water & sanitation

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Water and Sanitation
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Development of Operating Rules for Water Supply and Drought Management for Stand-Alone Dams and Schemes: Eastern Planning Area

ANNUAL OPERATING ANALYSIS FOR THE SABIE RIVER SYSTEM 2022

Final Report: P RSA 000/00/22921/7

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EXECUTIVE SUMMARY

This report describes the 2022 *Annual Operating Analysis* (AOA) for the Sabie River Water Supply System (WSS). The purpose of an AOA is to define and optimise the short-term (annual) allocation of water from an integrated system with consideration of current water requirement levels and the water storage volumes in reservoirs. The operating rule also considers the defined risk of non-supply for water users in the system. As such, the outcome of the AOA is aimed at minimising the risk of non-supply to high priority water use in the system (e.g. strategic, industrial and basic human needs), by restricting lower priority water use.

Several scenarios were modelled with both the WRYM and WRPM models in order to better understand the capacity of the system to meet the existing water requireements. Of special interest in the Sabie System is the ecological water requirements (EWR). While these have been determined and Gazetted there are alternative views as to how the EWR is defined and how it should be implemented.

The conclusions reached are:

- The water balance of the Sabie/Sand system is very sensitive to the assumptions as to how the Ecological Water Requirements are interpreted and how they are met. The analyses in this report are based on a Department of Water Affairs (DWA) study to develop operating rules for the Sabie/Sand System (DWA, 2013).
- The water use within the Sabie/Sand System has increased rapidly over the past few years to the point at which part of the system are becoming stressed. Restrictions will need to be applied to users in order to ensure that the system does not fail.
- An assurance of supply of 98% for domestic use and 80% for irrigation is still achievable.
- Based on the state of storage at the start of May, restrictions will not be required for the next year.
- No new allocations to high assurance users should be made. However, there is scope for a small increase in low assurance use in the middle reaches of the Sabie River.

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LIST OF ABBREVIATIONS AND ACRONYMS

AOA	Annual Operating Analysis
ARC	Agricultural Research Council
CMA	Catchment Management Agency
DM	District Municipality
DSS	Decision Support System
DWS	Department of Water and Sanitation
EWR	Ecological Water Requirement
FSC	Full Supply Capacity
HIS	Hydrological Information System
IVRS	Integrated Vaal River System
LM	Local Municipality
LTY	Long Term Yield
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NIAPS	National Invasive Alien Plant Survey
PS	Power Station
PSP	Professional Service Provider
SMC	Study Management Committee
STY	Short Term Yield
WARMS	Water Use Authorization and Registration Management System
WCWDM	Water Conservation and Water Demand Management
WMA	Water Management Area
WRC	Water Research Commission
WRMF	Water Resources Modelling Framework
WRPM	Water Resources Planning Model
WRYM	Water Resources Yield Model
WR90	The Water Resources of South Africa 1990 (Midgely et al. 1994)
WR2005	The Water Resources of South Africa 2005 (Middleton and Bailey, 2008)
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Services Provider
WSS	Water Supply Scheme
WTP	Water Treatment Plant
WUA	Water User Association
WUL	Water Use License
WSDP	Water Services Development Plant
uTW	uThukela Water
UW	Umgeni Water
YRC	Yield-Reliability Characteristics (Curve)
ha	hectares
km^2	square kilometres
ℓ/c/day	litres per capita per day
ℓ/s	litres per second
mm	Millimeters
Mℓ	Megalitres
m^3/a	Cubic metres per annum
m^3/s	Cubic metres per second

1 INTRODUCTION

The development of the 2022 annual operating rules for the Sabie River System in Mpumalanga is undertaken through a support project by the Department of Water and Sanitation (DWS) to 'Develop water supply operating rules for stand-alone dams or schemes typical for rural and small municipal set-ups for the Eastern region'. The operating rules for the Sabie System were developed during a previous study (DWA, 2013) and implemented through the Crocodile Operations Committee which is managed by the Inkomati-Usuthu Catchment Management Agency. The model developed for DWA in 2013 was aimed at real-time decision making with a focus on implementing the ecological water requirements. While the Real-Time model does make long term projections based on the antecedent conditions in the catchment, these projections have not been proven to be accurate beyond nine months and are best suited to predicting winter river flows.

The operating analysis described in this report is based on the Water Resources Planning Model (WRPM) which is better suited to making long term (up to ten years) analyses of a systems performance based on the probability of the occurrence of droughts. The WRPM model was set up as part of the Mbombela Reconciliation Strategy Implementation Phase (DWS, 2021).

The Sabie/Sand River system is located within the X3 secondary catchment. See Figure 1.1.

The purpose of this report is to present the results of scenario analysis to evaluate existing operating rules and an updated restriction rule taking into account the latest water demands placed on the system. Recommendations on an updated restriction rule to ensure that the system can be operated sustainably for at least the next five years are presented.

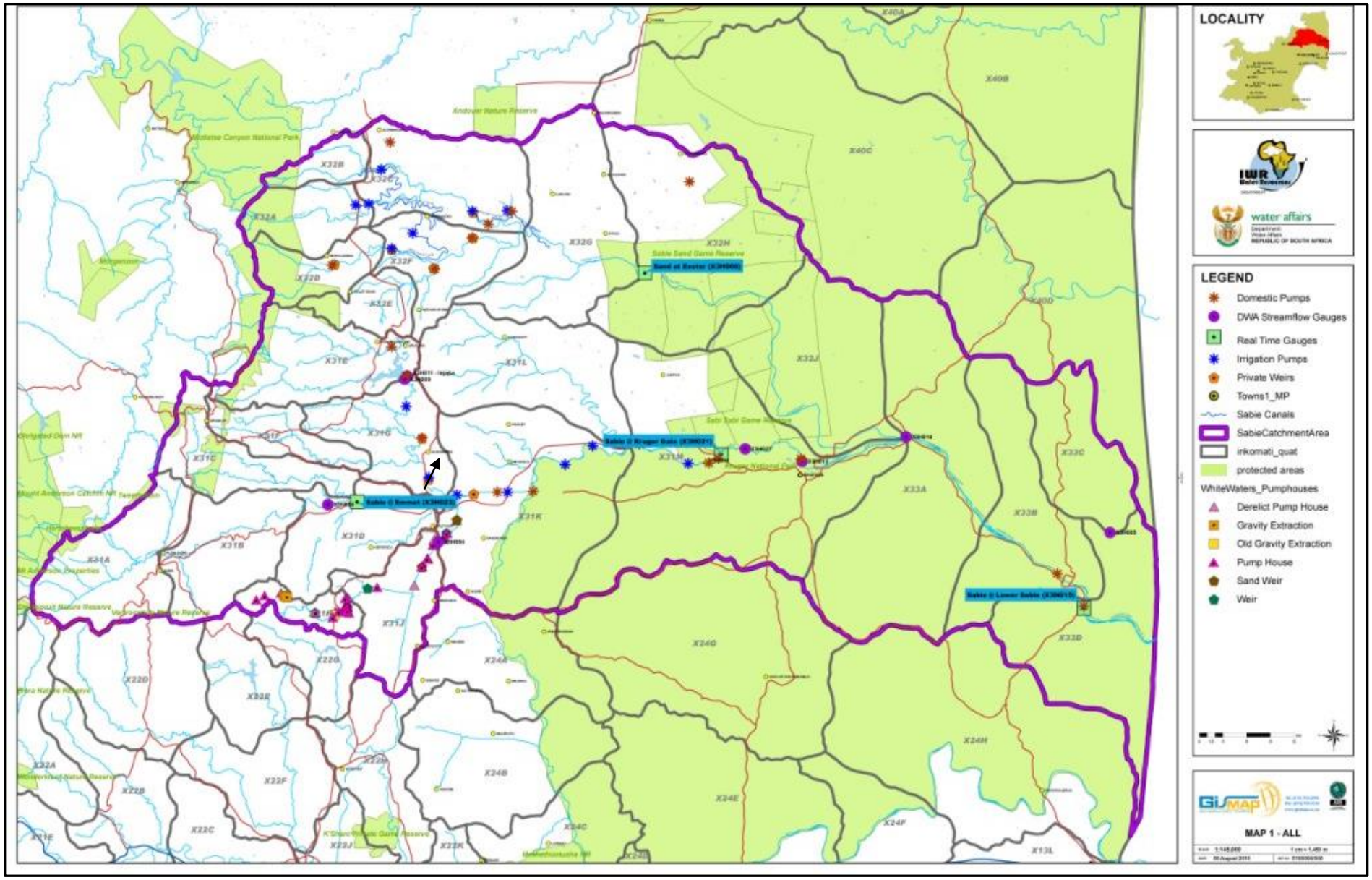

Figure 1.1: Sabie/Sand River System

2 HYDROLOGY OF THE SABIE/SAND RIVER CATCHMENT

The hydrology of the Sabie/Sand River catchment was recently updated by the IUCMA (IUCMA, 2021). Table 2.1 provides a summary of the natural flows derived from this update as well as a comparison with the IWAAS hydrology which was used in previous studies. A table with the natural flows for each quinary catchment is attached as Appendix A.

Table 2.1: Natural flow summary

Catchment	Incremental Natural runoff (million m^3/annum)	
	IWAAS (1920 to 2004)	IUCMA (1920 to 2016)
Upper Sabie (X31A to X31D)	278.80	298.8
Inyaka Dam (X31E)	79.90	78.3
Marite (X31F an X31G)	77.20	78.8
White Waters (X31H and X31J)	47.3	45.5
Middle Sabie (X31K to X31M)	44.0	86.1
Klein Sand (X32A to x32C)	53.2	53.6
Mutlamuvi (X32D to X32F)	51.0	53.8
Sand (X32G to X32J)	31.8	37.3
Lower Sabie (X33A to X33D)	12.5	3.2
TOTAL	**675.7**	**735.4**

3 WATER RESOURCES INFRASTRUCTURE

3.1 Introduction

It is important to document the water supply infrastructure within the Sabie/Sand River system as captured within the WRPM since this has an impact on the amount of water that can be supplied. If there are changes made to the infrastructure in future then the model must be updated in order to accurately represent the system.

3.2 Dams

The parameters of significant dams within the Sabie Sand system are given in Table 3.1.

Table 3.1 List of dams and their characteristics

Dam	FSA(km^2)	FSC (Mm^3)	Dead storage	*User category*
Acornhoek	0.19	1.05	0	Domestic
Casteel	0.16	1.32	0	Dingleydale scheme
Edinburgh	0.60	2.42	0	Allendale and Dumfries Irrigation scheme
Orinoco	0.20	1.62	0	New Forest Irrigation scheme
Inyaka	8.11	125.03	6.470	Domestic and EWR
Da Gama	*1.29*	*13.58*	*0.54*	White Waters Irrigation Board
Maritsane	*0.50*	*2.04*	*0*	Wales irrigation scheme

Source: Dam safety database, 2018

3.3 Transfer schemes

Water is transferred from the Inyaka Dam to the Sand River catchment. The limit on this transfer is 25 million m^3/annum. This water is used to supplement the domestic water requirements of the Sand River catchment.

4 ANNUAL OPERATING ANALYSIS PROCEDURE

4.1 Introduction

The purpose of an annual operating analysis (AOA) is to define and optimise the short-term (annual) scheduling of water supply by means of operating rules. The operating rule takes into consideration the reservoir storage level at a given point in time. For the Sabie/Sand River system, it is recommended that this point or decision date should be the 1st of May since statistically this is the time at which the dam is likely to be at it fullest over any one year. The operating rule takes into consideration a defined risk of non-supply for water users in the system. The outcome of the AOA is to minimise the risk of non-supply to users in the system while meeting the ecological water requirements.

The water supply and drought operating rules for the Sabie/Sand system are currently modelled using the Water Resources Modelling Platform (Mallory et al, 2013), a short-term stochastic model which takes into account the antecedent flow conditions in the catchment. This model has performed well and through the timely implementation of restrictions the system has never failed. However, the short-term model has not been tested over longer time periods. Since the main source of stored water in the Sabie/Sand system is the Inyaka Dam, which has a critical period of 5 years, longer-term stochastic analyses are required to advise on when and if the water resource will need to be augmented to meet growing water demands. These longer-term analyses were performed with the use of the Water Resources Planning Model (WRPM) as set up as part of DWS's Reconciliation Strategy study for the Crocodile and Sabie River catchments (DWS, 2021).

The general methodology followed in the AOA can be described as follows:

- Update the system configuration with new information, i.e., operational issues and infrastructure related information.
- Update reservoir water levels to correspond to the start date of the particular analysis.
- Perform operating analyses and simulate the system behaviour based on actual water levels.
- Review results from the analyses for the various scenarios identified, and
- Propose restriction levels where it is required.

4.2 Water Resources Planning Model

Water Resources planning is based on the fundamental principle that water users may be periodically restricted (i.e., water requirement is not fully supplied). Water restrictions are implemented in a controlled way based on the acceptable risk of non-supply for specific water users. For this purpose, users are prioritised into classes and lower priority users are restricted first to protect higher priority users. The process of determining restrictions involves a simple comparison, at a particular point in time, of the system's water requirements and its short-term yield capability. The latter is based on the available water in storage and the system's corresponding short-term yields.

By far the largest storage in the Sabie/Sand system is the Inyaka Dam with a full supply capacity of 125 million m^3. This dam supplies most of the Sabie/Sand's domestic water requirements directly from the dam while also supplementing the supply to downstream users and making releases to meet the EWR. Hence the tool applied up to this point was to apply restrictions based on the water level in the Inyaka Dam. The WRPM model has been set up to also use the storage in Inyaka Dam as a drought indicator through the use of short-term yield curves for the Inyaka Dam. See **Appendix B**.

Restrictions are managed in the WRPM based on the water allocation definition, which includes three main components, namely (a) the decision month for implementation of restrictions; (b) the water user priority classification and (c) the restriction definition. These are discussed in the following subsections.

(a) Decision month

When planning analyses are undertaken, certain months are identified which are considered to be critical, (either from a water supply or financial point of view) for making decisions on the water supply and the restriction to be applied to the allocation. These decisions are then applied for a pre-determined period of time, usually over the year following the decision date. In the Sabie/Sand River system the recommended decision date is 1 May.

(b) Water user priority classification

The water user priority classification applied in the planning analysis of the Sabie/Sand System has not been previously fully formulated or presented to stakeholders. The current WRMP aims for a 1 in 50 assurance for domestic users but makes no restrictions to irrigators. The Sabie Real-Time model aims to supply domestic users at a 98% assurance and irrigators at 80% assurance. Expressing the target assurance of supply and level of restriction to be applied in terms of Priority Classification results in priority classes, each with a selected risk of non-supply criteria as shown in **Table** 4.1.

Table 4.1: Water user priority classification

User Category	Priority of water supply within indicated priority class				
	High	Medium high	Medium Low	Low	Total
	1:200 (99.5%)	1: 50 (98%)	1:20 (95%)	1:5 (80%)	
Domestic	80	20	0	0	100
Industrial	90	10	0	0	100
Irrigation	40	20	20	20	100

(c) Curtailment definition

The severity of curtailments imposed by the WRPM is described in terms of restriction levels. The restriction levels adopted for the Sabie River System can be summarised as follows:

- **Restriction level "0":** No restrictions are applied.
- **Restriction level "1":** The full requirement of Low and Medium-Low priority users are restricted, but none of the other users.
- **Restriction level "2":** The full requirement of Low and Medium-Low and Medium-High priority users are restricted, but not the High priority users.

  Restriction level "3": The full requirement of all users in the system is restricted (i.e.) no water supplied.

4.3 Monthly Monitoring of System Performance

The monthly monitoring of system performance is important to determine the extent and effectiveness of implemented restrictions, or to monitor those systems that might be on the verge of needing restrictions. Monitoring is also used as an early warning system to assist in identifying the potential need for and prepare for future interventions. Operating rules are of no use if they are not implemented timeously. Monitoring of the systems involves the monthly tracking of the dam storage levels and total releases. These are compared with the projected system performance, represented as Box-and-whisker plots. Through the plots, it can be determined if the system is responding positively to the restrictions imposed and if the intervention is sufficient to safeguard the system.

4.4 Types of Output

The results obtained from the planning analysis are in a form of a 5 year projection of dam trajectories represented by box plots. The box-and-whisker plot definition is shown in **Figure** 4.1. The 'box-and-whisker'-plot concept presents a range of possible future storage levels in a graphical format in terms of exceedance possibilities. The results of the three worst (min, 99.5% and 99% exceedance probabilities) and the three best scenarios (max, 0.5% and 1%) are indicated by three different line types. The more average projections are summarised in the form of the box with whiskers. Other types of output from a planning analysis are curtailment plots, target transfers and releases, etc.

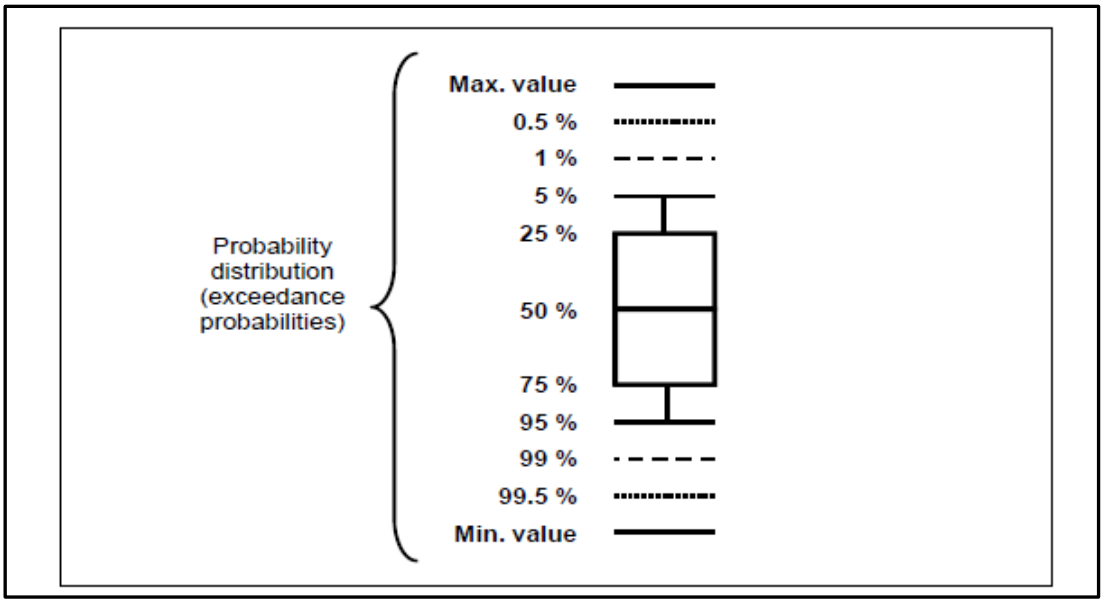

Figure 4.1: Boxplot Definition

5 Annual Operating Analysis

5.1 Model updates for the 2022 AOA

The WRPM and WRYM models were sourced from the DWS Reconciliation Strategy Study (C seago, pers. comm). This model and the various reports produced by the latter study were reviewed and the following model updates carried out.

5.1.1 Redefine the EWR

- According to the DWS 2013 study, which developed a near real-time model to implement the reserve, there was never any intention to implement EWR5, the reasoning being that the releases from the dam to meet EWR3 as well as downstream users should more than suffice for the ecological functioning of the Marite River. In order to be consistent with this approach, EWR5 was removed from the WRPM Sabie setup.
- The EWRs in the WRPM have not been adjusted for the update hydrology.

5.1.2 Add Bushbuckridge as a user

The Reconciliation Strategy (DWS 2021) seems to omit the town Bushbuckridge as a user. According to water use data received recently from the IUCMA (T Sawunyama, pers. comm), production at the Inyaka WTW is approximately 36 million m^3/annum. See Appenix C. Of this, 25 million m^3/annum is transferred to the Sand River catchment, 4 million m^3/annum is supplied to the town of Marite and the remaining 7 million m^3/annum is supplied to the town of Bushbuckridge.

5.1.3 Update AIPs

- Subsequent to the IWAAS study (DWS 2009), the Agricultural Research Council (ARC) produced a report on the extent of Invasive Alien Plants in South Africa (Kotze, 2011). Based on this report, the extend of AIPs is only a small fraction of the area estimated as part of the IWAAS study. This streamflow reduction due to this much smaller area of AIPs were recalculated and time series files generated for each quinary catchment.
-

5.1.4 Increase storage of Acornhoek Dam

- During the course of the IWAAS study the Acornhoek Dam was raised and the Dam Safety office now quote the full supply capacity as 1.05 million m^3. Also, there is a pumpstation on the Klein Sand River which transfers water to the Acornhoek WTW. The WRYM and WRPM models were updated with this new information.
-

5.1.5 Update the STYC

The short-term yield curves need to be updated with the reduced AIPs.

5.1.6 Update water demands to 2022

The water demands in the WRYM were updated to 2022 using the growth in water demand from the Reconciliation Strategy (DWS, 2018).

5.1.7 Update the Priority Classification

The priority classification in WRPM was updated.

5.1.8 Include irrigators as restricted users

The WRPM model has a limitation on the number of Demand Centres that can be modelled. This limitation precluded the inclusion of the Sabie irrigation demands as demand centres. This is a major flaw since the irrigation sector is the largest user in the Sabie catchment and need to be restricted during droughts so that the EWR can be met.

5.2 Current and future water requirements

The AOA for the Sabie/Sand River System is based on current and future water demands derived mostly from the Reconciliation Strategy reports. (DWS, 2021 and DWS, 2018). See Table 5.1. This information was supplemented by a recently obtained record of the water supplied from the Inyaka WTW. See Appendix C.

Table 5.1: Domestic Water Requirements

User	Annual requirement (estimate for 2022)	Abstraction point
Marite	3.70	Inyaka Dam
Bushbuckridge	7.30	Inyaka Dam
Hoxane	15.00	Sabie River with support from Inyaka Dam
Nzikasi North	11.00	Sabie River with support from Inyaka Dam
Sabie	1.78	Groundwater
Graskop	0.90	Groundwater
Hazyview	1.85	Sabie River
Acornhoek	21.50	Klein Sand River, Inyaka Dam and groundwater
Tulamahashe	13.50	Mutlumuvi River, Inyaka Dam and groundwater

Table 5.2: Irrigation water requirements

Location	Allocation (million m^3/annum)	Source of water
Sabie Irrigation Board (X31B)	17.00	Sabie River
White Water Irrigation Board (X31H)	13.20	Da Gama Dam, White Water River

Location	Allocation (million m^3/annum)	Source of water
X31D	25.60	Sabane River
X31E	5.60	Marite River
X31G	1.50	Marite River
X31J	16.00	Sabie River
X31K	7.20	Sabie River
X31M	4.30	Sabie River
Dingleydale Scheme (X32C)	4.60	Tluandzteka River
New Forest Scheme	3.10	Mutlumuvi River
Champagne Scheme	1.30	Klein Sand River
TOTAL	**99.4**	

It needs to be noted that no irrigation water is supplied directly from Inyaka Dam. The irrigators downstream of the Inyaka Dam on the Marite and Sabie River were in existence before the Inyaka Dam was constructed and are not entitled to support from the dam. However, as new development takes place (Hoxane and Nsikasi North) it is assumed that releases from the Inyaka Dam will need to ensure a reasonable assurance of supply to existing irrigators.

5.3 Scenario definition

As part of the AOA, scenarios are defined to assess the system's behaviour to changes in operational and infrastructure-related conditions. The results are used to implement decisions about the system. The conclusions of the Reconciliation Strategy (DWS, 2021) that the Sabie System is overallocated while the performance of the system would suggest otherwise. See Figure 5.1. Several scenarios were modelled to understand and explain these differences.

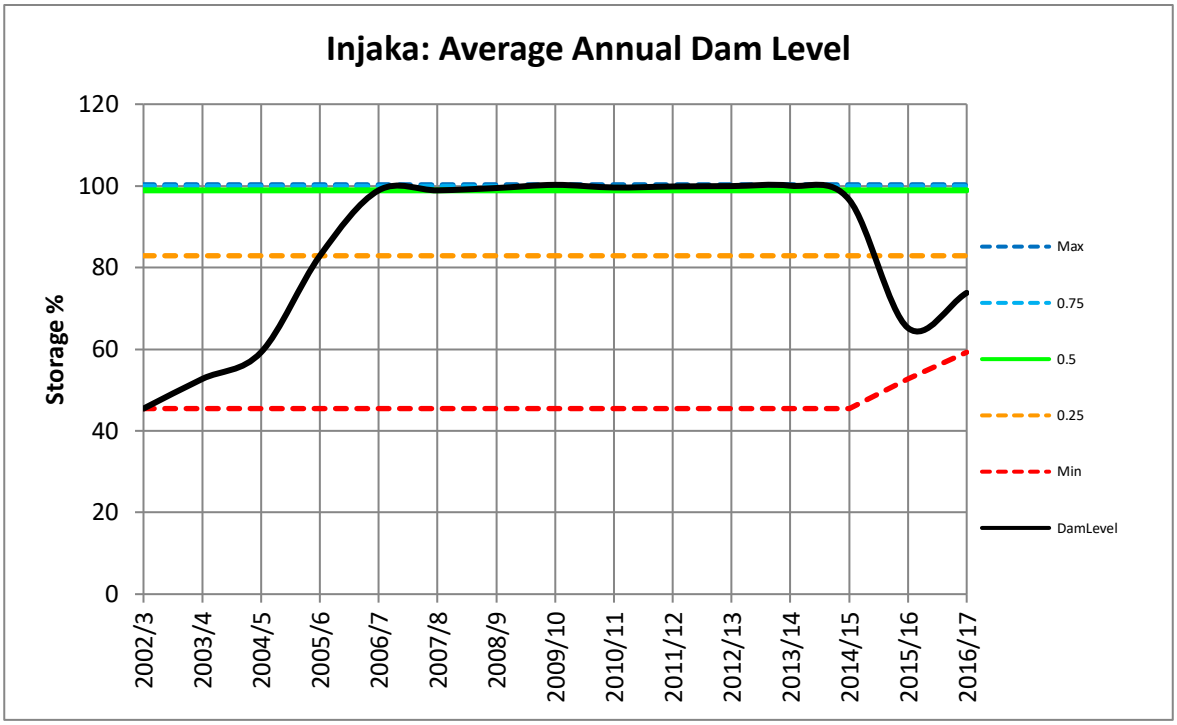

Figure 5.1: Observed storage in the Inyaka Dam. Source: IUCMA

5.3.1 Scenario 1: Recon Strategy Historical Yield Setup

This scenario is the Historical Yield setup reported in in the Recon Strategy Water Resources Report (DWS, 2021). In this report the Historical Yield of Inyaka Dam is stated as being 21.3 million m^3/annum. This yield estimate needs to be understood in the context of the releases made from the dam when determining this yield. It is common and accepted practice to determine the yield of a dam ***after*** meeting the EWR. The Recon Strategy used the EWRs as defined in Classification Study (DWS, 2016). These EWR are summarised on Table 5.2.

The Historic Yield quoted in the Recon Strategy for this scenario is 25.3 million m^3/annum using the IUCMA hydrology (IUCMA, 2021).

Table 5.3: Summary of EWR as defined in the Reconciliation Strategy

EWR	Site Name	Category	MAR upstream of EWR site (million m^3/annum)	Ecological Reserve (% of NMAR)
EWR1	Upper Sabie	B/C	132.0	35.8
EWR2	Aan de Vliet	C	261.7	27.3
EWR3	Kidney	A/B	493.7	30.8
EWR4	Mac Mac	B	65.8	45.4
EWR5	Marite	B/C	156.4	21.7
EWR6	Mutlumuvi	C	45.0	26.0
EWR7	Upper Sand	C	28.9	20.4
EWR8	Lower Sand	B	133.6	18.5

5.3.2 Scenario 2: Inyaka Dam as Operated (only EWR 3 met)

The operating rules for the Sabie/Sand River System were established as part of a DWA study which was completed in 2013 (DWA, 2013). During the course of this study, the methodology developed as part of a Water Research Commission study (Pollard et al, 2012) was applied to meeting the EWR at Kruger Gate (EWR3). The EWR on the Marite River was not considered for implementation at that time. With only EWR3 met, the historic yield of the Inyaka Dam is estimated to be 45.3 million m^3/annum.

5.3.3 Scenario 3: Inyaka Dam as Operated: Minimum flow release and EWR 3

In order to simplify the operation of Inyaka Dam in terms of meeting EWR3, a minimum flow of 0.4 m^3/s is currently being released from the dam (S Magagulu, pers. comm). With this minimum flow release the Historical Yield of the Inyaka Dam drops to 32. 7 million m^3/annum.

5.3.4 Scenario 4: Implementation of the Reserve, as Gazetted

The Reserve for the Sabie River, as Gazetted in 2016, does not include the EWR Rule curves as defined as part of the Classification Study (DWS, 2015). Instead the Gazetted Reserve (Government Gazette, 2016) specifies the river flow required as a percentage of the Natural MAR and also specifies the low flow (90 percentile) for the months of October and February. See Table 5.4.

Table 5.4: Summary of EWRs as Gazetted in 2016

Specified flow	EWR3	EWR5
MAR	37.10% of Natural	36.40% of Natural
October 90%	0.58 m^3/s	0.68 m^3/s
February 90%	1.50 m^3/s	0.75 $m^3/3$

The Historic Yield of Inyaka Dam for this scenario is 41.7 million m^3/annum.

5.3.5 Scenario Summary: Historic Yields

Table 5.5 Summarises the historic yield of the Inyaka Dam

Table 5.5: Summary of Historic Yields of Inyaka Dam

Scenario	Historic yield (million m^3/annum)	
	This study	Previous studies
1: All EWRs as per the Classification study	25.30	25.30 (DWS, in progress)
2: Only EWR 3 met	45.30	50.00 (DWA, 2016)
3: As currently operated with minimum flow release	32.70	
4: Implement Reserve as Gazetted	41.70	

While Scenario 2, 3 and 4 indicate higher yields (based on different interpretations of the Reserve), than reported in the DWS 2021 Reconciliation Strategy study, of more importance is the system yield since the large abstractions on the Sabie River are not supplied directly from Inyaka Dam but are only supported by releases from the dam. These demands are Nsikazi North (11 million m^3/annum), Hoxane (15 million m^3/annum), and irrigation (13 million m^3/annum).

A systems analysis was carried out for two scenarios, described below.

5.3.6 Scenario 5: System yield as understood in the White Paper (WPD-94)

The White Paper (RSA, 1994) states that the Inyaka Dam 'adds 57.8 million m^3/annum to the system yield, 14.0 million m^3/annum of which is low assurance yield'. It is not clear, however, where the new irrigation development would take place. From a system yield perspective, the system yield would be lowest if the new irrigation is supplied directly from the dam. When modelled with this assumption (see Figure 5.2), the system of yield is 58 million m^3/annum which is in line with the White Paper.

5.3.7 Scenario 6: Additional yield located on the Sabie River near the border of the Kruger National Park

The Reconciliation Strategy report (DWS, 2021) states that the 14.0 million m^3/annum of additional irrigation cannot be met from the Inyaka Dam. However, the White Paper proposed allocations from the ***Sabie System*** and not necessarily directly from the dam. Assuming that EWR3 is retained as defined in the Classification Study, an additional 8 million m^3/annum of low assurance could be allocated from the Sabie River (with support from Inyaka Dam) near the border with the Kruger National Park, See Figure 5.3. As a sub scenario, if the Gazetted Reserve is accepted at EWR3 then additional irrigation of up to 50 million m^3/annum at low assurance is possible from the Sabie River.

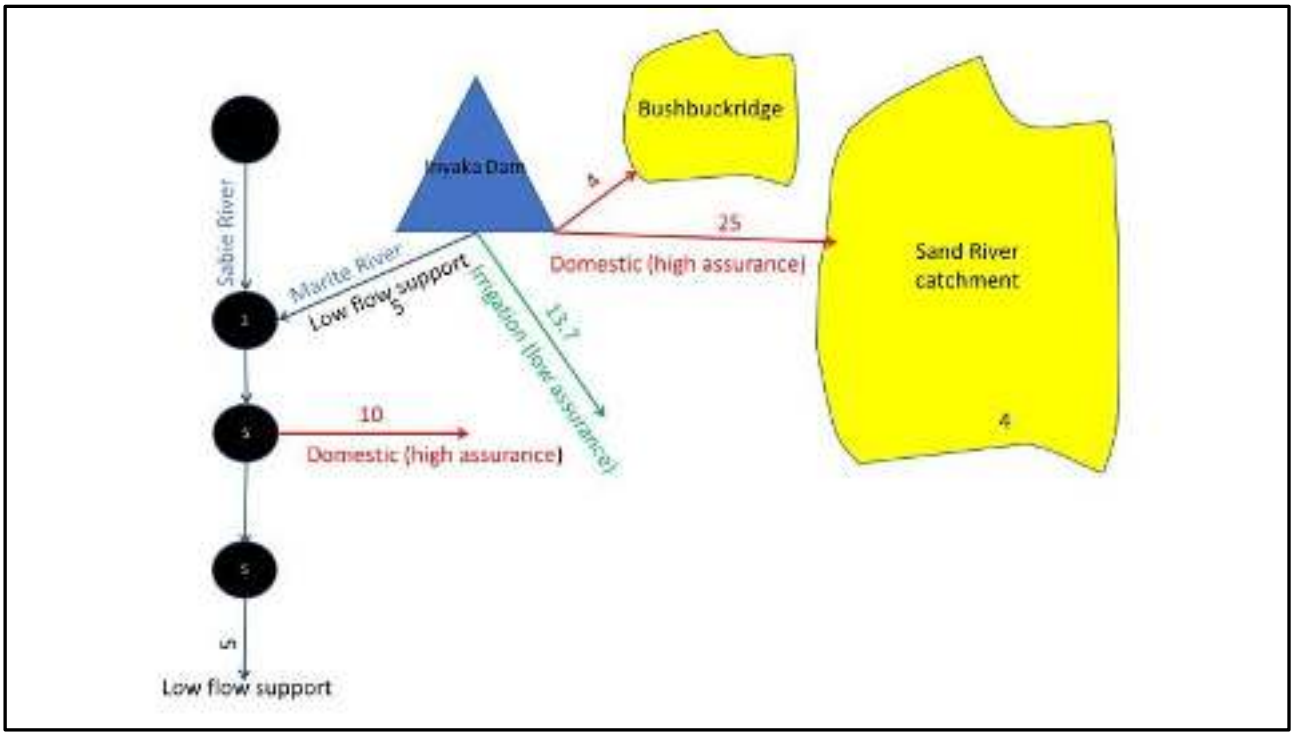

Figure 5.2: Systems Diagram of the Sabie System as modelled for White Paper WPD-94 (RSA, 1994)

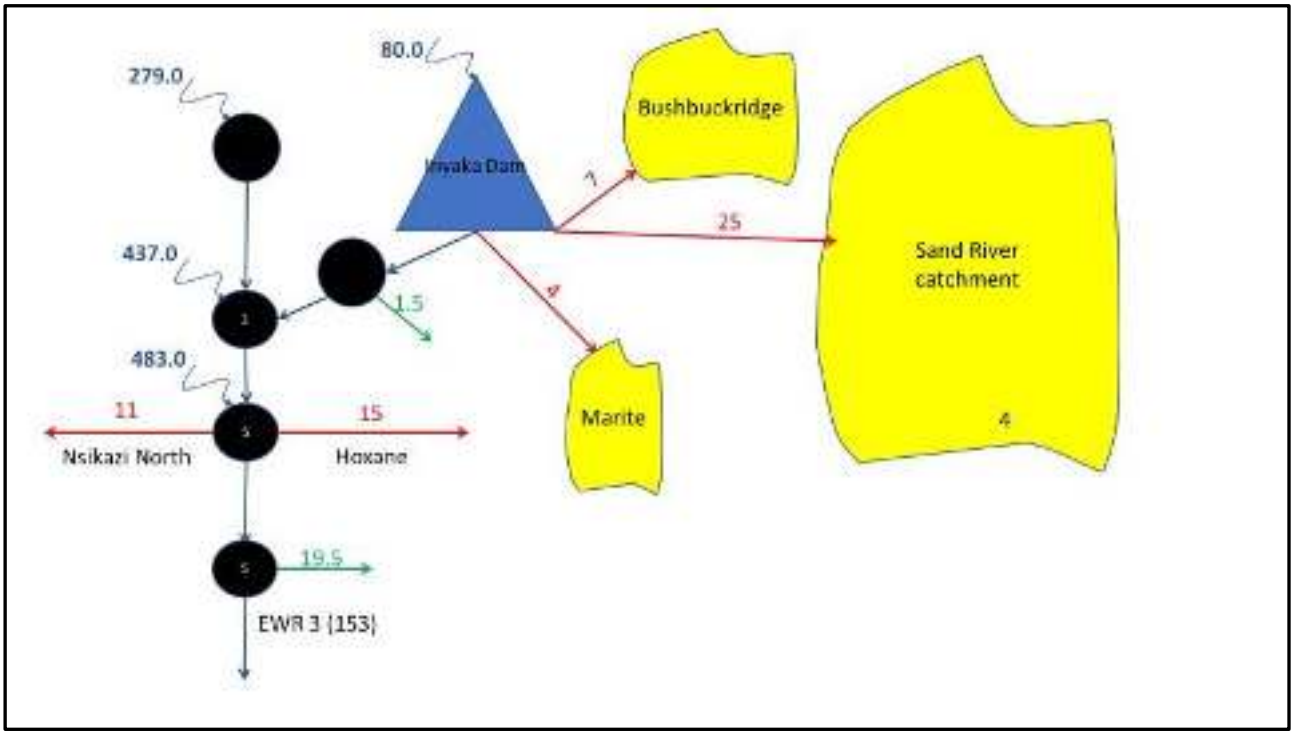

Figure 5.3: System analysis to quantify low assurance yield in Middle reaches of the Sabie River

5.4 Long Term Yield Analysis

A long-term yield analysis was carried out using WRYM for the system, as shown in Figure 5.4. The Long-Term Yield curve is shown in Figure 5.5.

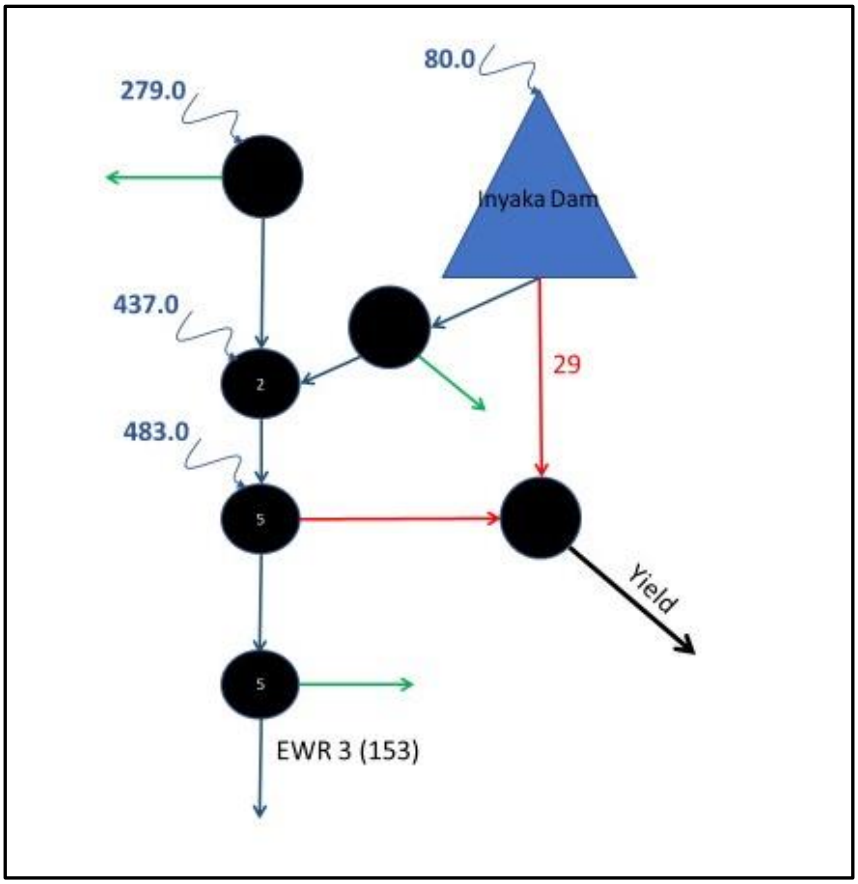

Figure 5.4: System Yield system diagram

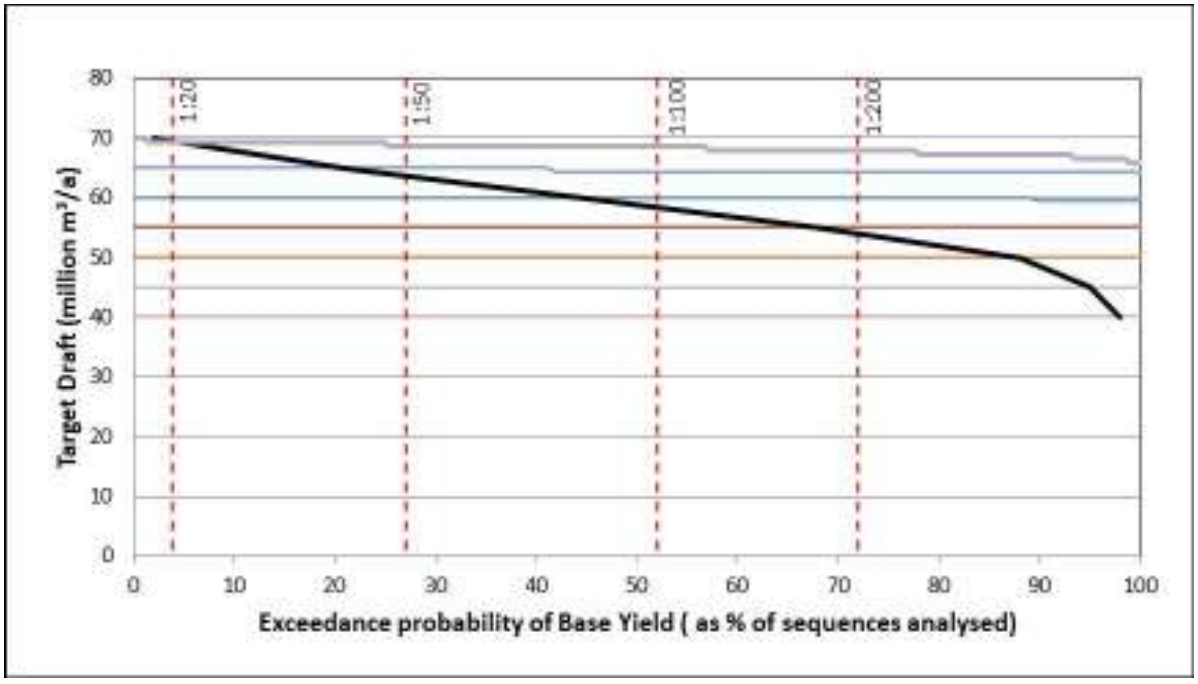

Figure 5.5: System Yield Long Term Yield Curve

While water balances are generally not presented on Annual Operating Rule reports, it is necessary in this case since the Reconciliation Strategy (DWS, 2021) reported a large negative balance for the Inyaka Dam. Based on the above long term system yield of 63 million m^3/annum (at 98% assurance) and the high assurance demand of 62 million m^3/annum (36 + 11 + 15), the Inyaka Dam is in balance.

5.5 Short term analysis

A stochastic short-term analysis was carried out using WRPM. This analysis is based on Scenario 2 as described in section 5.3.2 and allows for growth in domestic requirements. Irrigation requirements are assumed to remain fixed. It is noted that none of the irrigators in the Sabie system are restricted in WRPM setup obtained from the Recon Strategy study. It was also not possible to add irrigators as demand centres since the limitation on the number of demand centres in the model is already at the maximum.

The starting storage of the Inyaka Dam for this analysis was set at 87% which was the storage at the beginning of May.

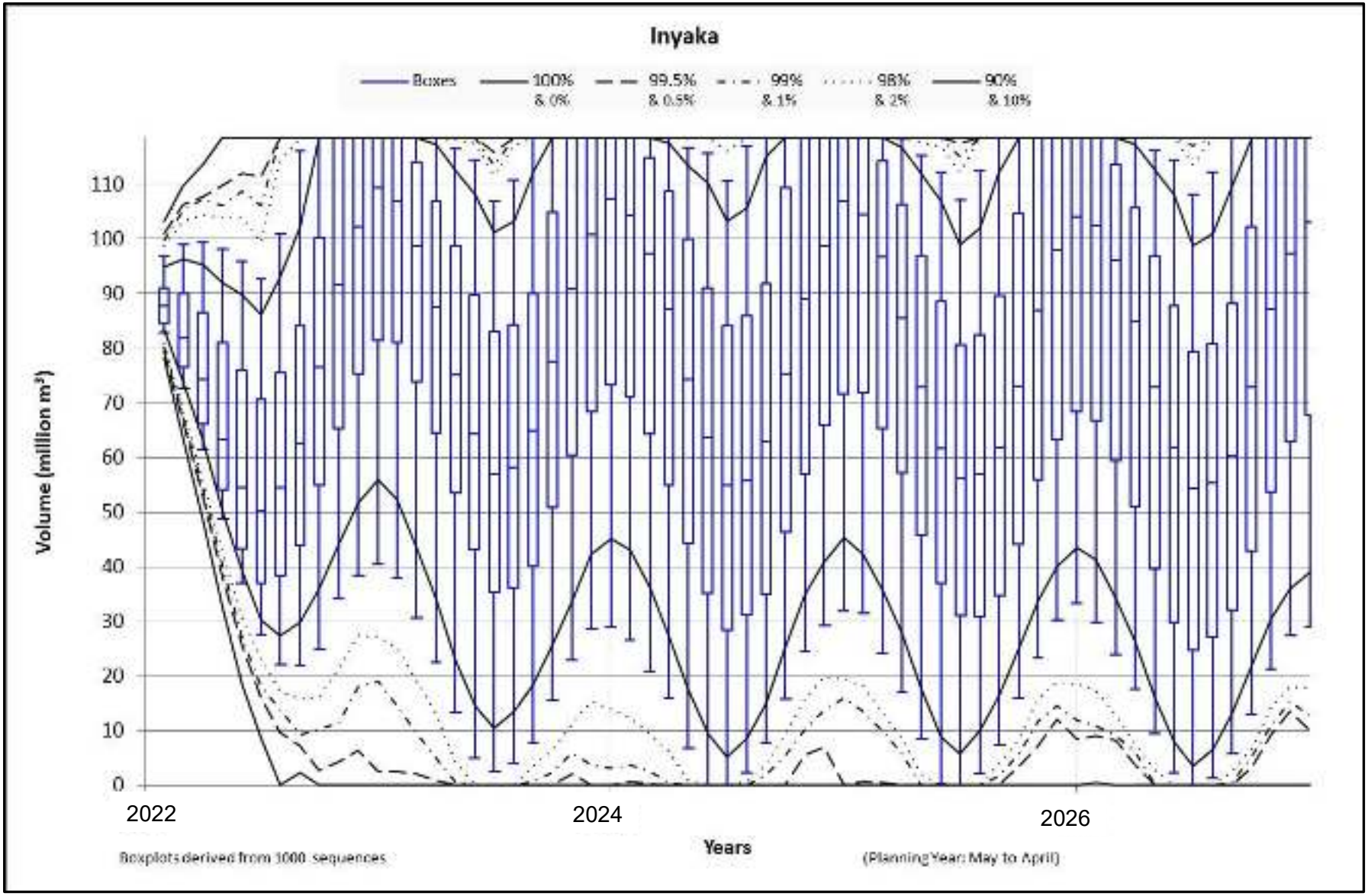

Figure 5.6: Dam storage trajectory for Inyaka Dam: Scenario 2

5.5.1 Proposed restrictions for the 2022/23 Operating period

Based on the short-term analysis and the state of storage at the beginning of May, restrictions are not required now and are unlikely to be required over the next year.

5.6 Stakeholder Operating Forum (SOF)

Stakeholder Operating Forum are consultative platforms that allow for the implementation, monitoring, auditing and updating of system operating rules and or restrictions. These are particularly important during drought periods and should be held during the decision month to decide on annual allocations and on the need for short term restrictions.

The SOF is typically attended by the DWS as the custodian of water resources, relevant Water Management Authorities, Water Supply Authorities and key water users, and the Professional Service Provider.

A SOF meeting will be arranged to discuss the results of this analysis. The main points of discussion will be:

- What is the EWR and how is this being managed.
- Priority classification.

6 Conclusion and Recommendations

Based on the results of the 2022 AOA for the Sabie System, the following is concluded:

- No restrictions on the water supply are required for the current planning year.
- While the water supply to the Acornhoek and Tulamahashe Demand Centres is problematic, this is constrained by the capacity of the transfer infrastructure.
- The Inyaka Dam is fully utilised and no further allocations from the dam can be made.
- However, there is some scope for increased low assurance allocation from the middle reached of the Sabie River.
- The interpretation of the EWR (given conflicting reports) needs to be finalised and agreed on with stakeholders before allocating additional water to irrigators.

7 REFERENCES

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APPENDIX A: NATURAL FLOW

Table 0.1: Sabie River Hydrology

Quaternary Catchment	Quinary Catchments	Area (km^2)	Natural Mean annual Runoff MAR (million m^3/annum)	
			IWASS (1920 – 2004)	IUCMA (1920 – 2016)
X31A	X31A1	174	80.24	
	X31A2	55.7	16.62	
X31B	X31B1	198	76.81	
X31C	X31C1	54	31.50	
	X31C2	99.5	38.78	
X31D	X31D2	99.5	22.46	
	X31D3	89.9	17.06	
X31E	X31E1	97.9	38.09	
	X31E2	80.0	33.15	
	X31E3	35.8	8.64	
X31F	X31F1	92.6	41.26	
X31G	X31G1	115.8	26.33	
	X31G2	10.3	2.65	
	X31G3	41.6	6.98	
X31H	X31H1	45.3	16.77	
	X31H2	16.0	3.54	
X31J	X31J1	153.7	26.99	
X31K	X31K1	80.2	2.64	
	X31K2	100.4	2.50	
	X31K3	50.5	3.00	
	X31K4	260	6.74	
X31L	X31L1	66.9	3.24	
	X31L2	69.7	3.84	
	X31L3	158.4	4.76	
X31M	X31M1	214.9	3.88	
	X31M2	141.9	2.95	
	X31M3	357.1	5.28	
X33A	X33A1	166.8	1.97	
	X33A2	434.8	4.12	
X33B	X33B1	317.2	2.95	
X33C	X33C1	178.5	1.24	
X33D	X33D1	311.1	2.24	
TOTAL			**539.19**	

Sand River Hydrology

Quaternary Catchment	Quinary Catchments	Area (km^2)	Natural Mean annual Runoff MAR (million m^3/annum)	
			IWASS (1920 – 2004)	IUCMA (1920 – 2016)
X32A	X32A1	37.9	12.96	
	X32A2	72.2	13.86	
X32B	X32B1	54.1	9.99	
X32C	X32C1	15.9	1.45	
	X32C2	13.1	0.98	
	X32C3	10.9	1.16	
	X32C4	57.5	4.21	
	X32C5	66.6	4.53	
	X32C6	59.2	3.13	
	X32C7	18.1	0.89	
X32D	X32D1	62.0	22.39	
	X32D2	35.9	5.40	
X32E	X32E1	28.3	6.39	
	X32E2	51.2	6.86	
X32F	X32F1	65.2	4.20	
	X32F2	14.2	1.07	
	X32F3	26.1	2.06	
	X32F4	57.5	2.64	
X32G	X32G1	198.3	7.42	
	X32G2	112.2	3.94	
	X32G3	28.9	0.94	
X32H	X32H1	199.7	4.87	
	X32H2	281.5	7.59	
X32J	X32J1	232.9	4.71	
	X32J2	110.9	2.23	
	X32J3	7.4	0.08	
			135.96	

APPENDIX B: SHORT TERM YIELD CURVES

Inyaka Dam: Source, DWS, 2021

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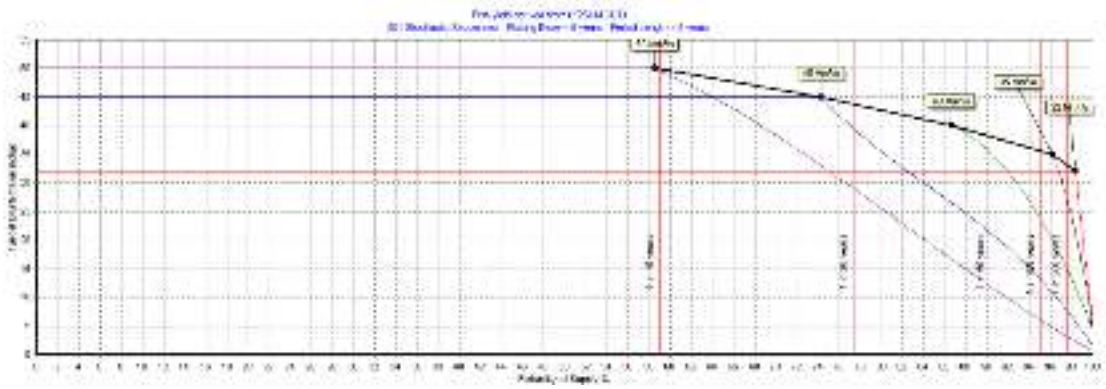

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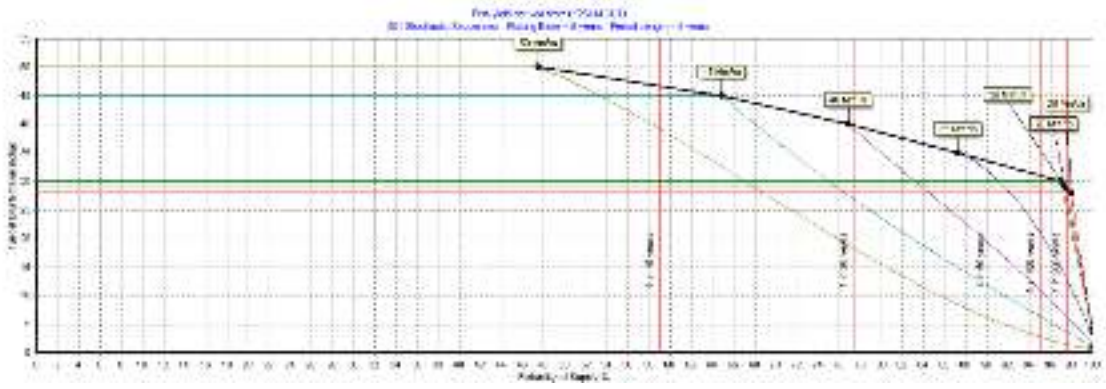

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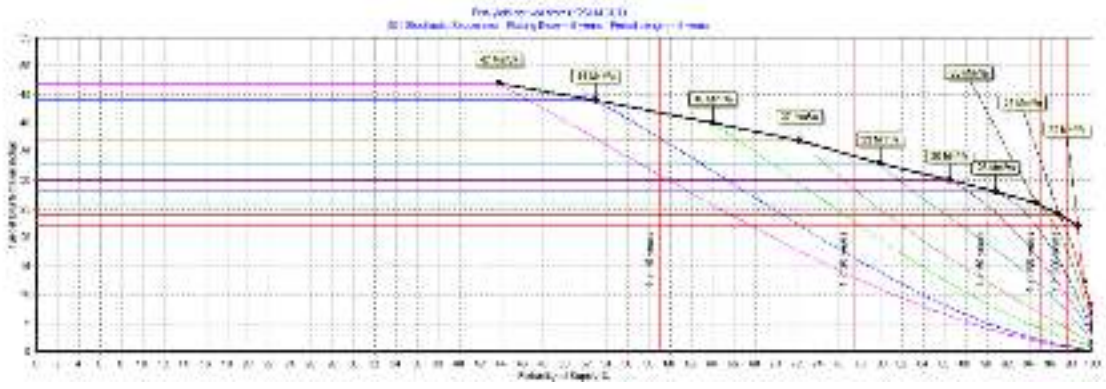

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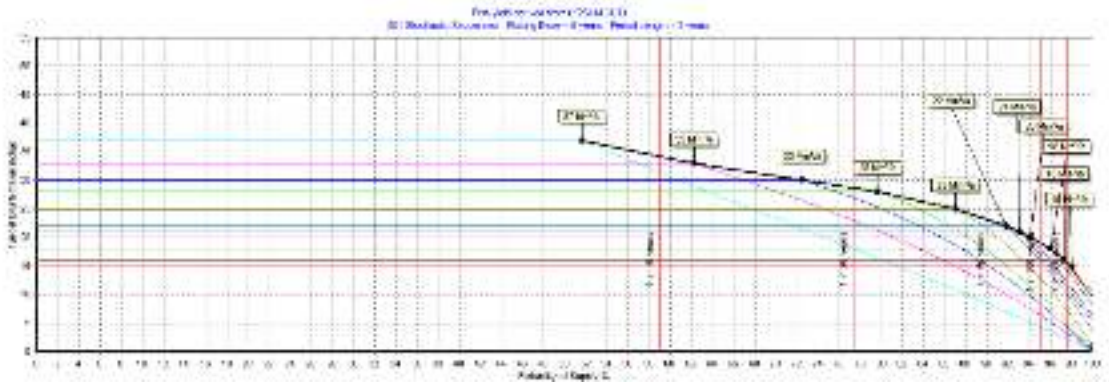

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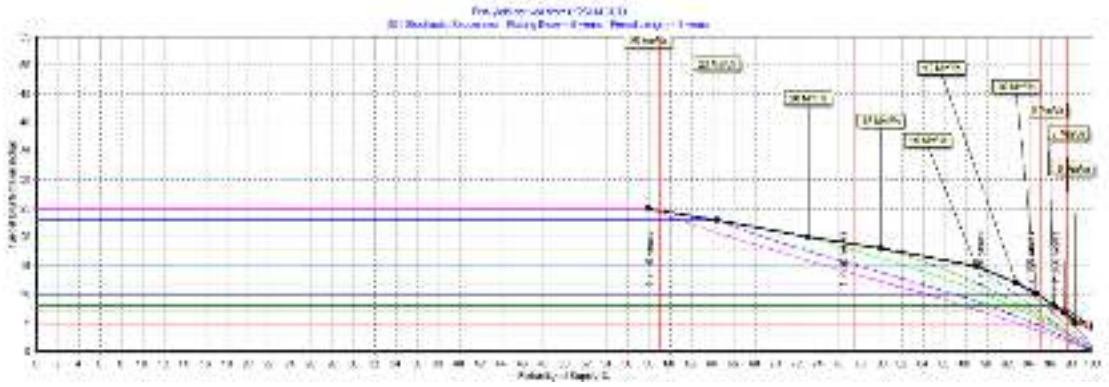

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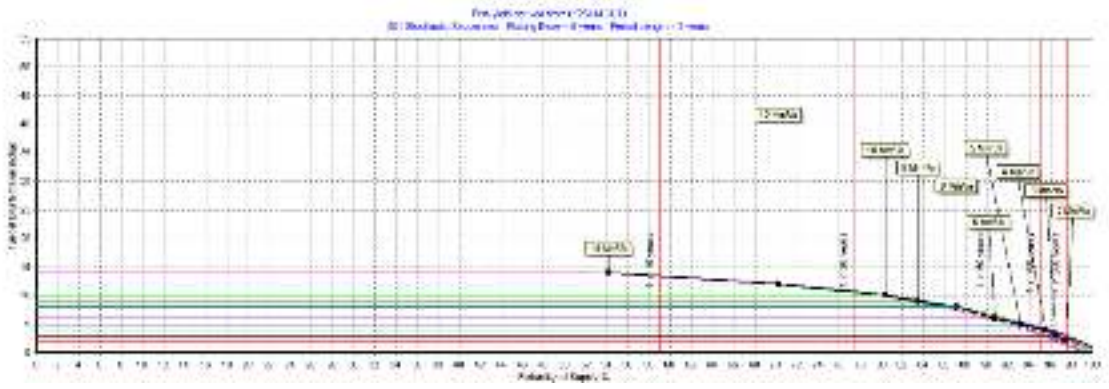

APPENDIX C: WATER USE IN THE SABIE SAND SYSTEM

Item	Pant Name	Dam Level	Raw Flow meters		Quantity in M^3
			25/10/2021	25/11/2021	
1	Thulamahashe	Full	6215635	6308097	187462
2	Acornhoek	Full	4178272	4312203	133931
3	Inyoka	90%	99761110	101431679	1670569
			96770454	98120349	1349895
					3020464
4	Hoxani	Full	59996748	60674244	677496
5	Sandriver	Full	1076390	1086699	10309
6	Edinburgh	Full	1483889	1568041	85152
7	Merite	Full	54480	55140	9660
			728188	737477	9289
			623110	623113	3
			153701	153701	0
	Total				**18952**

APPENDIX B: WATER USE

High assurance supplies	
Water for primary use in the Sand River sub-catchment	18,1 million m^3/a
Water for primary use in the Sabie River sub-catchment	14,0 million m^3/a
Water for augmenting the low flow of the Sand River in the Sabi Sand Game Reserve	4,1 million m^3/a
Water for augmenting the low flow of the Sabie River in the Kruger National Park	5,0 million m^3/a
Low assurance supplies	
Irrigation of 280 ha in the Sand River sub-catchment	2,9 million m^3/a
Irrigation of 1 480 ha in the Sabie River sub-catchment	13,7 million m^3/a
Total	57,8 million m^3/a

The high assurance water supplies will be available for 98% of the time on average, taken over a long period.

The low assurance water supplies for irrigation will be available for 80% of the time on average, taken over a long period. For the remaining dry periods the water supplies will have to be reduced by 50% for 20% of the time on average.