0.158	0.122	0.101	0.09
Mar	1.816	1.345	0.757	0.461	0.315	0.229	0.163	0.129	0.125	0.125
Apr	1.053	1.032	0.721	0.387	0.279	0.205	0.154	0.124	0.112	0.112
May	0.887	0.775	0.583	0.329	0.276	0.182	0.147	0.124	0.107	0.107
Jun	0.776	0.657	0.462	0.286	0.228	0.167	0.138	0.114	0.102	0.102
Jul	0.767	0.647	0.454	0.275	0.204	0.163	0.136	0.114	0.112	0.112
Aug	0.693	0.537	0.381	0.232	0.178	0.144	0.119	0.104	0.104	0.104
Sep	0.585	0.412	0.306	0.203	0.15	0.117	0.092	0.085	0.085	0.085
C/D Category										
Oct	0.423	0.286	0.2	0.143	0.106	0.08	0.063	0.051	0.042	0.036
Nov	0.47	0.38	0.244	0.164	0.131	0.097	0.069	0.058	0.058	0.058
Dec	0.543	0.384	0.266	0.209	0.177	0.119	0.078	0.073	0.072	0.072
Jan	1.036	0.75	0.423	0.285	0.249	0.159	0.117	0.091	0.073	0.072

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Feb	1.872	1.13	0.521	0.367	0.254	0.176	0.127	0.096	0.078	0.069
Mar	1.419	0.963	0.534	0.383	0.257	0.186	0.129	0.099	0.095	0.095
Apr	0.836	0.706	0.479	0.321	0.228	0.166	0.123	0.096	0.084	0.084
May	0.702	0.574	0.4	0.272	0.227	0.147	0.116	0.097	0.081	0.081
Jun	0.625	0.495	0.329	0.236	0.187	0.134	0.109	0.089	0.077	0.077
Jul	0.625	0.491	0.325	0.227	0.166	0.131	0.107	0.088	0.084	0.084
Aug	0.569	0.417	0.281	0.19	0.144	0.115	0.093	0.079	0.079	0.079
Sep	0.485	0.331	0.236	0.166	0.121	0.093	0.071	0.064	0.064	0.064
D Category										
Oct	0.381	0.254	0.174	0.122	0.087	0.064	0.047	0.036	0.028	0.023
Nov	0.416	0.317	0.215	0.141	0.11	0.078	0.053	0.041	0.04	0.04
Dec	0.472	0.324	0.232	0.18	0.15	0.097	0.06	0.051	0.05	0.05
Jan	0.886	0.6	0.365	0.249	0.214	0.132	0.093	0.069	0.051	0.051
Feb	1.547	0.857	0.467	0.324	0.219	0.148	0.102	0.074	0.057	0.049
Mar	1.196	0.765	0.464	0.337	0.219	0.156	0.102	0.074	0.066	0.066
Apr	0.721	0.56	0.414	0.281	0.194	0.138	0.098	0.072	0.059	0.059
May	0.607	0.472	0.347	0.237	0.195	0.121	0.093	0.074	0.058	0.057
Jun	0.547	0.411	0.285	0.205	0.159	0.111	0.087	0.068	0.055	0.054
Jul	0.549	0.41	0.281	0.196	0.14	0.107	0.085	0.067	0.059	0.059
Aug	0.503	0.354	0.243	0.164	0.121	0.093	0.073	0.055	0.055	0.055
Sep	0.432	0.287	0.205	0.143	0.101	0.074	0.054	0.044	0.044	0.044
Category Total Flow Assurance curves (mill. m^3)										
A Category										
Oct	0.943	0.521	0.379	0.286	0.224	0.181	0.152	0.132	0.118	0.109
Nov	5.192	3.606	2.93	2.455	2.355	2.166	1.728	1.062	0.16	0.15
Dec	11.755	7.884	6.374	5.849	5.712	5.273	4.208	2.532	0.213	0.188
Jan	12.529	8.723	6.857	5.885	5.63	5.151	4.119	2.464	0.21	0.186
Feb	16.753	11.424	8.722	7.334	6.789	6.259	4.998	2.975	0.218	0.173
Mar	11.088	7.695	5.892	5.025	4.468	4.086	3.256	1.976	0.263	0.244
Apr	2.071	2.059	1.644	0.835	0.449	0.337	0.265	0.227	0.217	0.217
May	1.658	1.481	1.257	0.658	0.44	0.304	0.255	0.224	0.208	0.207
Jun	1.483	1.194	0.947	0.561	0.367	0.28	0.241	0.208	0.197	0.197
Jul	1.482	1.147	0.911	0.527	0.332	0.275	0.238	0.217	0.217	0.217
Aug	1.343	0.923	0.72	0.415	0.293	0.246	0.212	0.202	0.202	0.202
Sep	1.141	0.693	0.546	0.372	0.25	0.204	0.168	0.167	0.166	0.166
A/B Category										
Oct	0.831	0.489	0.353	0.264	0.205	0.165	0.137	0.118	0.104	0.095
Nov	4.735	3.313	2.68	2.249	2.163	1.988	1.584	0.971	0.142	0.132
Dec	10.771	7.245	5.852	5.357	5.247	4.841	3.857	2.318	0.189	0.166
Jan	11.48	8	6.283	5.368	5.174	4.73	3.779	2.258	0.187	0.164
Feb	15.424	10.446	7.959	6.645	6.239	5.748	4.587	2.728	0.195	0.153
Mar	10.182	7.053	5.388	4.549	4.106	3.752	2.987	1.806	0.232	0.216
Apr	1.887	1.88	1.487	0.716	0.415	0.309	0.241	0.204	0.192	0.192
May	1.486	1.358	1.142	0.572	0.407	0.279	0.231	0.201	0.183	0.183
Jun	1.326	1.097	0.863	0.492	0.34	0.256	0.218	0.187	0.174	0.174
Jul	1.323	1.055	0.832	0.464	0.306	0.251	0.216	0.192	0.192	0.191
Aug	1.196	0.852	0.661	0.372	0.27	0.224	0.191	0.179	0.179	0.178
Sep	1.011	0.642	0.503	0.335	0.23	0.185	0.151	0.147	0.147	0.146
B Category										

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Oct	0.659	0.432	0.31	0.231	0.178	0.142	0.117	0.1	0.088	0.08
Nov	4.221	2.979	2.387	2.035	1.97	1.811	1.442	0.881	0.122	0.113
Dec	9.744	6.583	5.312	4.869	4.792	4.422	3.523	2.113	0.163	0.142
Jan	10.297	7.185	5.618	4.83	4.722	4.319	3.45	2.058	0.161	0.141
Feb	13.802	9.331	7.052	5.894	5.698	5.251	4.19	2.488	0.169	0.131
Mar	9.059	6.265	4.764	4.005	3.741	3.422	2.722	1.641	0.2	0.185
Apr	1.558	1.555	1.186	0.536	0.364	0.271	0.21	0.176	0.164	0.164
May	1.199	1.134	0.923	0.445	0.358	0.243	0.201	0.174	0.157	0.157
Jun	1.067	0.926	0.706	0.387	0.298	0.224	0.189	0.161	0.149	0.149
Jul	1.064	0.889	0.684	0.37	0.268	0.219	0.187	0.164	0.164	0.164
Aug	0.958	0.728	0.552	0.307	0.236	0.195	0.166	0.153	0.153	0.153
Sep	0.807	0.55	0.426	0.276	0.2	0.16	0.13	0.126	0.126	0.125
B/C Category										
Oct	0.583	0.4	0.285	0.21	0.159	0.125	0.102	0.086	0.074	0.067
Nov	3.836	2.718	2.157	1.853	1.796	1.649	1.311	0.796	0.103	0.096
Dec	8.877	6.01	4.838	4.443	4.372	4.032	3.208	1.919	0.139	0.12
Jan	9.364	6.543	5.081	4.391	4.31	3.938	3.143	1.871	0.137	0.119
Feb	12.536	8.5	6.344	5.386	5.201	4.79	3.819	2.264	0.146	0.111
Mar	8.229	5.702	4.289	3.615	3.413	3.119	2.478	1.488	0.17	0.156
Apr	1.38	1.378	1.018	0.463	0.33	0.243	0.185	0.152	0.139	0.139
May	1.072	1.005	0.8	0.391	0.326	0.218	0.177	0.151	0.133	0.133
Jun	0.95	0.828	0.617	0.34	0.27	0.2	0.167	0.14	0.126	0.126
Jul	0.947	0.798	0.601	0.327	0.242	0.195	0.165	0.14	0.139	0.139
Aug	0.852	0.659	0.49	0.275	0.212	0.173	0.145	0.13	0.129	0.129
Sep	0.717	0.499	0.382	0.244	0.18	0.142	0.113	0.106	0.106	0.106
C Category										
Oct	0.503	0.343	0.242	0.177	0.133	0.103	0.082	0.068	0.058	0.052
Nov	3.42	2.414	1.888	1.668	1.62	1.487	1.182	0.714	0.084	0.077
Dec	7.989	5.415	4.345	4.023	3.96	3.654	2.907	1.733	0.114	0.096
Jan	8.338	5.779	4.462	3.966	3.9	3.566	2.845	1.689	0.112	0.096
Feb	11.04	7.432	5.484	4.873	4.711	4.341	3.46	2.047	0.121	0.09
Mar	7.223	4.981	3.71	3.246	3.081	2.82	2.238	1.338	0.138	0.125
Apr	1.053	1.032	0.721	0.387	0.279	0.205	0.154	0.124	0.112	0.112
May	0.887	0.775	0.583	0.329	0.276	0.182	0.147	0.124	0.107	0.107
Jun	0.776	0.657	0.462	0.286	0.228	0.167	0.138	0.114	0.102	0.102
Jul	0.767	0.647	0.454	0.275	0.204	0.163	0.136	0.114	0.112	0.112
Aug	0.693	0.537	0.381	0.232	0.178	0.144	0.119	0.104	0.104	0.104
Sep	0.585	0.412	0.306	0.203	0.15	0.117	0.092	0.085	0.085	0.085
C/D Category										
Oct	0.423	0.286	0.2	0.143	0.106	0.08	0.063	0.051	0.042	0.036
Nov	3.05	2.115	1.653	1.493	1.452	1.334	1.059	0.635	0.064	0.058
Dec	7.171	4.841	3.886	3.624	3.569	3.295	2.621	1.555	0.088	0.072
Jan	7.406	5.034	3.903	3.567	3.509	3.212	2.561	1.516	0.088	0.072
Feb	9.671	6.374	4.781	4.384	4.244	3.914	3.119	1.84	0.097	0.069
Mar	6.318	4.258	3.209	2.907	2.764	2.534	2.009	1.195	0.106	0.095
Apr	0.836	0.706	0.479	0.321	0.228	0.166	0.123	0.096	0.084	0.084
May	0.702	0.574	0.4	0.272	0.227	0.147	0.116	0.097	0.081	0.081
Jun	0.625	0.495	0.329	0.236	0.187	0.134	0.109	0.089	0.077	0.077
Jul	0.625	0.491	0.325	0.227	0.166	0.131	0.107	0.088	0.084	0.084

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Aug	0.569	0.417	0.281	0.19	0.144	0.115	0.093	0.079	0.079	0.079
Sep	0.485	0.331	0.236	0.166	0.121	0.093	0.071	0.064	0.064	0.064
D Category										
Oct	0.381	0.254	0.174	0.122	0.087	0.064	0.047	0.036	0.028	0.023
Nov	2.743	1.883	1.486	1.34	1.301	1.194	0.946	0.562	0.046	0.04
Dec	6.451	4.345	3.498	3.26	3.21	2.962	2.354	1.388	0.065	0.05
Jan	6.633	4.465	3.504	3.21	3.155	2.886	2.298	1.354	0.064	0.051
Feb	8.583	5.588	4.309	3.948	3.819	3.519	2.801	1.647	0.074	0.049
Mar	5.615	3.738	2.878	2.613	2.481	2.273	1.798	1.062	0.077	0.066
Apr	0.721	0.56	0.414	0.281	0.194	0.138	0.098	0.072	0.059	0.059
May	0.607	0.472	0.347	0.237	0.195	0.121	0.093	0.074	0.058	0.057
Jun	0.547	0.411	0.285	0.205	0.159	0.111	0.087	0.068	0.055	0.054
Jul	0.549	0.41	0.281	0.196	0.14	0.107	0.085	0.067	0.059	0.059
Aug	0.503	0.354	0.243	0.164	0.121	0.093	0.073	0.055	0.055	0.055
Sep	0.432	0.287	0.205	0.143	0.101	0.074	0.054	0.044	0.044	0.044

11.6 EWR 7: LETABA RANCH

11.6.1 Hydrology data summary

Natural Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0.0	646.28	860.99	14.3	1.33
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.41
Hydro Index				6.2

Present Day Flows:				
Area (km^2)	MAR	Ann.SD	Q75	Ann. CV
	($m^3 * 10^6$)			
0	360.69	820.38	1.55	2.27
% Zero flows	0.0			
Baseflow Parameters:			A	0.96
			B	0.44
BFI				0.24
Hydro Index				15.4

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	13.66	5.47	0.4
Nov	23.15	20.56	0.89
Dec	44.75	49.49	1.11
Jan	106.99	208.31	1.95
Feb	175.28	436.73	2.49
Mar	131.47	290.94	2.21
Apr	56.75	73.42	1.29
May	27.28	12.84	0.47
Jun	20.25	7.22	0.36
Jul	17.64	6.19	0.35
Aug	15.43	5.44	0.35
Sep	13.64	5.13	0.38

MONTH	MEAN	SD	CV
	($m^3 * 10^6$)		
Oct	1.74	0.93	0.54
Nov	4.6	10.47	2.28
Dec	15.01	33.77	2.25
Jan	65.21	192.46	2.95
Feb	135.27	430.29	3.18
Mar	96.27	284.8	2.96
Apr	29.39	67.41	2.29
May	5.5	7.07	1.29
Jun	2.57	3.06	1.19
Jul	1.99	1.49	0.75
Aug	1.6	0.16	0.1
Sep	1.53	0.21	0.14

Critical months:	Wet Season	Apr	Dry Season	Oct
Max. baseflows (m^3/s)	8.938		4.753	

11.6.2 Hydraulics data summary

Geomorph. Zone	*6*
Flood Zone	*9*
Max. Channel width (m)	*168.46*
Max. Channel Depth (m)	*11.28*
Observed Channel XS used	
Observed Rating Curve used	
(Gradients and Roughness n values calibrated)	
Max. Gradient	*0.01*
Min. Gradient	*0.001*
Gradient Shape Factor	*20*
Max. Mannings n	*0.08*
n Shape Factor	*20*

11.6.3 Flow - stressor response data summary

Table of initial SHIFT factors for the Stress Frequency Curves		
Category	**High SHIFT**	**Low SHIFT**
A	*1.2*	*0.2*
A/B	*1.3*	*0.25*
B	*1.4*	*0.28*
B/C	*1.45*	*0.3*
C	*1.5*	*0.32*
C/D	*1.55*	*0.35*
D	*1.6*	*0.4*
Perenniality Rules: All Seasons Perennial Forced		
Alignment of maximum stress to Present Day stress B/C Category Aligned		
Table of flows (m^3/s) v stress index		
Stress	**Wet Season Flow**	**Dry Season Flow**
0	*9.024*	*4.899*
1	*6.799*	*3.29*
2	*5.306*	*2.96*
3	*4.405*	*2.731*
4	*3.327*	*2.384*
5	*3.078*	*1.986*
6	*2.925*	*1.589*
7	*2.746*	*1.192*
8	*1.831*	*0.795*
9	*0.915*	*0.397*
10	*0*	*0*

11.6.4 High flow estimation summary details

No High flows when natural high flows are < 25% of total flows							
Maximum high flows are 200% greater than normal high flows							
Table of normal high flow requirements (Mill. m^3)							
Category	**A**	**A/B**	**B**	**B/C**	**C**	**C/D**	**D**
Annual	*76.217*	*71.745*	*67.349*	*63.027*	*58.779*	*54.603*	*50.498*
Oct	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Nov	*4.834*	*4.55*	*4.272*	*3.997*	*3.728*	*3.463*	*1.193*
Dec	*12.395*	*11.668*	*10.953*	*10.25*	*9.559*	*8.88*	*3.065*
Jan	*17.987*	*16.932*	*15.894*	*14.874*	*13.872*	*12.886*	*2.946*

Feb	19.429	18.289	17.168	16.066	14.983	13.919	3.606
Mar	14.145	13.315	12.499	11.697	10.909	10.134	2.265
Apr	7.427	6.992	6.563	6.142	5.728	5.321	0
May	0	0	0	0	0	0	0
Jun	0	0	0	0	0	0	0
Jul	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0

11.6.5 Final Reserve summary details

EWR Flows are NOT constrained to be below Natural or Present Day Flows				
Long term mean flow requirements (Mill. m^3 and %MAR)				
Category	**Low Flows**		**Total Flows**	
	Mill. m^3	**%MAR**	**Mill. m^3**	**%MAR**
A	59.797	9.3	133.541	20.7
A/B	54.03	8.4	123.448	19.1
B	50.173	7.8	115.338	17.8
B/C	47.772	7.4	108.755	16.8
C	45.356	7	102.228	15.8
C/D	42.572	6.6	95.404	14.8
D	39.201	6.1	88.061	13.6

11.6.6 Flow duration and Reserve assurance tables

Columns are FDC percentage points:										
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**99**
Natural Total flow duration curve (mill. m^3)										
Oct	21.53	19.234	16.476	14.542	13.175	11.33	9.817	8.614	7.337	4.843
Nov	41.151	27.276	24.789	21.206	18.215	16.274	13.48	10.782	8.627	5.048
Dec	85.645	60.828	48.486	39.96	30.18	24.36	19.526	16.572	11.251	6.579
Jan	211.829	145.388	95.963	55.84	45.655	33.89	28.517	24.004	18.489	9.222
Feb	380.368	233.618	132.566	75.232	53.26	39.592	29.116	23.526	19.992	10.223
Mar	304.973	174.61	117.296	62.88	47.085	34.53	25.96	21.332	17.56	11.358
Apr	113.078	70.428	59.121	45.994	36.515	26.286	22.091	19.792	16.073	10.87
May	45.214	36.174	33.48	29.362	24.24	21.652	18.93	16.772	13.347	8.698
Jun	28.141	26.148	24.75	22.936	19.695	17.406	15.796	14.2	10.94	7.256
Jul	25.201	23.238	21.419	18.466	16.935	15.188	13.68	12.346	10.086	6.396
Aug	22.381	20.61	18.203	16.744	15.3	13.236	12.01	10.606	9.038	5.607
Sep	21.735	17.756	16.343	14.596	13.815	11.752	9.935	8.942	7.86	4.904
Natural Baseflow flow duration curve (mill. m^3)										
Oct	19.208	16.791	14.8	13.94	12.639	10.627	9.27	8.512	7.076	4.843
Nov	19.936	18.185	16.023	14.914	12.913	11.555	10.454	8.909	7.406	4.871
Dec	24.46	22.464	19.046	17.337	15.854	13.964	12.486	11.101	8.897	5.739
Jan	43.441	33.878	28.291	22.376	19.745	16.818	15.023	13.319	10.594	6.624
Feb	78.307	48.729	33.388	26.637	21.423	18.578	16.999	14.992	11.327	7.417
Mar	72.852	49.251	38.047	28.571	22.896	19.517	17.484	15.645	11.947	8.833
Apr	54.155	39.51	32.295	26.603	23.033	19.813	17.381	14.393	11.434	9.215
May	35.689	32.716	27.059	23.972	20.308	18.417	16.905	13.814	11.287	8.682
Jun	28.141	25.99	23.54	20.854	18.763	16.514	15.352	13.385	10.834	7.256
Jul	25.201	23.222	21.03	18.426	16.805	15.05	13.394	11.855	9.859	6.396
Aug	22.192	20.569	18.203	16.256	15.08	13.024	11.727	10.558	9.038	5.607
Sep	19.873	17.728	15.999	14.354	13.595	11.274	9.839	8.942	7.86	4.904

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Category Low Flow Assurance curves (mill. m^3)										
A Category										
Oct	3.866	2.956	2.576	2.382	2.271	2.203	2.16	2.131	2.111	2.098
Nov	4.174	3.207	2.846	2.583	2.484	2.479	2.407	2.225	2.141	2.046
Dec	5.523	4.439	3.85	3.601	3.595	3.439	3.089	2.801	2.585	2.463
Jan	10.486	8.563	6.833	5.679	5.414	4.636	3.858	3.393	3.114	2.703
Feb	16.94	10.198	7.207	6.621	5.803	4.772	3.999	3.37	3.005	2.99
Mar	16.947	11.294	8.55	7.177	7.112	5.58	4.427	3.939	3.463	3.375
Apr	12.854	10.947	8.417	7.742	7.239	5.696	4.374	3.624	3.245	3.084
May	8.164	7.956	6.614	6.508	5.933	5.256	4.379	3.547	3.29	3.1
Jun	6.102	5.426	5.064	4.925	4.754	4.233	3.772	3.27	2.997	2.854
Jul	5.503	4.725	4.399	4.039	4.021	3.683	3.311	3.047	2.919	2.753
Aug	4.76	3.938	3.54	3.236	3.219	3.051	2.846	2.702	2.655	2.466
Sep	4.193	3.107	2.826	2.592	2.591	2.427	2.254	2.239	2.204	2.144
A/B Category										
Oct	3.546	2.678	2.316	2.13	2.024	1.96	1.918	1.89	1.871	1.859
Nov	3.832	2.904	2.578	2.335	2.204	2.189	2.12	1.949	1.88	1.812
Dec	5.063	4.004	3.544	3.339	3.244	3.026	2.678	2.401	2.207	2.117
Jan	9.562	7.658	6.483	5.442	5.073	4.052	3.288	2.815	2.54	2.271
Feb	15.492	9.152	6.798	6.428	5.488	4.157	3.372	2.806	2.48	2.477
Mar	15.495	10.134	8.005	6.85	6.762	4.876	3.802	3.343	2.887	2.799
Apr	11.716	9.657	8.144	7.59	6.921	4.948	3.671	2.945	2.578	2.423
May	7.459	7.116	6.279	6.276	5.583	4.579	3.693	2.918	2.638	2.477
Jun	5.588	4.88	4.743	4.679	4.433	3.702	3.212	2.716	2.447	2.322
Jul	5.044	4.26	4.082	3.776	3.646	3.235	2.854	2.574	2.422	2.29
Aug	4.367	3.558	3.243	2.971	2.91	2.692	2.482	2.318	2.254	2.116
Sep	3.849	2.814	2.558	2.319	2.319	2.153	1.993	1.956	1.922	1.869
B Category										
Oct	3.286	2.43	2.072	1.889	1.785	1.721	1.68	1.653	1.634	1.622
Nov	3.561	2.645	2.335	2.1	1.954	1.938	1.87	1.707	1.644	1.581
Dec	4.712	3.67	3.286	3.1	2.957	2.726	2.387	2.12	1.936	1.85
Jan	8.946	7.119	6.271	5.249	4.777	3.711	2.966	2.507	2.242	1.989
Feb	14.471	8.46	6.572	6.293	5.223	3.832	3.067	2.498	2.173	2.17
Mar	14.47	9.364	7.606	6.57	6.461	4.485	3.412	2.959	2.539	2.452
Apr	10.965	8.905	7.995	7.498	6.506	4.586	3.343	2.637	2.281	2.13
May	6.961	6.638	6.112	6.106	5.291	4.22	3.358	2.606	2.332	2.176
Jun	5.204	4.54	4.505	4.471	4.151	3.38	2.9	2.419	2.158	2.036
Jul	4.693	3.915	3.826	3.542	3.363	2.926	2.553	2.281	2.132	2.005
Aug	4.059	3.255	2.986	2.729	2.638	2.41	2.202	2.043	1.979	1.85
Sep	3.577	2.562	2.316	2.081	2.067	1.906	1.751	1.713	1.682	1.632
B/C Category										
Oct	3.142	2.298	1.946	1.766	1.663	1.601	1.56	1.533	1.515	1.503
Nov	3.407	2.507	2.209	1.978	1.823	1.805	1.735	1.577	1.519	1.464
Dec	4.504	3.492	3.149	2.972	2.793	2.548	2.21	1.95	1.774	1.696
Jan	8.522	6.822	6.151	5.134	4.557	3.478	2.743	2.285	2.022	1.809
Feb	13.809	8.079	6.488	6.201	5.002	3.595	2.832	2.278	1.965	1.964
Mar	13.806	8.943	7.388	6.346	6.196	4.21	3.157	2.713	2.307	2.221
Apr	10.422	8.57	7.92	7.43	6.197	4.307	3.084	2.389	2.038	1.889
May	6.643	6.45	5.996	5.991	5.06	3.96	3.101	2.369	2.091	1.945

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Jun	4.972	4.403	4.375	4.344	3.952	3.166	2.68	2.205	1.948	1.831
Jul	4.486	3.755	3.689	3.416	3.185	2.737	2.363	2.089	1.935	1.817
Aug	3.882	3.093	2.851	2.601	2.485	2.249	2.041	1.88	1.809	1.695
Sep	3.422	2.428	2.19	1.956	1.933	1.776	1.626	1.581	1.551	1.504
C Category										
Oct	2.997	2.167	1.821	1.643	1.542	1.48	1.44	1.414	1.396	1.384
Nov	3.253	2.372	2.083	1.857	1.691	1.672	1.601	1.447	1.395	1.348
Dec	4.297	3.328	3.014	2.842	2.621	2.369	2.034	1.779	1.611	1.543
Jan	8.1	6.602	6.035	5.014	4.317	3.246	2.519	2.062	1.803	1.63
Feb	13.15	7.762	6.415	6.103	4.754	3.359	2.597	2.059	1.758	1.758
Mar	13.146	8.591	7.175	6.067	5.896	3.935	2.902	2.467	2.074	1.989
Apr	9.879	8.452	7.854	7.362	5.888	4.028	2.824	2.141	1.795	1.649
May	6.343	6.311	5.87	5.865	4.803	3.7	2.844	2.132	1.85	1.713
Jun	4.742	4.272	4.25	4.211	3.738	2.951	2.461	1.991	1.737	1.625
Jul	4.28	3.61	3.555	3.286	2.999	2.547	2.172	1.896	1.737	1.63
Aug	3.705	2.94	2.716	2.472	2.327	2.089	1.88	1.718	1.64	1.541
Sep	3.267	2.295	2.064	1.83	1.8	1.645	1.5	1.449	1.42	1.376
C/D Category										
Oct	2.822	2.02	1.686	1.515	1.417	1.357	1.319	1.293	1.276	1.265
Nov	3.064	2.223	1.947	1.729	1.554	1.534	1.462	1.317	1.269	1.231
Dec	4.035	3.153	2.867	2.699	2.43	2.177	1.85	1.604	1.446	1.388
Jan	7.519	6.414	5.902	4.867	4.026	2.987	2.28	1.832	1.58	1.45
Feb	12.265	7.455	6.301	5.969	4.443	3.092	2.344	1.832	1.552	1.551
Mar	12.263	8.25	6.937	5.705	5.515	3.625	2.632	2.215	1.839	1.755
Apr	9.072	8.281	7.763	7.272	5.508	3.709	2.544	1.882	1.548	1.407
May	6.18	6.152	5.701	5.693	4.485	3.406	2.567	1.887	1.605	1.48
Jun	4.447	4.126	4.112	4.05	3.482	2.714	2.227	1.77	1.522	1.423
Jul	4.021	3.449	3.407	3.141	2.785	2.341	1.972	1.698	1.537	1.441
Aug	3.487	2.773	2.571	2.332	2.153	1.918	1.712	1.552	1.468	1.386
Sep	3.076	2.148	1.929	1.695	1.659	1.51	1.372	1.317	1.288	1.247
D Category										
Oct	2.588	1.844	1.534	1.375	1.285	1.229	1.194	1.17	1.154	1.144
Nov	2.811	2.042	1.793	1.586	1.404	1.386	1.317	1.183	1.141	1.112
Dec	3.706	2.939	2.695	2.521	2.201	1.958	1.65	1.42	1.278	1.232
Jan	6.912	6.16	5.727	4.649	3.647	2.674	2.011	1.586	1.349	1.266
Feb	11.276	7.071	6.123	5.744	4.024	2.763	2.054	1.59	1.344	1.34
Mar	11.28	7.824	6.645	5.277	4.997	3.245	2.333	1.948	1.597	1.518
Apr	8.419	8.005	7.619	7.119	4.987	3.309	2.222	1.605	1.293	1.161
May	5.976	5.938	5.493	5.394	4.062	3.043	2.249	1.623	1.351	1.243
Jun	4.093	3.946	3.938	3.788	3.154	2.432	1.963	1.534	1.301	1.224
Jul	3.698	3.264	3.231	2.954	2.523	2.103	1.753	1.49	1.33	1.256
Aug	3.203	2.57	2.402	2.166	1.951	1.728	1.532	1.378	1.292	1.228
Sep	2.823	1.97	1.774	1.54	1.504	1.365	1.238	1.183	1.154	1.116
Category Total Flow Assurance curves (mill. m^3)										
A Category										
Oct	3.866	2.956	2.576	2.382	2.271	2.203	2.16	2.131	2.111	2.098
Nov	13.087	10.736	9.183	7.977	7.324	6.998	6.026	4.335	2.164	2.046
Dec	28.378	23.744	20.099	17.433	16.007	15.028	12.367	8.21	2.642	2.463
Jan	43.652	36.577	30.413	25.752	23.426	21.455	17.322	11.242	3.198	2.703

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Feb	52.764	40.457	32.677	28.302	25.26	22.938	18.542	11.849	3.095	2.99
Mar	43.029	33.324	27.093	22.962	21.277	18.806	15.015	10.112	3.529	3.375
Apr	26.549	22.515	18.154	16.031	14.677	12.64	9.934	6.865	3.279	3.084
May	8.164	7.956	6.614	6.508	5.933	5.256	4.379	3.547	3.29	3.1
Jun	6.102	5.426	5.064	4.925	4.754	4.233	3.772	3.27	2.997	2.854
Jul	5.503	4.725	4.399	4.039	4.021	3.683	3.311	3.047	2.919	2.753
Aug	4.76	3.938	3.54	3.236	3.219	3.051	2.846	2.702	2.655	2.466
Sep	4.193	3.107	2.826	2.592	2.591	2.427	2.254	2.239	2.204	2.144
A/B Category										
Oct	3.546	2.678	2.316	2.13	2.024	1.96	1.918	1.89	1.871	1.859
Nov	12.223	9.991	8.544	7.413	6.761	6.444	5.526	3.935	1.901	1.812
Dec	26.577	22.176	18.84	16.36	14.928	13.935	11.412	7.493	2.261	2.117
Jan	40.782	34.029	28.68	24.337	22.029	19.884	15.962	10.204	2.618	2.271
Feb	49.215	37.637	30.774	26.838	23.803	21.257	17.062	10.787	2.564	2.477
Mar	40.047	30.872	25.46	21.709	20.096	17.325	13.769	9.154	2.949	2.799
Apr	24.608	20.546	17.31	15.393	13.923	11.486	8.904	5.996	2.611	2.423
May	7.459	7.116	6.279	6.276	5.583	4.579	3.693	2.918	2.638	2.477
Jun	5.588	4.88	4.743	4.679	4.433	3.702	3.212	2.716	2.447	2.322
Jul	5.044	4.26	4.082	3.776	3.646	3.235	2.854	2.574	2.422	2.29
Aug	4.367	3.558	3.243	2.971	2.91	2.692	2.482	2.318	2.254	2.116
Sep	3.849	2.814	2.558	2.319	2.319	2.153	1.993	1.956	1.922	1.869
B Category										
Oct	3.286	2.43	2.072	1.889	1.785	1.721	1.68	1.653	1.634	1.622
Nov	11.437	9.297	7.935	6.867	6.231	5.932	5.067	3.571	1.664	1.581
Dec	24.908	20.729	17.645	15.323	13.926	12.968	10.585	6.9	1.987	1.85
Jan	38.254	31.874	27.108	22.986	20.694	18.572	14.864	9.444	2.315	1.989
Feb	46.128	35.199	29.079	25.452	22.416	19.884	15.918	9.99	2.253	2.17
Mar	37.517	28.832	23.992	20.519	18.978	16.172	12.768	8.414	2.597	2.452
Apr	23.067	19.127	16.599	14.822	13.078	10.723	8.256	5.502	2.311	2.13
May	6.961	6.638	6.112	6.106	5.291	4.22	3.358	2.606	2.332	2.176
Jun	5.204	4.54	4.505	4.471	4.151	3.38	2.9	2.419	2.158	2.036
Jul	4.693	3.915	3.826	3.542	3.363	2.926	2.553	2.281	2.132	2.005
Aug	4.059	3.255	2.986	2.729	2.638	2.41	2.202	2.043	1.979	1.85
Sep	3.577	2.562	2.316	2.081	2.067	1.906	1.751	1.713	1.682	1.632
B/C Category										
Oct	3.142	2.298	1.946	1.766	1.663	1.601	1.56	1.533	1.515	1.503
Nov	10.778	8.733	7.45	6.44	5.826	5.542	4.727	3.321	1.538	1.464
Dec	23.404	19.456	16.587	14.411	13.057	12.132	9.883	6.423	1.821	1.696
Jan	35.948	29.988	25.65	21.733	19.453	17.386	13.877	8.776	2.091	1.809
Feb	43.434	33.103	27.551	24.131	21.091	18.618	14.859	9.29	2.04	1.964
Mar	35.375	27.161	22.722	19.399	17.91	15.147	11.913	7.818	2.361	2.221
Apr	21.747	18.136	15.972	14.284	12.347	10.05	7.682	5.069	2.066	1.889
May	6.643	6.45	5.996	5.991	5.06	3.96	3.101	2.369	2.091	1.945
Jun	4.972	4.403	4.375	4.344	3.952	3.166	2.68	2.205	1.948	1.831
Jul	4.486	3.755	3.689	3.416	3.185	2.737	2.363	2.089	1.935	1.817
Aug	3.882	3.093	2.851	2.601	2.485	2.249	2.041	1.88	1.809	1.695
Sep	3.422	2.428	2.19	1.956	1.933	1.776	1.626	1.581	1.551	1.504
C Category										
Oct	2.997	2.167	1.821	1.643	1.542	1.48	1.44	1.414	1.396	1.384

Columns are FDC percentage points:										
	10	20	30	40	50	60	70	80	90	99
Nov	10.127	8.178	6.97	6.017	5.425	5.158	4.391	3.074	1.412	1.348
Dec	21.923	18.216	15.546	13.51	12.194	11.307	9.19	5.95	1.655	1.543
Jan	33.678	28.207	24.221	20.494	18.209	16.217	12.902	8.116	1.867	1.63
Feb	40.777	31.098	26.058	22.824	19.758	17.369	13.813	8.598	1.828	1.758
Mar	33.261	25.581	21.476	18.241	16.82	14.135	11.068	7.228	2.125	1.989
Apr	20.44	17.374	15.363	13.754	11.624	9.384	7.112	4.64	1.822	1.649
May	6.343	6.311	5.87	5.865	4.803	3.7	2.844	2.132	1.85	1.713
Jun	4.742	4.272	4.25	4.211	3.738	2.951	2.461	1.991	1.737	1.625
Jul	4.28	3.61	3.555	3.286	2.999	2.547	2.172	1.896	1.737	1.63
Aug	3.705	2.94	2.716	2.472	2.327	2.089	1.88	1.718	1.64	1.541
Sep	3.267	2.295	2.064	1.83	1.8	1.645	1.5	1.449	1.42	1.376
C/D Category										
Oct	2.822	2.02	1.686	1.515	1.417	1.357	1.319	1.293	1.276	1.265
Nov	9.449	7.617	6.488	5.594	5.022	4.772	4.055	2.828	1.285	1.231
Dec	20.409	16.984	14.508	12.608	11.322	10.48	8.497	5.479	1.488	1.388
Jan	31.279	26.484	22.796	19.247	16.931	15.036	11.926	7.455	1.639	1.45
Feb	37.93	29.133	24.548	21.502	18.381	16.107	12.763	7.906	1.616	1.551
Mar	30.948	24.033	20.222	17.014	15.663	13.1	10.218	6.637	1.886	1.755
Apr	18.883	16.568	14.738	13.21	10.837	8.684	6.527	4.205	1.573	1.407
May	6.18	6.152	5.701	5.693	4.485	3.406	2.567	1.887	1.605	1.48
Jun	4.447	4.126	4.112	4.05	3.482	2.714	2.227	1.77	1.522	1.423
Jul	4.021	3.449	3.407	3.141	2.785	2.341	1.972	1.698	1.537	1.441
Aug	3.487	2.773	2.571	2.332	2.153	1.918	1.712	1.552	1.468	1.386
Sep	3.076	2.148	1.929	1.695	1.659	1.51	1.372	1.317	1.288	1.247
D Category										
Oct	2.588	1.844	1.534	1.375	1.285	1.229	1.194	1.17	1.154	1.144
Nov	8.716	7.03	5.992	5.16	4.612	4.381	3.714	2.581	1.156	1.112
Dec	18.849	15.73	13.461	11.686	10.425	9.637	7.797	5.004	1.316	1.232
Jan	28.886	24.721	21.35	17.948	15.581	13.817	10.932	6.787	1.404	1.266
Feb	35.011	27.12	22.998	20.109	16.915	14.799	11.69	7.208	1.404	1.34
Mar	28.561	22.42	18.931	15.735	14.382	12.007	9.349	6.038	1.64	1.518
Apr	17.493	15.669	14.071	12.611	9.915	7.91	5.906	3.752	1.316	1.161
May	5.976	5.938	5.493	5.394	4.062	3.043	2.249	1.623	1.351	1.243
Jun	4.093	3.946	3.938	3.788	3.154	2.432	1.963	1.534	1.301	1.224
Jul	3.698	3.264	3.231	2.954	2.523	2.103	1.753	1.49	1.33	1.256
Aug	3.203	2.57	2.402	2.166	1.951	1.728	1.532	1.378	1.292	1.228
Sep	2.823	1.97	1.774	1.54	1.504	1.365	1.238	1.183	1.154	1.116