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

Project Steering Committee Meeting 3

Background Information Document

22 October 2024

water & sanitation
Department:
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PURPOSE OF THIS DOCUMENT

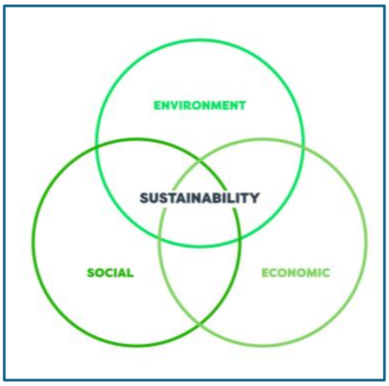
The purpose of this background information document (BID) is to assist members of the Project Steering Committee (PSC) in preparing for the third meeting to be held on the 22 October 2024 in Polokwane.

This BID contains a summary of information on the evaluation of scenarios configured within the integrated water resource management process so that a preferred scenario can be recommended leading to the setting of the proposed water resource classes.

STUDY OBJECTIVE

As part of the mandate of the Department of Water and Sanitation (DWS) to protect water resources as stipulated in Chapter 3 of the National Water Act,1998, the Chief Directorate (CD): Water Ecosystems Management (WEM) initiated the study “Determination of Water Resource Classes, Reserve and Resource Quality Objectives (RQOs) for all significant water resources in the Secondary Catchments (A5-A9) of the Limpopo WMA and B9 in the Olifants WMA” in 2021.

Implementing water resource classes, the Reserve and Resource Quality Objectives (RQOs) aims to ensure sustainable utilisation of water resources to meet the ecological, social and economic needs of the communities dependent on them and provide a mechanism against which the objectives set can be monitored for compliance.



WHERE ARE WE IN THE PROCESS

The Integrated Framework for incorporating the gazetted steps for the Classification, Reserve and RQOs is being used to guide this study (**Figure 1**). The current study has completed Steps 1 to 3 and are on Steps 4 and 5.

Scenarios, in the context of water resource management and planning are used to account for uncertainties associated with ecological, socio-economic and management conditions that affect the performance of water resource systems.

Each scenario represents a plausible alternative future condition, generally reflecting a change to the present condition. Analysis thereof gives the ability to compare the implications of one scenario against another, with the ultimate aim of selecting the preferred scenario.

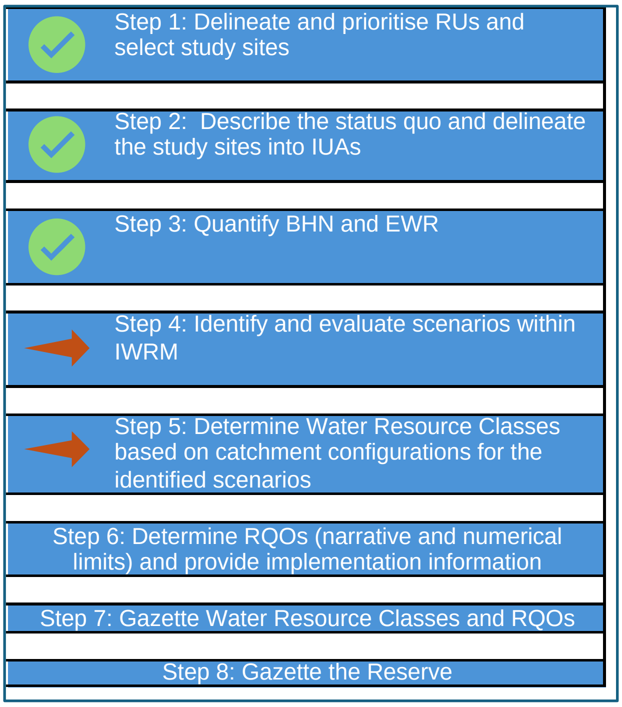


Figure 1. Integrated Framework for Resource Directed Measures

STUDY AREA

The study area quaternaries are divided into twelve integrated units of analysis (IUAs; **Figure 3**) as follows:

- Upper Lephalala (A50A-A50F)
- Lower Lephalala (A50G-A50H)
- Upper Nyl & Sterk (A61A-A61H, A161J)
- Mogalakwena (A62A-A62H, A62J, A63A, A63B, A63D)
- Kalkpan se Loop (A50J, A63C)
- Upper Sand (A71A-A71C, A71E, A71F)
- Lower Sand (A71D, A71G, A71H, A71J, A71K, A72A, A72B)
- Mapungubwe (A63E, A71L)
- Nzhelele/Ṅwaneḓi (A80A-A80H, A80J)
- Upper Luvuvhu (A91A-A91G)
- Lower Luvuvhu/Mutale (A91H, A91J, A91K, A92A-A92D)
- Shingwedzi (B90A-B90H).

APPROACH TO THE SCENARIO ANALYSIS

The overarching aim of the scenario evaluation process is to find the appropriate balance between the level of environmental protection and the use of water to sustain socio-economic activities. Once the preferred scenario has been selected, the Water Resource Class is defined by the level of environmental protection embedded in that scenario.

There are three main elements (variables) to consider in this balance, namely the **biodiversity**, **economic** and **societal benefits** obtained as a result of the water resource class chosen. The scenario evaluation process therefore estimates the consequences that a set of plausible scenarios will have on these elements by quantifying selected metrics to compare the scenarios with one another (**Figure 2**).

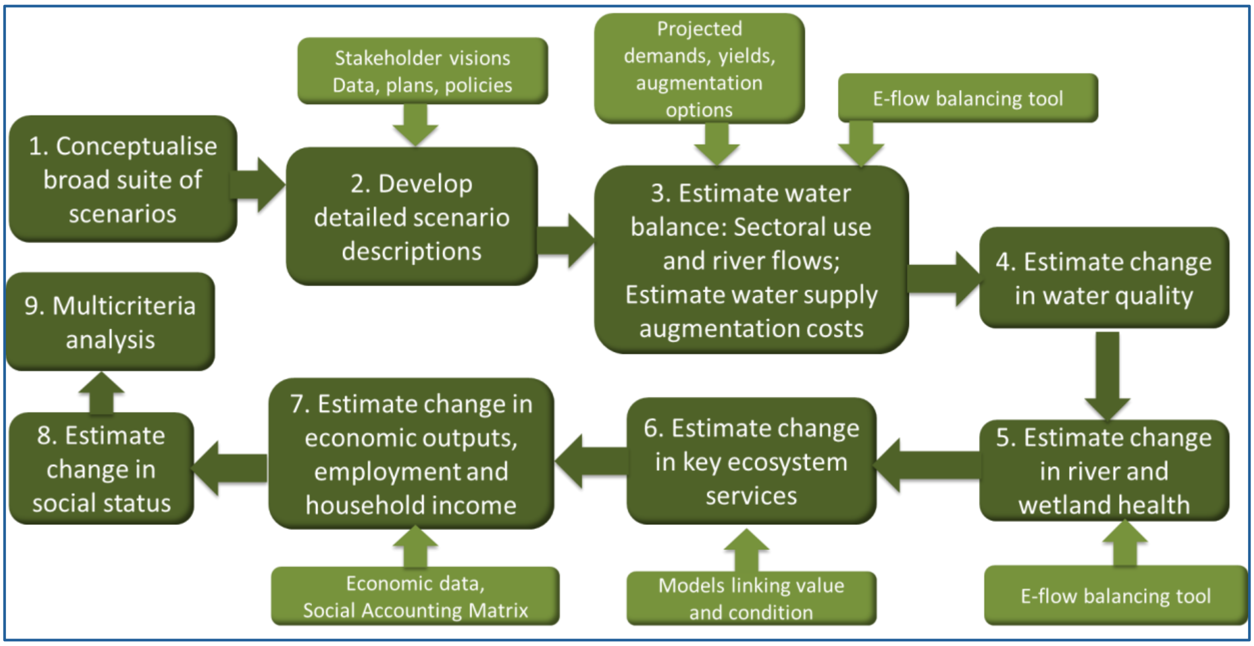


Figure 2. Schematic presentation of the scenario evaluation process

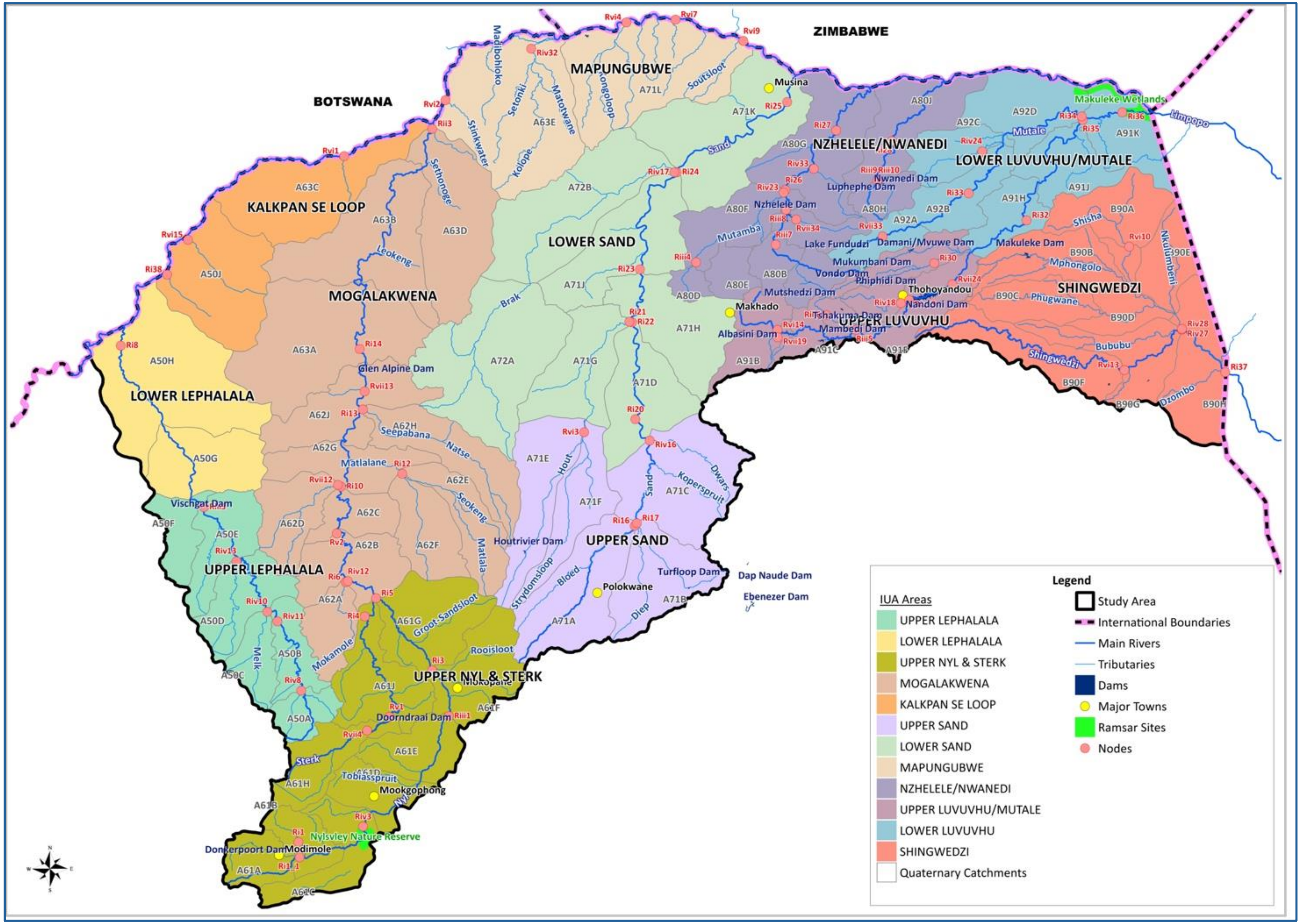


Figure 3. Locality map of the study area showing the 12 IUAs, quaternaries and nodes

OVERVIEW OF CONDITION-ECONOMY-SOCIETY LINKAGES

The allocation of the ecological Reserve is central to the environmental, economic and social outcomes of a region. Water is not only directly critical to social and economic development, but also indirectly, by supporting key ecological systems which provide essential ecosystem goods and services that underpin development and human wellbeing.

The roles of water and aquatic ecosystem services in determining the economic prosperity and the social wellbeing of people living in the study area are summarised in **Figure 4**. The Classification of water resources defines their intended condition as well as the quantity and quality of water required to maintain that specific condition. This in turn, determines the quantity of water that is available for use.

The economic impacts are considered in terms of changes in the two main macro-economic indicators of Gross Domestic Product (GDP) and employment, as well as changes in cost savings due to changes in relevant ecosystem services. This requires estimating the relationships between water use and economic outputs because of production in water user sectors, stream flow reducing sectors and sectors relying on ecosystem services (**Figure 4**). The social impacts are considered in terms of a composite index of societal wellbeing that takes impacts on household income, health and happiness into account.

DEFINING THE CLASSIFICATION SCENARIOS

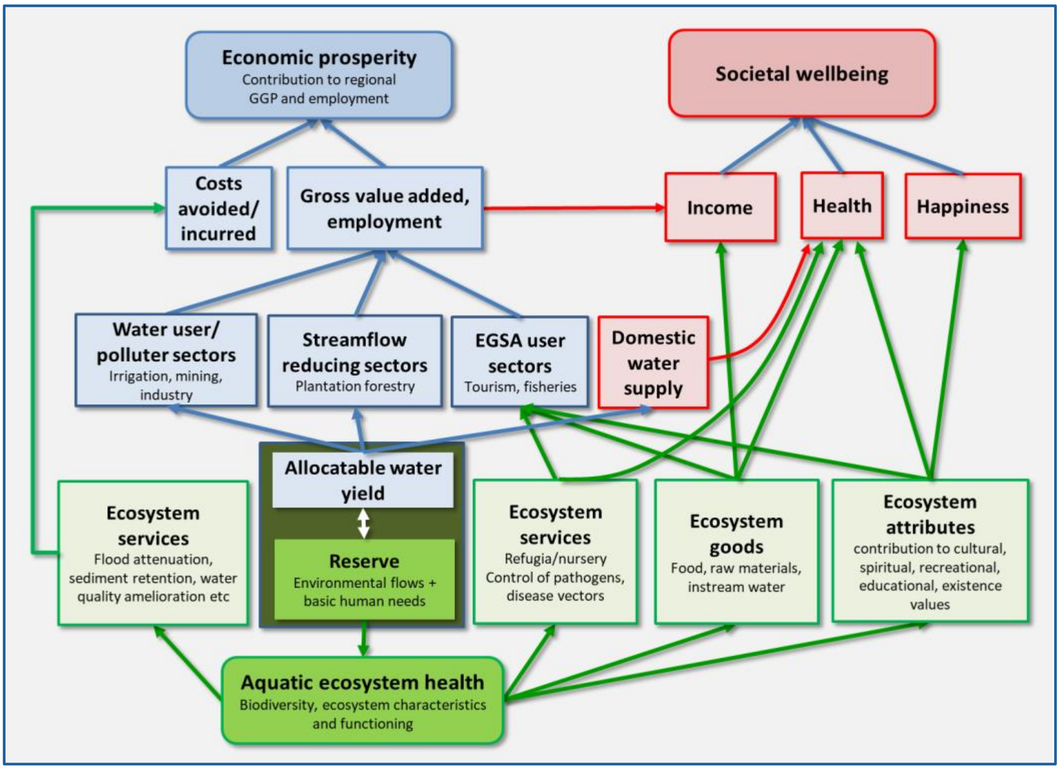


Figure 4. Linkages arising from the trade-off between water abstracted for use and water retained for the ecological Reserve. EGSA = ecosystem goods, services and attributes. Source: (DWS, 2017a) modified from (Turpie et al., 2006)

The rationale for the scenario analysis was to explore the potential water supply, biodiversity and socio-economic outcomes of a range of potential scenarios (ranging from high to low levels of ecosystem protection) against a range of demand contexts. It is important to test against future demands, since the choice of water resource classes made in this process should be robust (i.e. should remain the best choice) for the foreseeable future. There are a large number of potential combinations of the level of protection and contexts, thus a useful and straightforward subset had to be chosen.

Five different scenarios have been considered and are summarised in **Table 1**.

Only scenario 4 (DEV) is a development-driven scenario, in that what happens to water resource condition is an outcome of the scenario. The remaining scenarios are ecologically-driven, in that the ecological decisions are set first, and then the level of development possible under the scenarios is determined based on the resulting constraints on water yield and water quality. This difference is illustrated in **Figure 5**.

Table 1. Scenarios considered, all with 2050 levels of population

#	Scenario	Abbreviation	Description for river and wetland systems	Description for groundwater
1	Maintain Present Ecological Status	PES	River and wetland systems are maintained in their most recently assessed condition[1], or where currently in an E or F, improved to a D as far as possible.	Current groundwater index (i.e., groundwater contribution to baseflow, BHN and current groundwater abstraction)
2	Ecological Bottom Line	ESBC	The maximum volume of water is made available for abstraction from the system for economic activities, with the proviso that all water resources are just maintained in a D category (i.e. the "ecological bottom line") where possible. This can also be seen as a "constrained" development scenario.	Current groundwater uses plus allocable groundwater abstraction (i.e., groundwater contribution to baseflow, BHN and current groundwater abstraction + allocable groundwater) SI of 65 to 85%
3	Biodiversity Economy	BE	Rivers are maintained in their best attainable state (BAS) in order to maximise the possibilities of developing a sustainable biodiversity economy that is founded on a strong conservation outcome. In this scenario, ecosystem health is prioritised by limiting any further demands on water resources, and by increasing health where feasible.	Current groundwater uses while over-exploited catchments were reduced to a SI of below 95%.
4	Unconstrained Development	DEV	Water demands for all future planned or potential developments are met as far as possible without any limit on ecological condition (i.e. can have worse than a D category).	Current groundwater uses plus additional exploitation of groundwater (i.e., groundwater contribution to baseflow, BHN and current groundwater abstraction + additional groundwater potential) SI of 75% for areas with low to moderate to groundwater potential. SI of 85% with moderate groundwater potential.
5	Spatially-targeted Conservation and Development	STCD	Areas of high conservation value are protected by meeting RECs (including at LIMCOM sites), while other areas allow up to maximum sustainable use of water, within the constraint of min D category.	Like the DEV scenario but consideration is given to high ecological priority areas. As such groundwater development in these IUAs are limited to a SI of 50% or up to 60% with limited priority catchments.

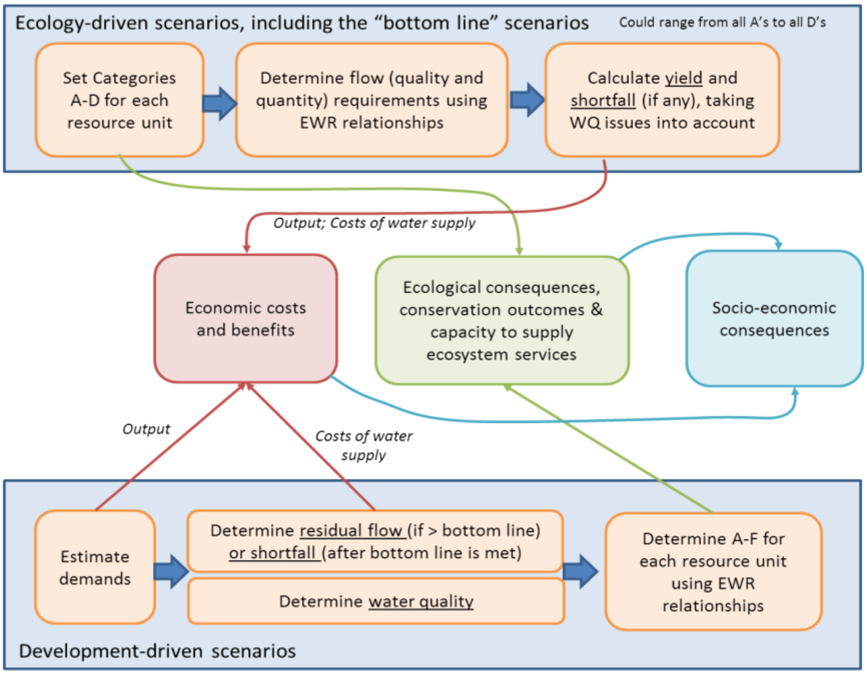


Figure 5. The technical process for assessment of the classification scenarios. Source: (DWS, 2017a)

1 The PES of the EWR sites is 2022, but of all other nodes is from 2014 (Department of Water and Sanitation. 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: W5 (example). Compiled by RQIS-RDM: http://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx)

METHODOLOGY

River flow and river health

Changes in river flow (volume in Million Cubic Meters, MCM) and ecological condition are modelled in a spreadsheet called the 'Balancing Tool'[2] (hereafter called the Tool). The purpose of the Tool is to determine the impact of changes in flow on the ecological condition (**Table 2**) of the river at various points (the river nodes). In the tool BHN allowances were treated as abstractions and all results reported include BHN demands.

Table 2. Definitions of the ecological categories (Kleynhans and Louw 2007)

ECOLOGICAL CATEGORY	GENERIC DESCRIPTION OF ECOLOGICAL CONDITIONS	SCORE (%)
A	Unmodified/natural. Close to natural or close to predevelopment conditions within the natural variability of the system drivers: hydrology, physico-chemical and geomorphology. The habitat template and biological components can be considered close to natural or to pre-development conditions. The resilience of the system has not been compromised.	>92-100
A/B	The system and its components are in a close to natural condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a B category.	>88-≤92
B	Largely natural with few modifications. A small change in the attributes of natural habitats and biota may have taken place in terms of frequencies of occurrence and abundance. Ecosystem functions and resilience are essentially unchanged.	>82-≤88
B/C	Close to largely natural most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a C category.	>78-≤82
C	Moderately modified. Loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundance. Basic ecosystem functions are still predominantly unchanged. The resilience of the system to recover from human impacts has not been lost and it is ability to recover to a moderately modified condition following disturbance has been maintained.	>62-≤78
C/D	The system is in a close to moderately modified condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a D category.	>58-≤62
D	Largely modified. A large change or loss of natural habitat, biota and basic ecosystem functions have occurred. The resilience of the system to sustain this category has not been compromised and the ability to deliver Ecosystem Services has been maintained.	>42-≤58
D/E	The system is in a close to largely modified condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of an E category. The resilience of the system is often under severe stress and may be lost permanently if adverse impacts continue.	>38-≤42
E	Seriously modified. The change in the natural habitat template, biota and basic ecosystem functions are extensive. Only resilient biota may survive, and it is highly likely that invasive and problem (pest) species may dominate. The resilience of the system is severely compromised as is the capacity to provide Ecosystem Services. However, geomorphological conditions are largely intact but extensive restoration may be required to improve the system's hydrology and physico-chemical conditions.	>22-≤38
E/F		>18-≤22
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete change of the natural habitat template, biota, and basic ecosystem functions. Ecosystem Services have largely been lost This is likely to include severe catchment changes as well as hydrological, physico-chemical, and geomorphological changes. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. Restoration of the system to a synthetic but sustainable condition acceptable for human purposes and to limit downstream impacts is the only option.	<18

[2] Also called the 'Basin Configuration Tool' due to its function of assisting with the compilation of configurations of node ECs.

Water quality

To assess the water quality consequences of different catchment scenarios, it is necessary to assess the present water quality status and the degree to which the water quality requirements of users are satisfied. This then forms the basis of predicting how a specific catchment scenario would change the water quality, and then assess how this change would affect water user requirements.

The fitness for use was described using four water quality categories

- **Ideal**: water quality that is fit for all uses and that would have no impacts on any of the users.
- **Acceptable**: water that is fit for most use, but the most sensitive users or crops might be slightly affected.
- **Tolerable**: water quality that is moderately fit for use but certain impacts such as a reduction in crop yield may occur.
- **Unacceptable**: water that is unfit for most use and that will definitely have a negative impact on water users.

Wetland health

The methodology for assessing changes in wetland health under each of the scenarios was conducted at different levels and with differing degrees of confidence / precision. At the broadest (IUA) scale, qualitative assessments based on expert opinion in terms of impacts from changes in surface and groundwater usage formed the basis of the assessment for wetlands in general.

However, distinction was made between different hydrogeomorphic (HGM) wetland types as these generally respond differently or are affected differently to scenarios. Where possible wetland HGMs were aligned to applicable river nodes and the associated changes in volume (from present day) used to make interpretations. Wetland condition (PES) was assigned generally using the wetland condition data field in the National wetland map 5 (Van Deventer *et al.*, 2018).

Two of these wetlands (both Ramsar sites: the Nyl and Luvuvhu floodplains) were selected for more detailed analysis and modelling to determine flow requirements. This process also allowed for the assessment of additional flow-related scenarios.

Groundwater

The approach for assessing impacts on groundwater condition (stress levels) was largely based on the variation of groundwater abstraction under the different scenarios. The Groundwater Resource Directed Measures (GRDM) classification system for groundwater comprise of a ranking approach by applying the stress index (SI) principle. The stress index provides a measure of the groundwater balance in a groundwater unit (in this case, the quaternary catchment), indicating the fraction of how much of the groundwater recharge [volume] is used, i.e. (i) the amount required for BHN (25 l /c /d), (ii) the volume of groundwater supporting the base flow, and (iii) the actual groundwater use /abstraction. When the SI is =1> 1.00, all the recharged groundwater is "allocated ". SI classification system is an indicator of the groundwater use impact and is shown in **Table 3**.

The presented outcome of the scenarios includes qualitative statements based on expert opinion in terms of impacts from groundwater usage on baseflow and the potential for further groundwater development.

Table 3. GRDM SI classification system

Index	Description
< 0.20 (20 %)	Low
0.20 (20 %) - 0.40 (40 %)	Moderate
0.40 (40 %) - 0.65 (65%)	Moderate to High
0.65 (65 %) - 0.95 (95%)	High
> 0.95 (95 %)	Critical

Ecosystem Goods, Services and Attributes (EGSAs)

Impacts of changes in Ecological Condition were estimated based on assumed relationships between ecosystem health and capacity to supply provisioning, regulating and cultural services, and the value of these services. The main types of ecosystem services considered are summarised in **Table 4**, along with the flow-related characteristics that are the main drivers of these values.

Table 4. Main ecosystem services provided by river and wetlands of the study area, and the main flow related variables that can be derived from Reserve studies to estimate changes in the capacity to deliver these services

Category of service	Types of values	Description of EGSA	Independent variables related to river and wetland condition
Goods (Provisioning services)	Harvesting of wild plant and animal resources	Wild plants and fish collected on a subsistence basis for consumption	Overall health Freshwater fish abundance Wetland plant abundance
	Instream water use	Instream water used by households for basic human needs and for irrigation of small home gardens.	Water quantity and quality
Services (Regulating services)	Carbon storage and sequestration	Contribution to the amelioration of climate change damages through sequestration of carbon by riverine and wetland habitats	Overall health Extent of riparian vegetation Water quantity and quality
Attributes (Cultural services)	Nature-based tourism value	A river or wetland's contribution to recreation/tourism appeal of a location	Overall health Water quality

Assessing economic costs and benefits

The following sectors**,** as the main water users in the study area, were considered in estimating economic costs and benefits associated with different scenarios

- Urban and domestic household use;
- Industry and mining; and
- Irrigation agriculture.

There is a hierarchy for water allocation. Apart from the Reserve, the needs of strategic development projects and households are met before those of non-strategic industry and agricultural users. This hierarchy was considered when estimating economic consequences under the scenarios when meeting shortfalls.

The economic impacts are described in terms of (1) value added to the economy (= contribution to GDP) and (2) costs saved or incurred in terms of water supply.

Assessing change in societal wellbeing

It is particularly difficult to describe and quantify changes in societal wellbeing. Peoples' wellbeing is affected by a very wide range of factors, only a few of which are being considered in this study, while the rest are 'held constant' as for the economic analysis.

The social impacts of water allocation will come from changes in household income, changes in the abundance of harvested resources, changes in human health risks as a result of water quality, and the more intangible amenity values associated with natural systems. The cultural, spiritual, and recreational values associated with natural systems are extremely difficult to measure, but very important for peoples' health and wellbeing.

Overall evaluation of scenarios

The ecosystem characteristics and the water available for abstraction form the basis for evaluating and estimating the consequences of each scenario. **Figure 6** shows the three key variables (biodiversity, economy, society) that are being evaluated

The consequences for each of these variables are expressed numerically for the scenarios and compared separately for each variable and then the results are combined for all variables to derive overall scores, which give effect to the ranking of scenarios. The methodology employed for this is based on multi-criteria analysis (MCA) approach where weighting factors are applied, firstly to give effect that certain nodes or catchments are more important than others and secondly that the variables listed in may differ in their relative importance. Each scenario is scored based on the change in a range of ecological, economic and social measures and/or indices which are referred to as criteria or indicators. Not all of these can be measured in comparable units such as money. Therefore, MCA is used in which both monetary and non-monetary impacts can be assessed. The weightings are shown in **Figure 6.**

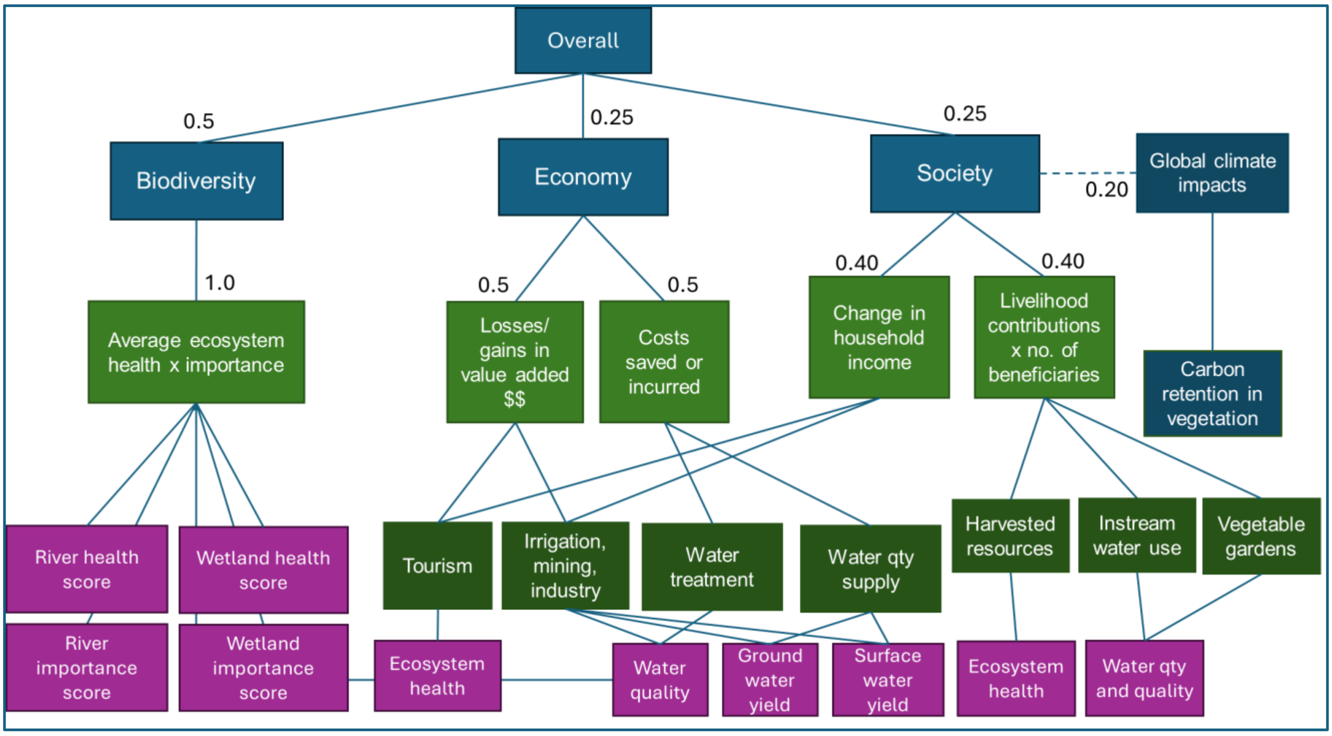


Figure 6. Variable and inputs into the multi-criteria analysis used to evaluate the scenarios

IMPLICATIONS FOR ECOSYSTEMS AND ECOSYSTEM HEALTH

In presenting the results of the scenarios, the IUAs have been grouped together, because of flow links between them. The scenario descriptions for surface water focus on changes in streamflow and the resulting changes in river ecological condition for each scenario as well as river linked wetlands. Condition is scored relative to the natural condition, with A being closest to natural and F being extremely modified. In some instances, and for certain IUAs, mention is also made of wetlands, conservation areas of importance or certain socio-economic factors, as appropriate.

In addition to the impact of each scenario on the ecological condition at the river nodes, the overall impact on water quality, wetlands, water supply, groundwater and ecological goods, services and attributes (EGSAs) are also described for each scenario and for each IUA or group of IUAs. An example of the consequences of the scenarios in the Nzhelele/ Ṅwanedi IUA is provided below (**Table 5** to **Table 8**, **Figure 7** and **Figure 8**). Similar information is provided for the remaining eleven (11) IUAs and is provided in the Scenario Evaluation and Draft Water Resource Classes Report.

CONSEQUENCES OF SCENARIOS IN THE NZHELELE/ ṄWANEḒI IUA

Table 5. Annual volume (MCM), and river condition (A to F) at each node for all scenarios

Node	River	Natural	PES		ESBC		BE		DEV		STCD	
		Vol	Vol	EC	Vol	EC	Vol	EC	Vol	EC	Vol	EC
Riii4	Mutamba	7.14	6.96	C	4.01	D	6.96	C	6.96	C	6.96	C
Riv23	Mutamba	18.61	20.99	C	11.35	D	20.99	C	14.26	C	14.26	C
Riii7	Nzhelele	14.81	13.69	D	11.91	D	13.69	D	13.63	D	13.63	D
Rvii34	Mufungudi	6.68	6.00	D	5.38	D	6.00	D	5.95	D	5.95	D
Riii8	Nzhelele	76.26	56.61	D	43.63	D	56.61	D	53.68	D	49.72	D
Ri26	Nzhelele	94.92	61.08	C	55.53	C	84.48	A/B	54.44	C	64.52	B/C
Riv33	Tshishiru	1.27	0.72	C	0.51	D	0.83	B/C	0.68	C/D	0.68	C/D
Ri27	Nzhelele	99.73	59.60	C	50.02	C/D	87.25	A/B	53.27	C/D	59.12	C
Riii9	Ṅwanedi	21.85	17.91	B	8.51	D	17.91	B	14.31	B/C	14.31	B/C
Riii10	Luphephe	10.17	8.08	C	4.74	D	8.57	C	10.47	B	10.47	B
Ri28	Ṅwanedi	33.47	26.63	C	15.49	D	31.23	B/C	21.07	C/D	24.84	C

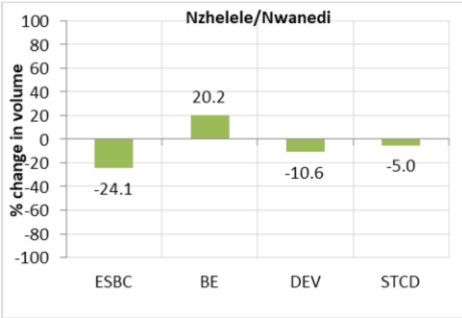


Figure 7. The percentage change in volume from the PES (2022) scenario

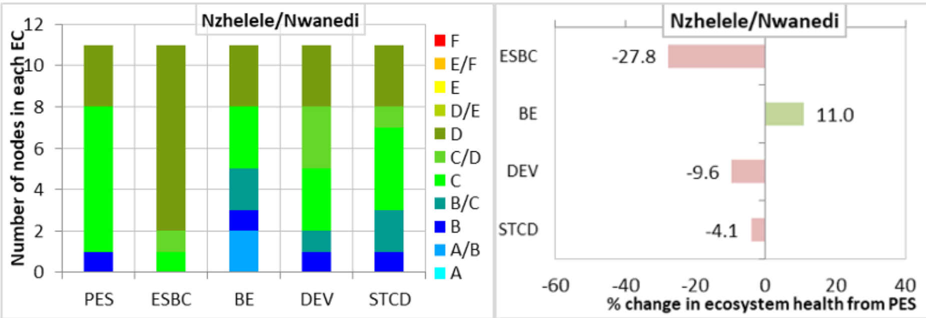


Figure 8. The number of nodes in each EC per scenario and the consequent change in health relative to PES

Table 6. Annual volume (MCM), and river / wetland HGM condition (A to F), generalised for wetlands using applicable nodes, and representing all scenarios

Ref node	River/Wetland HGM	Nat	PES		ESBC		BE		DEV		STCD	
		Vol	Vol	EC	Vol	EC	Vol	EC	Vol	EC	Vol	EC
Riii7	Nzhelele	14.81	13.7	D	11.9	D	13.69	D	13.6	D	13.6	D
	Unchanneled valley bottom			C/D		D		C		C/D		C/D
Ri26	Nzhelele	94.92	61.1	C	55.5	C	84.48	A/B	54.4	C	64.5	B/C
Ri27	Nzhelele	99.73	59.6	C	50.0	C/D	87.25	A/B	53.3	C/D	59.1	C
	Channelled valley bottom			C/D		D		B/C		D		C
Riii9	Ṅwaneḓi	21.85	17.9	B	8.51	D	17.91	B	14.3	B/C	14.3	B/C
Riii10	Luphephe	10.17	8.08	C	4.74	D	8.57	C	10.5	B	10.5	B
	Riverine			C		D		B		B/C		B/C

Table 7. Likely water quality impacts

Scenario	Likely water quality impacts
PES	Overall C category in the lower reaches, overallocation of 123% of natural.
ESBC	Deterioration to D water quality category due to increased allocation of 156% of natural.
BE	Maintain overall C category in the lower reaches, overallocation of 140% of natural.
DEV	Deterioration to D water quality category due to increased allocation of 156% of natural.
STCD	Maintain overall C category in the lower reaches, overallocation of 152% of natural.

Table 8. The percentage change in the groundwater balance from the base scenario (i.e., PES)

Scenario	Volume (MCM/A)	% Index Classification	% Change in Classification	Comment
PES	42.22	43.61%		Low to Moderate groundwater use
ESBC	67.68	69.90%	26.29%	Potential for additional abstraction with limited impact on the groundwater system
BE	42.22	43.61%	0.00%	
DEV	72.22	74.59%	30.98%	Potential for groundwater development; groundwater development within the upper Nzhelele may impact on baseflow
STCD	49.22	50.84%	7.23%	High priority areas limit large groundwater development under this scenario

The total value of EGSA in the Nzhelele/Ṅwanedi IUA is around R354 million per year, which is 12% of the total EGSA value in the WMA. Carbon stocks account for 11% of the total and nature-based tourism, instream water use, and harvested resources are also important, contributing to household incomes and wellbeing. This value declines by some 23% under the ESBC and DEV scenarios and remains largely the same under the BE and STCD scenarios, when compared to the PES.

SUMMARY OF OVERALL IMPACTS OF THE ALTERNATIVE SCENARIOS ACROSS THE STUDY AREA

A multicriteria analysis involved scoring the scenarios based on the change in a range of ecological, economic and social criteria or indicators. Not all of these could be measured in comparable units such as money. The MCA approach allows for both monetary and non-monetary impacts to be assessed. This was done through score normalisation, ensuring equal importance in the data. A normalised score was generated for biodiversity (based on wetland and river health and importance, **Figure 9** below), for economy (based on value added gains or losses to the economy and water supply costs), and for society (based on change in household income and ecosystem goods and services).

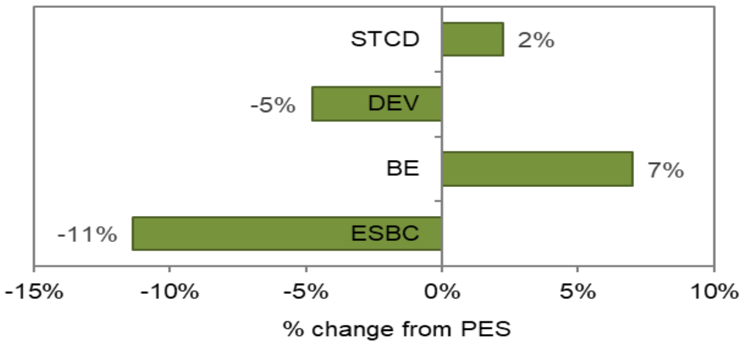


Figure 9. The overall % change in biodiversity score for each scenario compared to the PES. The biodiversity score is a combination of river and wetland health and importance with the incorporation of water quality.

To generate an overall score and ranking of scenarios, the variable scores are weighted. In this analysis, biodiversity was given a weighting of 0.5 and the variables of economy and society were weighted as 0.25 each. It was deemed appropriate to give a higher weighting to biodiversity because of the important intangible elements associated with biodiversity that are not being captured through the scenario process. However, a sensitivity analysis was also undertaken which explored the changes under different weightings. The final scores and ranking of scenarios are shown in **Table 9** and **Figure 10**.

Table 9. Overall scores and ranking of scenarios across scenarios.

Variable	PES	ESBC	BE	DEV	STCD
Biodiversity	0.66	0.12	1.00	0.44	0.77
Economy	0.40	0.66	0.17	0.67	0.57
Society	0.41	0.45	0.56	0.62	0.83
Overall score and ranking	**0.53**	**0.34**	**0.68**	**0.54**	**0.74**

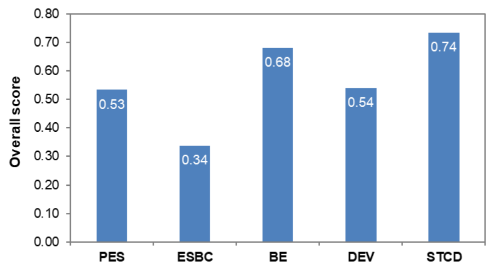


Figure 10. The overall score and ranking of scenarios from the MCA.

Figure 11 shows the normalised score across the three variables for each of the scenarios. This clearly illustrates the trade-offs involved. For example, under the BE scenario, a trade-off is made in terms of the economy and to some extent society through changes in household income, for higher biodiversity gains. Societal gains are highest under the STCD, and the economy and biodiversity scores are higher than maintaining PES.

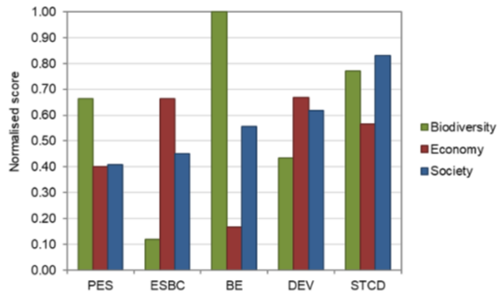


Figure 11. The normalised score for each of the variables (Biodiversity, Economy and Society) for each of the scenarios.

PROPOSED WATER RESOURCE CLASS

The results for each scenario were compared to determine the water resource classes (WRCs) for each IUA. These are presented in **Table 10** and shown graphically in **Figure 12**. All scenarios are mostly in a Class II, except for the ESBC scenario, which is mostly Class III. The DEV scenario is the same as the PES scenario. The BE scenario has no IUAs in a Class III and the highest number of IUAs in a Class I. The STCD scenario has the same number of IUAs in Class II as the BE scenario but with one IUA in a Class III (Upper Sand) and one IUA in a Class I (Kalkpan se Loop).

Table 10. Water resource classes for each IUA under each scenario

Variable	PES	ESBC	BE	DEV	STCD
Lephalala	II	II	II	II	II
Kalkpan Se Loop	I	III	I	I	I
Upper Nyl & Sterk	III	III	II	III	II
Mogalakwena	II	III	II	II	II
Mapungupwe	II	III	I	II	II
Upper Sand	III	III	II	III	III
Lower Sand	II	II	II	II	II
Nzhelele/Nwanedi	II	III	II	II	II
Upper Luvuvhu	II	III	II	II	II
Lower Luvuvhu/Mutale	II	III	II	II	II
Shingwedzi	II	III	II	II	II

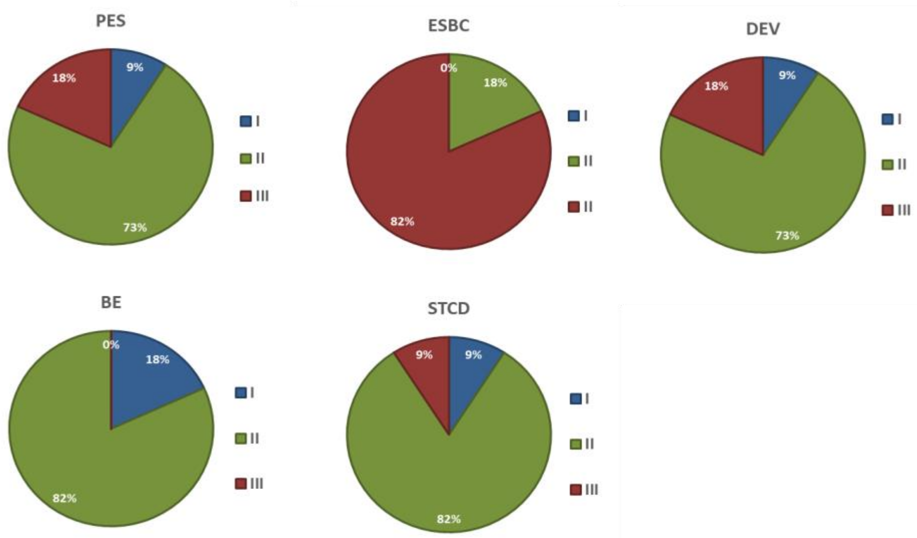


Figure 12. The number of IUAs within each WRC under each of the scenarios. Class I represents higher ECs and minimal use, Class II represents moderate use and Class III lower ECs with heavy use

For more information on the project, you can contact the Stakeholder Engagement office:

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

https://www.dws.gov.za/wem/WRCS/lvhv.aspx

ACRONYMS

BAS	Best Attainable State
BE	Biodiversity Economy
BHN	Basic Human Needs
BID	Background Information Document
CD	Chief Directorate
DEV	Unconstrained Development
DWS	Department of Water and Sanitation
EC	Ecological Condition
EGSA	Ecological, Goods, Services and Attributes
ESBC	Ecologically Sustainable Baseline Configuration
EWR	Ecological Water Requirements
GDE	Groundwater Dependent Ecosystems
GDP	Gross Domestic Product
GRDM	Groundwater Resource Directed Measures
HGM	Hydrogeomorphic
HH	Household
IUAs	Integrated Units of Analysis
IWRM	Integrated Water Resource Management
LIMCOM	Limpopo Watercourse Commission
MCA	Multi-criteria analysis
MCM	Million Cubic Meters
PES	Present Ecological State
PSC	Project Steering Committee
QTY	Quantity
RDM	Resource Directed Measures
REC	Recommended Ecological Category
RQOs	Resource Quality Objectives
RU	Resource Units
SI	Stress Index
STCD	Spatially-targeted Conservation and Development
WEM	Water Ecosystems Management
WMA	Water Management Area
WQ	Water Quality
WW	Wastewater
WWTW	Wastewater Treatment Works