The Determination Of Water Resource Classes, Reserve And Resource Quality Objectives For Secondary Catchments (A5-A9) Within The Limpopo WMA and Secondary Catchment B9 in the Olifants WMA

Project Steering Committee Meeting No. 2

Ecological Water Requirements for rivers

Presented by: Karl Reinecke and Toriso Tlou
Date: 14 March 2024

WATER IS LIFE - SANITATION IS DIGNITY

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

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- Project overview – EWRs, WRCS, RQOs
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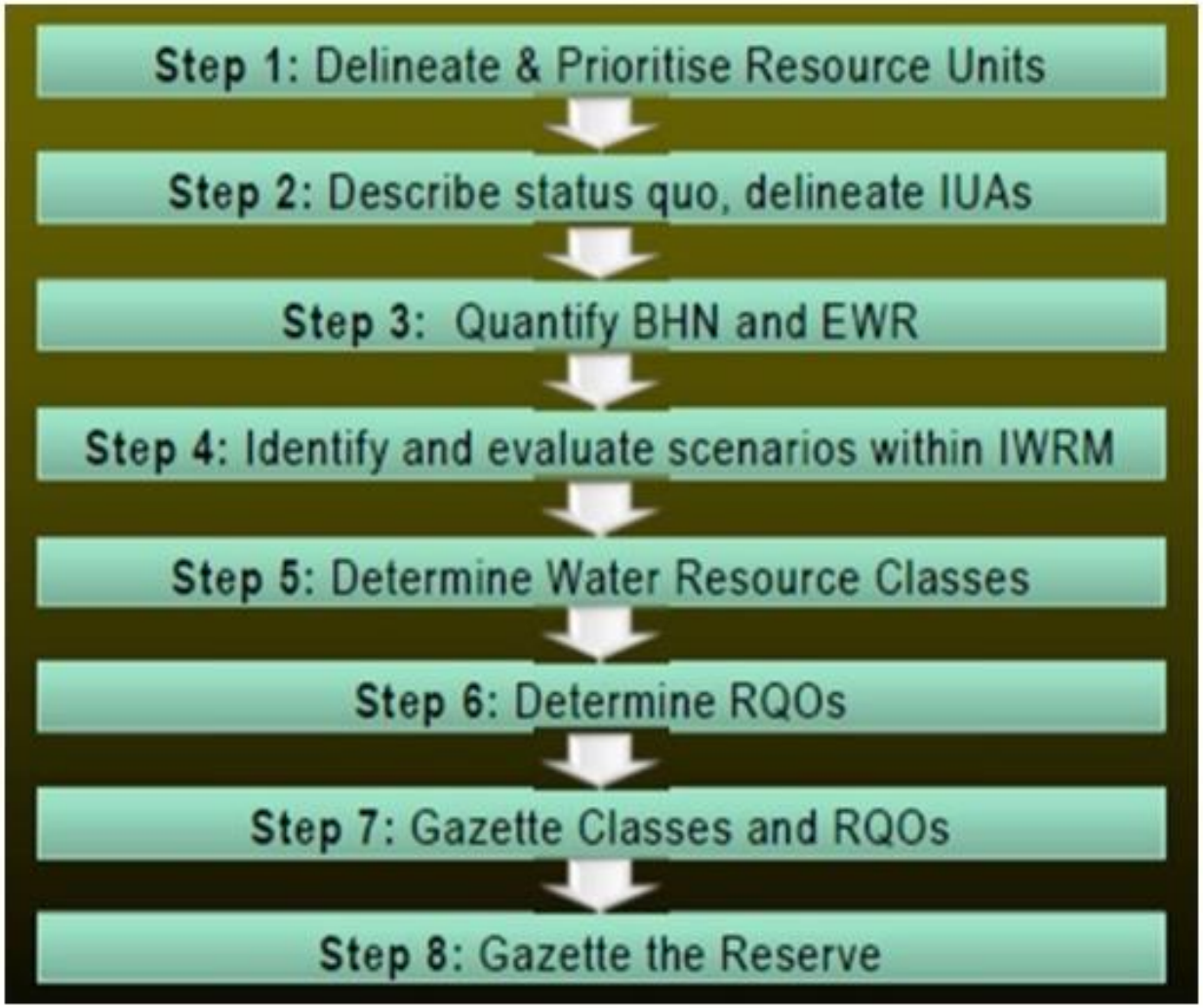
EWR, WRCS, RQO PROCESS



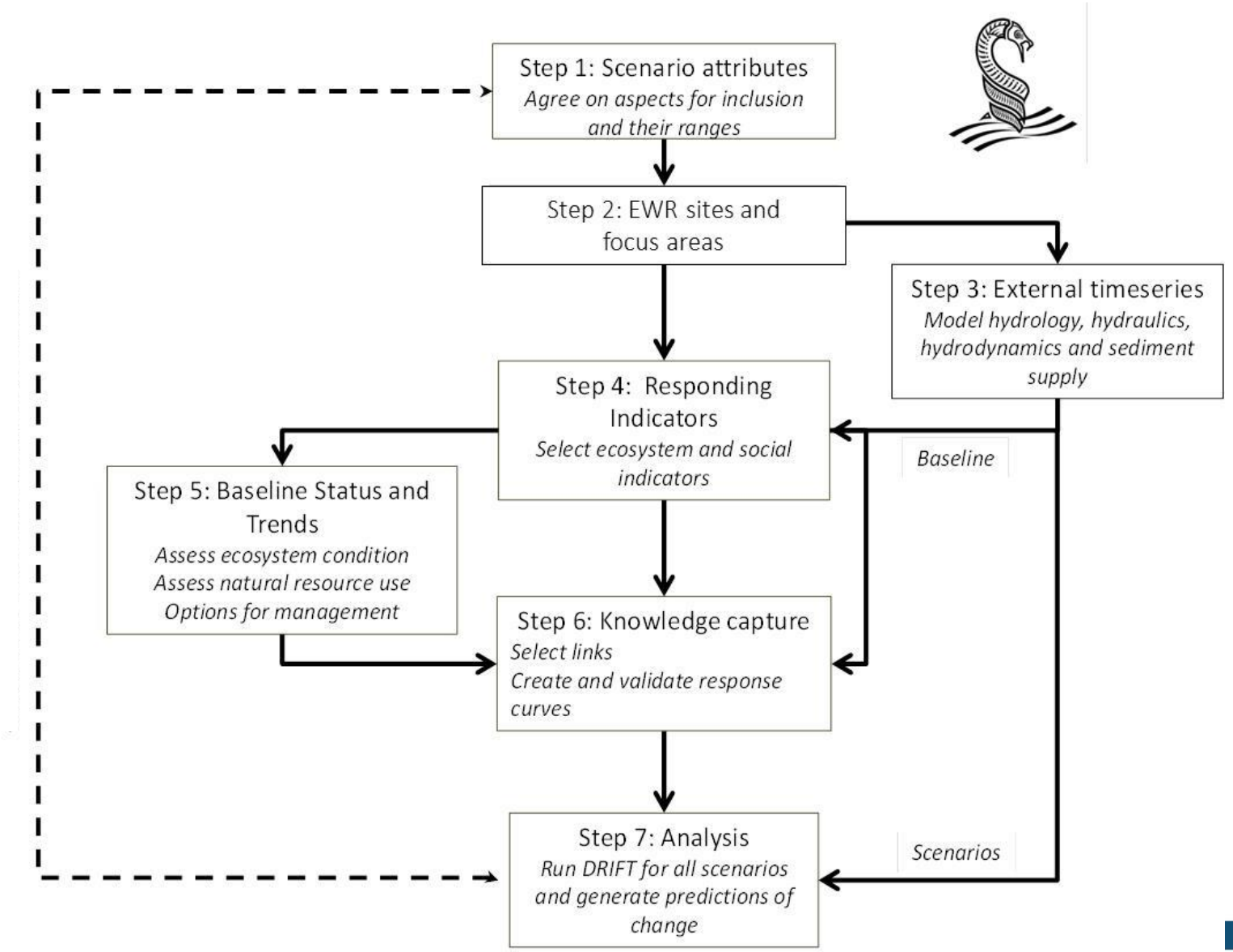
EWRs, WRCS, RQOs

- EWRs are '…the quantity, quality and timing of flow to support ecosystem function…'
- EcoCategorisation is step 1, to describe the status of groundwater, rivers and wetlands
- EWRs go into the WRCS
  - stakeholders consider the tradeoffs between water for development and that for the environment
- One EWR is chosen in the WRCS
- RQOs are numerical and descriptive statements of the biological, chemical and physical attributes of the river at the defined level of protection

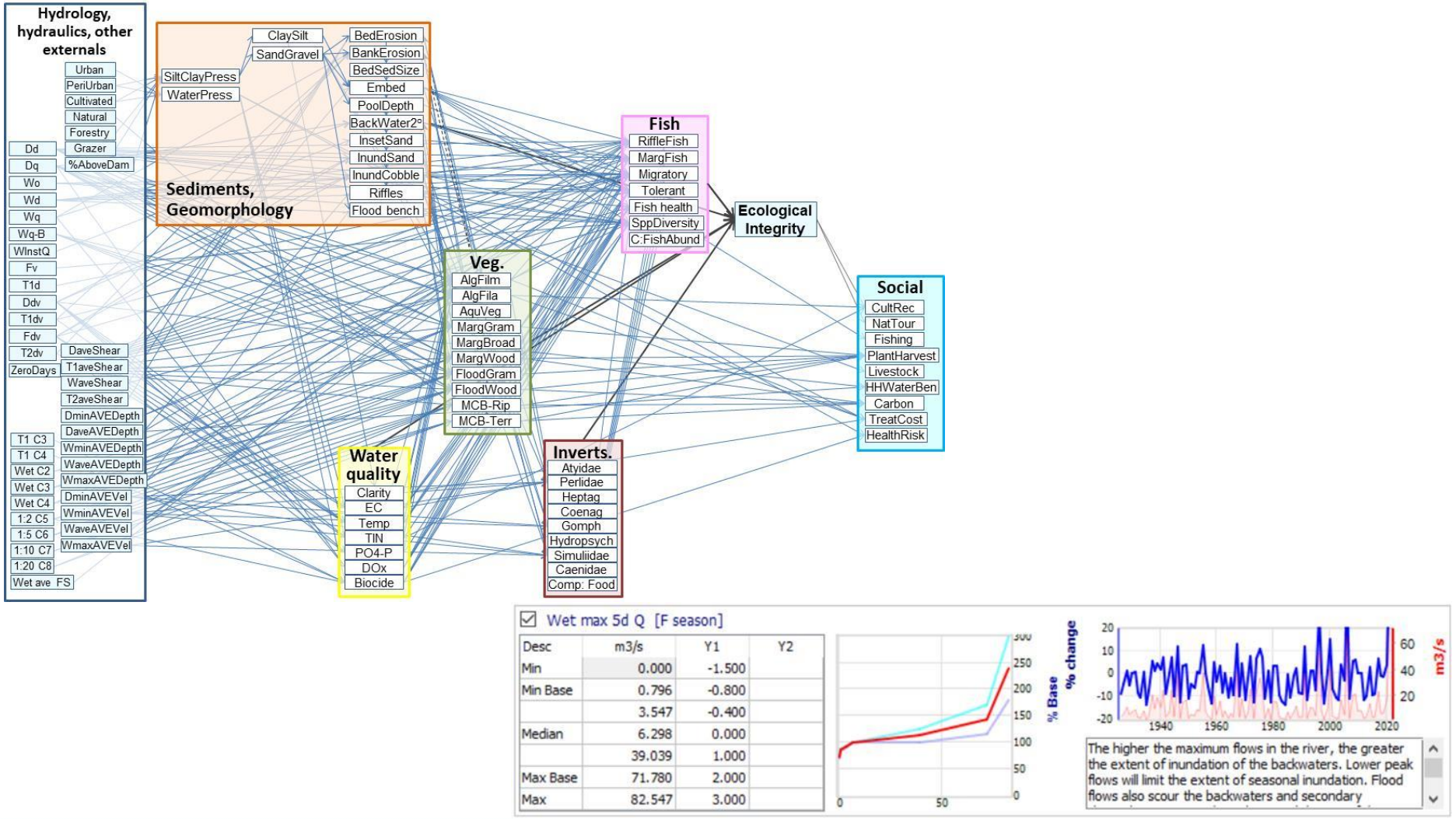
River EWRs

- Objective of the DRIFT-EWR process:
  - Select ecosystem indicators
  - Assess ecological status and trends of each indicator in the scenarios and predict change relative to PES (2022)
  - Predict the overall ecological status under each scenario
- Outcomes in 3 River Assessment reports:
  - (Volume 1) Eco-Categorisation Report
  - (Volume 2) Ecological Water Requirements Data Collection and Analysis Report
  - (Volume 3) Ecological Water Requirements Assessment Report

The 7-step DRIFT process



DRIFT-Limpopo, response curves



Hydrologic and hydraulic drivers

Discipline		Indicator	Units	Discipline	Indicator	Units
Hydrology	Annual	Mean annual runoff	m^3/s	River hydraulics (for all seasons above, at one or two selected cross-section at each EWR site)	Average shear stress	N/m^2
		Zero flow days per year	days		Minimum (of average) depth	m
		Days continuous depth > 5 cm			Maximum (of average) depth	
		Days continuous depth > 10 cm			Minimum (of average) velocity	m/s
	Dry Season	Onset	calendar week		Average (of maximum) velocity	
		Duration	days		Maximum (of average) velocity	
		Minimum 5-day discharge	m^3/s		Minimum 5-day wetted perimeter	m
		Average daily volume	$m^3 \times 10^6$		Maximum 5-day wetted perimeter	
	Transition Season 1	Average daily volume			Average fast very shallow flow	% cross-setion
		Duration	days		Average fast shallow flow	
	Flood/Wet Season	Onset	calendar week		Average fast deep flow	
		Duration	days		Average slow deep flow	
		Maximum 5-day discharge	m^3/s		Average slow very shallow flow	
		Maximum 5-day instantaneous discharge			Average slow shallow flow	
		Maximum 5-day baseflow discharge			Average slow deep flow	
		Average daily volume	$m^3 \times 10^6$			
		Volume				
	Transition Season 2	Average daily volume				
		Duration	days			

Eco-social responders

Indicators	EWR site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Discipline: Water quality														
Water clarity														
Electrical conductivity														
Water temperature														
Total inorganic nitrogen (TIN)														
Orthophosphate (PO_4-P)														
Dissolved oxygen														
Biocides														
Discipline: Geomorphology														
Clay silt FPOM supply														
Sand gravel supply														
Bed erosion														
Bank erosion														
Bed sediment size														
Embeddedness														
Pool depth														
Backwaters and secdonary channels														
Inset bench and sand bars														
Inundated sandy habitat														
Inundated cobble habitat														
Riffles														
Flood benches														

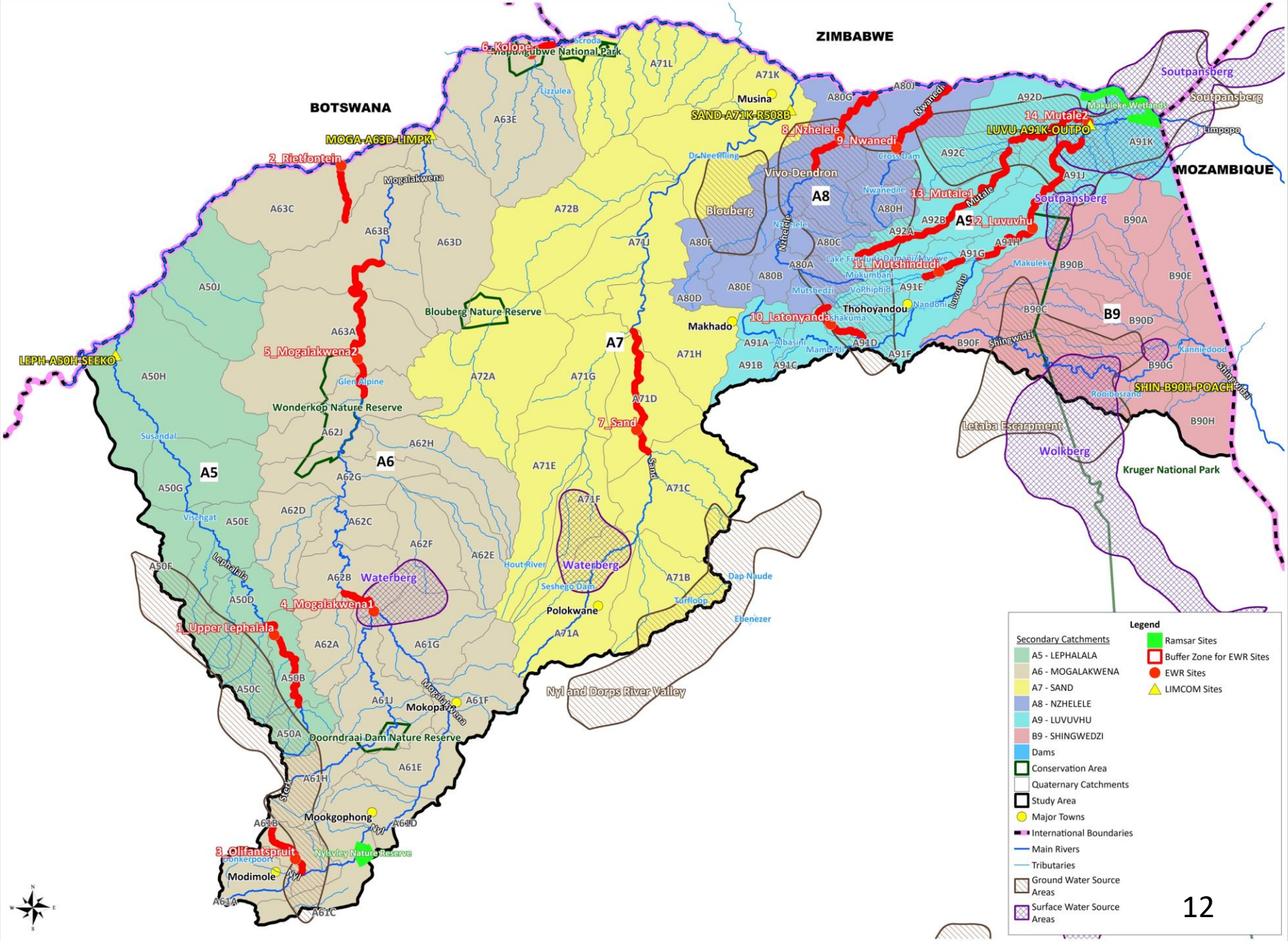
Eco-social responders

Indicators	EWR site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Discipline: Vegetation														
Algal biofilms														
Filamentous algae														
Aquatic vegetation														
Marginal zone graminoids														
Marginal zone broadleaf plants														
Marginal zone woody vegetation														
Flood bench graminoids														
Flood bench woody vegetation														
Macrochannel bank riparian trees														
Terrestrial wood plants														
Discipline: Aquatic macroinvertebrates														
Atyidae (shrimps)														
Perlidae (stone files)														
Heptageniidae (flat-head mayflies)														
Coenograionidae (sprites and blues)														
Gomphidae (club-tailed dragonflies)														
Hydropsychidae (caddisflies)														
Simulidae (blackflies)														
Caenidae (cainflies)														
Composit: Invertebrate foor for fish														

Indicators	EWR site													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Discipline: Fish														
Rocky riffle fish														
Quiet vegetated water fish														
Migratory fish														
Tolerant species														
Fish health														
Species diversity														
Composite: fish abundance														
Discipline: Social														
Recreation, cultural value														
Nature tourism value														
Fisheries value														
Plant resource value														
Household water benefits														
Subsistence livestock grazing														
Carbon retention value														
Water treatment costs														
Health risk														
Discipline: Pressures														
Pressures affecting sediment supply														
Pressures affecting sediments														
Pressures affecting water quality														

PES (2022), EIS, RECs

EWR Site	Quaternary Catchment	PES	EIS	REC	Improved management to achieve REC?
1_Lephalala	A50B	C	Moderate	B/C	Re-stock with indigenous fish and clear exotic plants.
LEPH-A50H-SEEKO	A50H	C		C	No non-flow related management specified.
2_Rietfontein	A63C	B/C	Moderate	B/C	
3_Olifantspruit	A61B	C	Moderate	C	
4_Mogalakwena1	A62B	C	Moderate	C	
5_Mogalakwena2	A63A	C	Moderate	C	
MOGA-A63D-LIMPK	A63D	C		C	
6_Kolope	A63E	C	Moderate	C	
7_Sand	A71D	C	Moderate	C	
SAND-A71K-R508B	A71K	C		C	
8_Nzhelele	A80G	C	Moderate	C	
9_Nwanedi	A80J	C	Moderate	C	
10_Latonyanda	A91D	C	Moderate	B/C	Manage local landuse practices (subsistence agriculture, livestock watering, cattle grazing) to reduce erosion.
11_Mutshindudi	A91G	C	Moderate	C	No non-flow related management specified.
12_Luvuvhu	A91H	C	Moderate	C	
LUVU-A91K-OUTPO	A91K	C		C	
13_Mutale1	A92B	C	Moderate	B/C	Manage local landuse practices to reduce erosion, and clear exotic plants.
14_Mutale2	A92D	C	Moderate	B/C	Manage local landuse practices to reduce erosion, reduce trampling of riparian plants by humans and livestock.
SHIN-B90H-POACH	B90H	B/C		B/C	No non-flow related management specified.


ZIMBABWE
BOTSWANA
MOZAMBIQUE
6_Kolope
Mapungubwe National Park
MOGA-A63D-LIMPK
2_Rietfontein
LEPH-A50H-SEEKO
5_Mogalakwena2
4_Mogalakwena1
1_Upper Lephalala
3_Olifantspruit
7_Sand
SAND-A71K-R508B
8_Nzhelele
9_Nwanedi
14_Mutale2
LUVU-A91K-OUTPO
13_Mutale1
12_Luvuvhu
11_Mutshindudi
10_Latonyanda
SHIN-B90H-POACH
A5
A6
A7
A8
A9
B9
Musina
Makhado
Thohoyandou
Polokwane
Mokopane
Mookgophong
Modimole
Vivo-Dendron
Blouberg
Soutpansberg
Waterberg
Blouberg Nature Reserve
Wonderkop Nature Reserve
Doorndraai Dam Nature Reserve
Nylsvley Nature Reserve
Kruger National Park
Letaba Escarpment
Wolkberg
Nyl and Dorps River Valley
Legend
Secondary Catchments
A5 - LEPHALALA
A6 - MOGALAKWENA
A7 - SAND
A8 - NZHELELE
A9 - LUVUVHU
B9 - SHINGWEDZI
Dams
Conservation Area
Quaternary Catchments
Study Area
Major Towns
International Boundaries
Main Rivers
Tributaries
Ground Water Source Areas
Surface Water Source Areas
Ramsar Sites
Buffer Zone for EWR Sites
EWR Sites
LIMCOM Sites

Human pressures

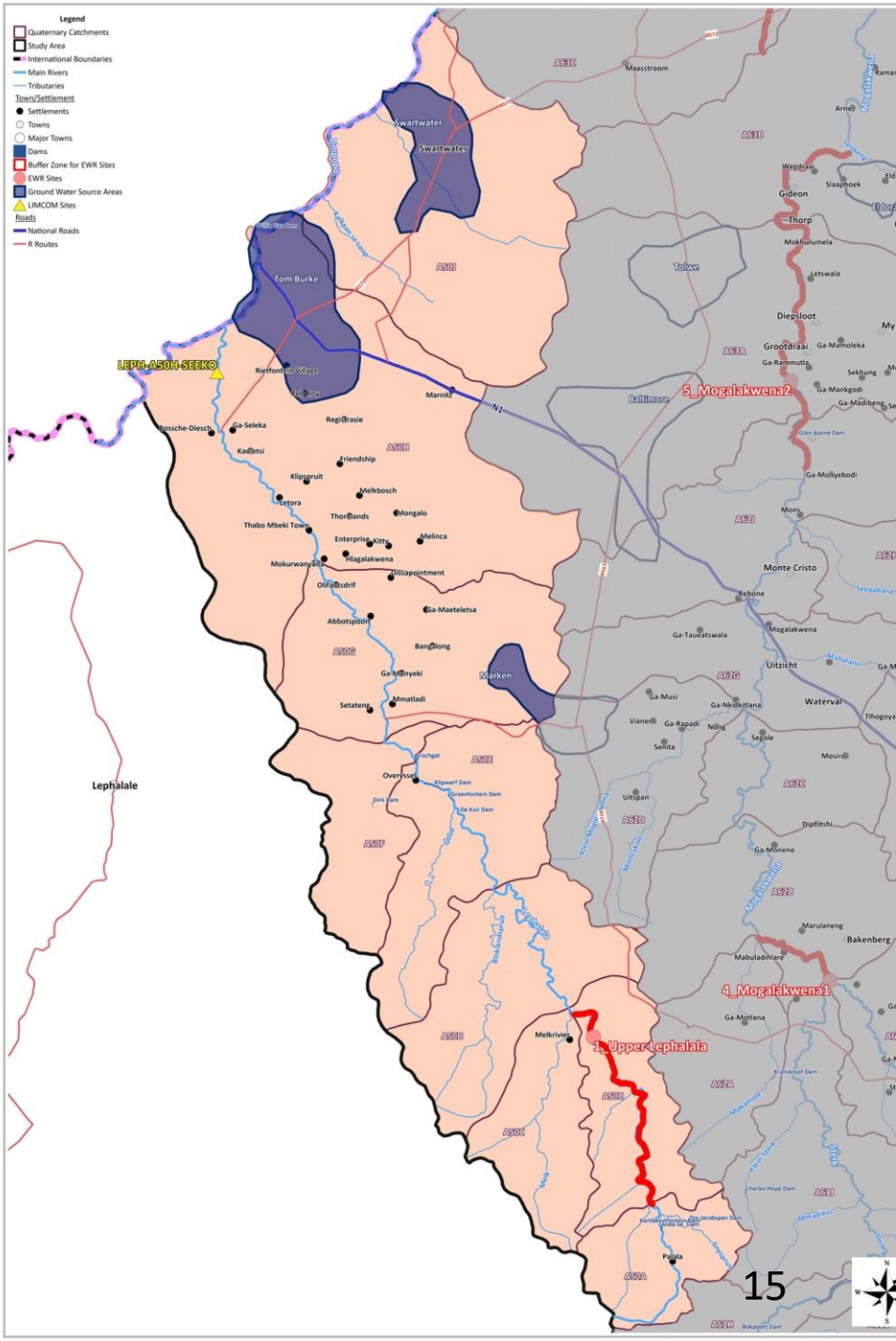
- WQ
  - Irrigation and WWTW return flows, mining pollutants, turbidity
- Geomorphology
  - Grazing, farm roads, clearing natural vegetation, sand mining, agriculture and in-channel sediments; sediment trapping in dams
- Vegetation
  - Exotic plant species, flow regulation, afforestation
- Invertebrates
  - Nutrients from urban and agricultural runoff, livestock watering, clearing of marginal vegetation
- Fish
  - Migration barriers (weirs, dams), sedimentation (spawning gravels and riffles), turbidity

Current and Future Water Resource Development in the catchments

- There are six major catchments where varying economic growth will have an impact on the resources of these catchments;
- Six catchments include
  - Lephalala River catchment
  - Mogalakwena River catchment
  - Sand River catchment
  - Nzhelele River catchment
  - Luvuvhu River catchment
  - Shingwedzi River catchment

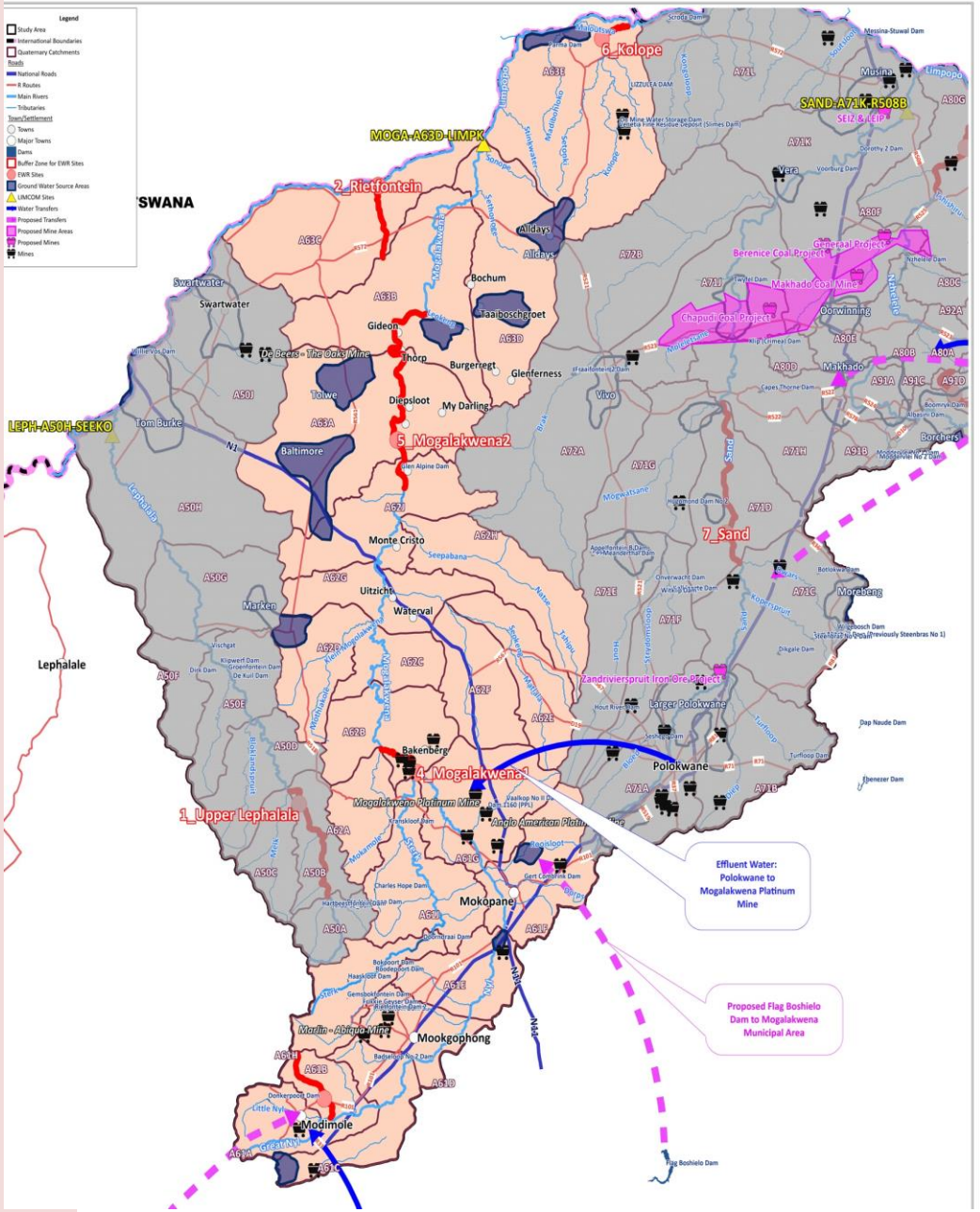
A5 - Lephalala catchment

- Limited local water resources
- Main activity is irrigation agriculture which is taking place in the upper reaches
- Large number of farm dams
- Lower catchment – irrigation makes use of alluvial aquifers
- Domestic water use – groundwater & run-of-river abstraction
- No potential for additional resource development



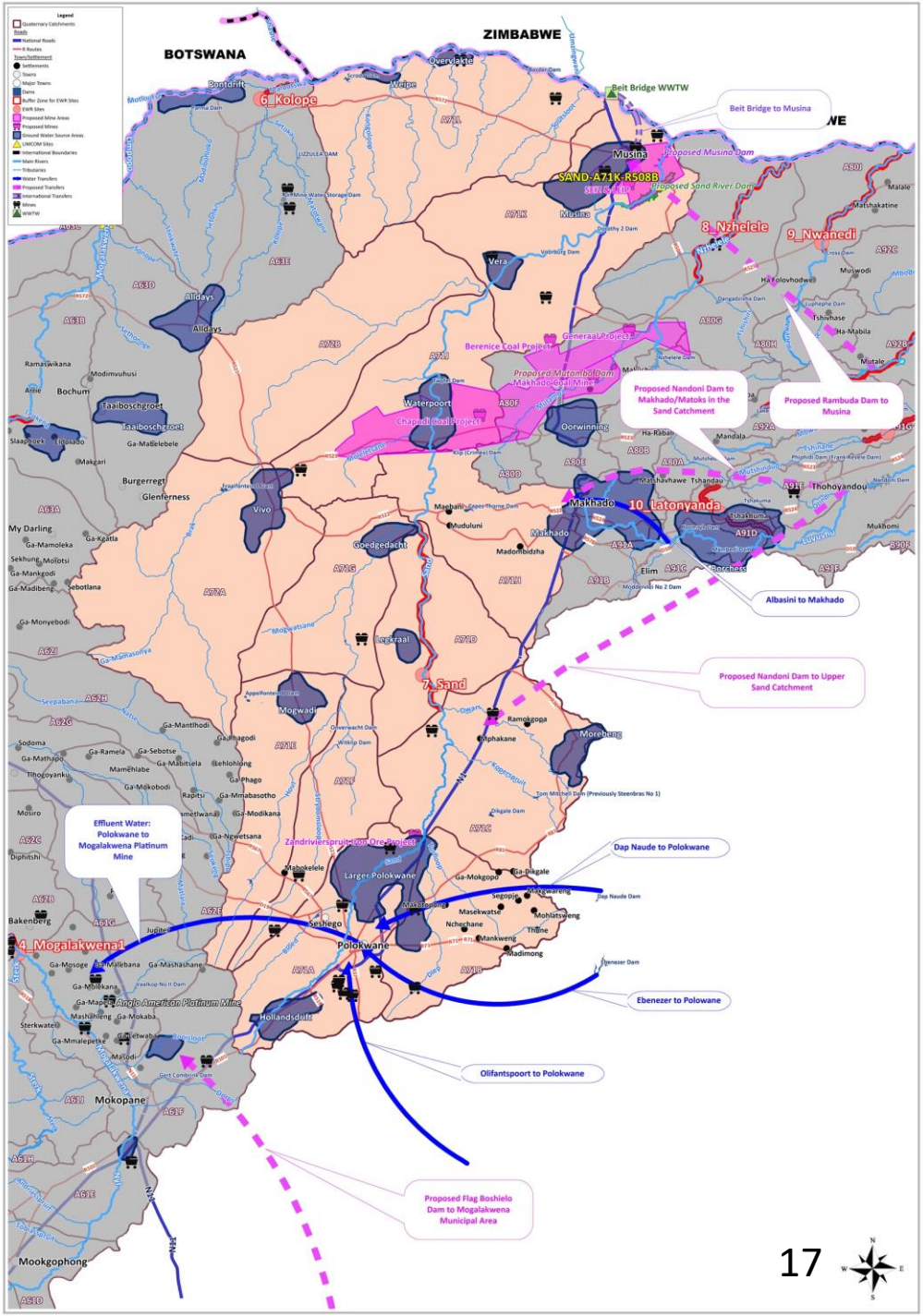
A6 - Mogalakwena catchment

- Significant economic activities in catchment ranging from mining activities & irrigation agriculture
- Two major dams not sufficient to meet current & growing demands
  - Doorndraai & Glen Alpine
- Transfers from neighbouring catchment namely
  - Flag Boshielo Dam
  - Klipvoor Dam



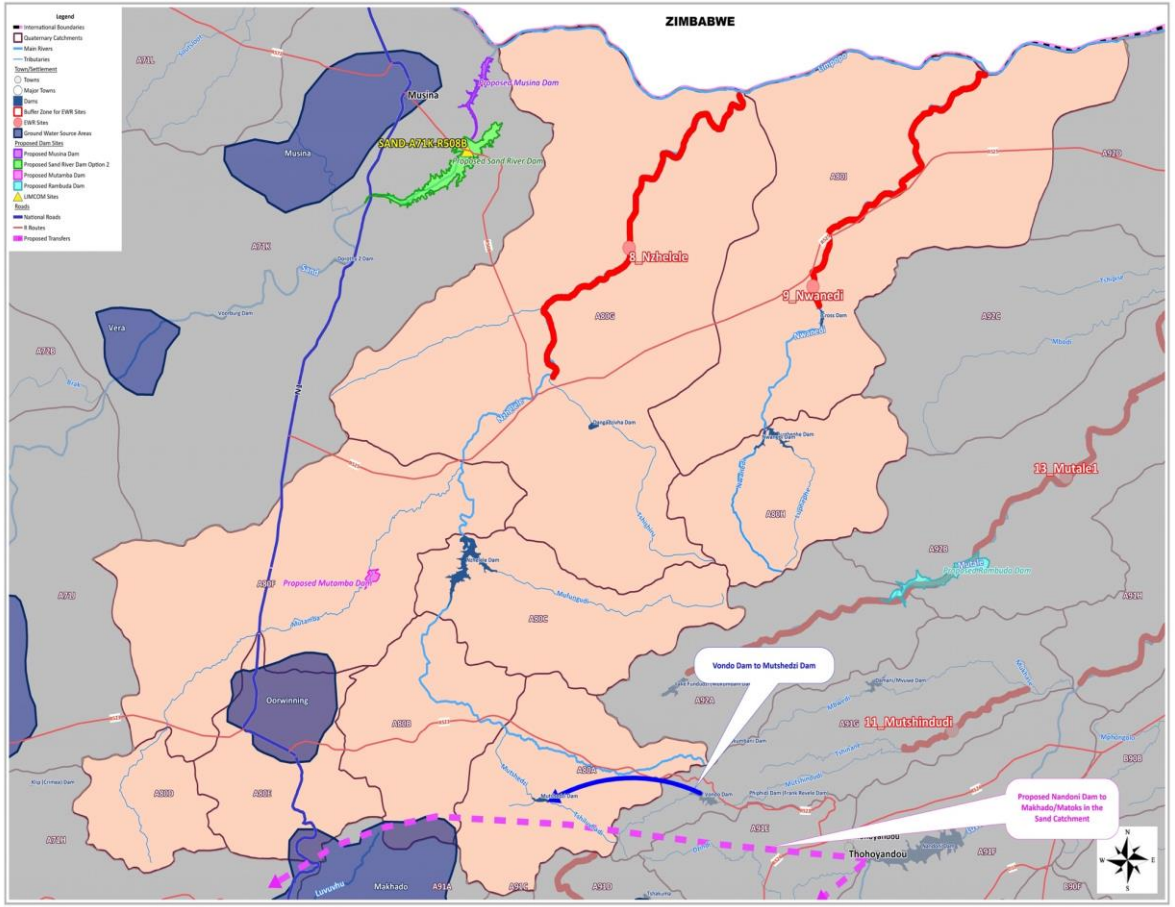
A7 - Sand catchment

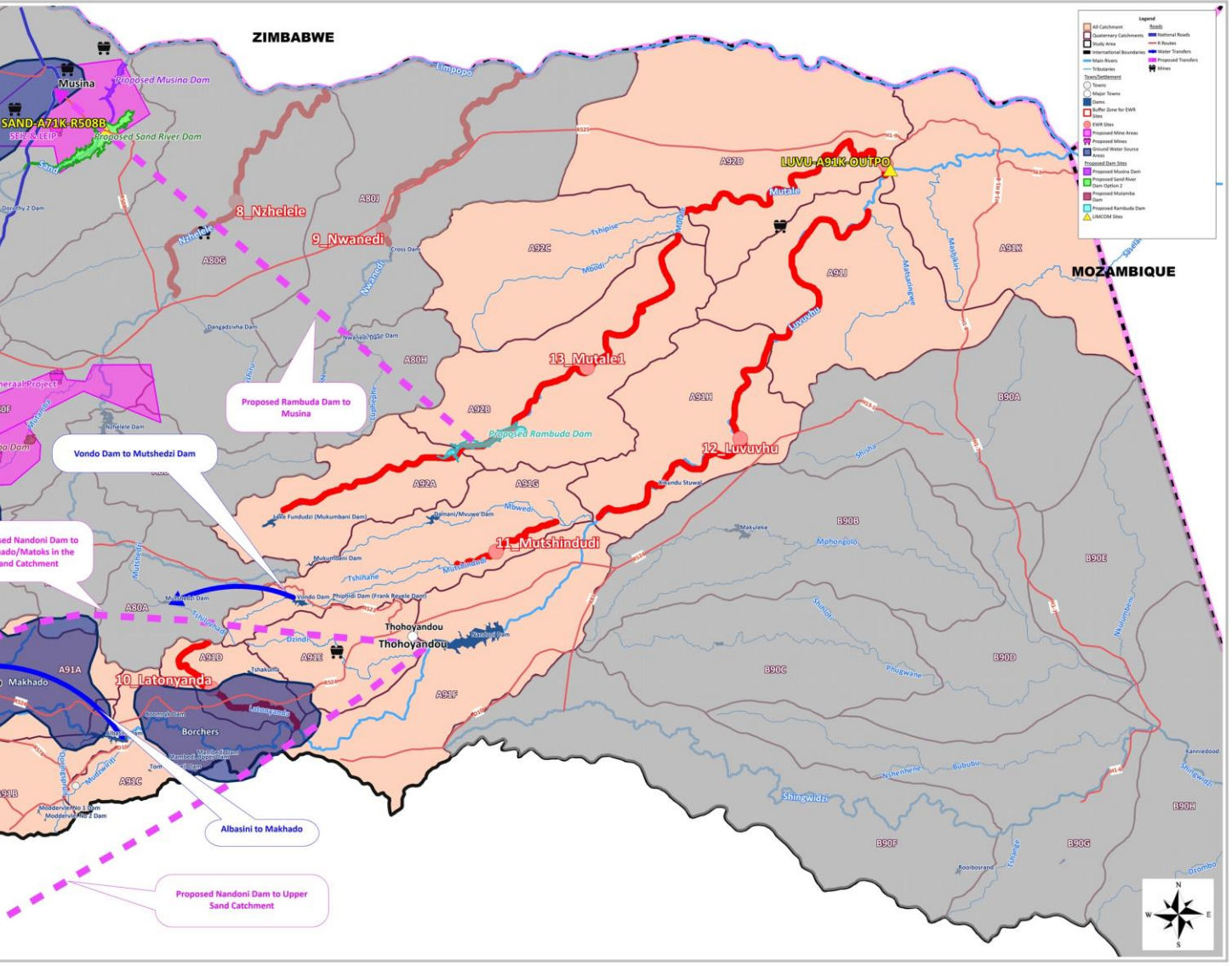
- Driest catchment in Limpopo WMA with very limited surface water resources
- Groundwater reserves fully utilised
- Large water requirements – irrigation being the largest user
- Domestic water requirements supplied mostly from transfers from other catchments
- Major economic developments anticipated
    - MSEZ near Musina – potential source proposed Sand River Dam and/or Musina Dam – pumped storage systems
    - Makhado – transfers from Nandoni Dam
- Return Flows
    - Used downstream for tomato irrigation around Mooketsi
    - Also transferred to Mogalakwena for use by platinum mines



A8 – Nzhelele and Nwanedi catchment

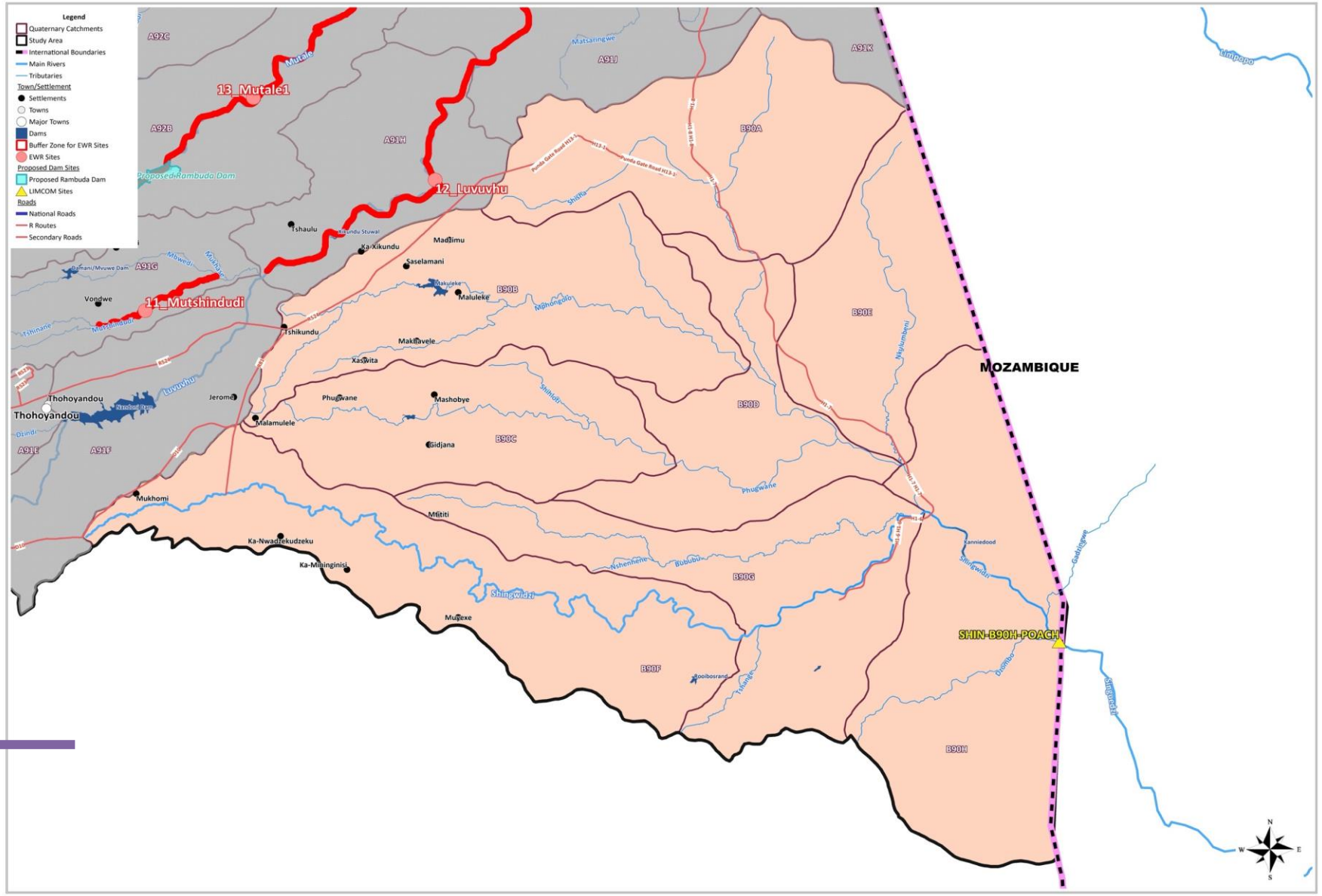
- Catchment is dominated by irrigation agriculture
- Main source of supply is Nzhelele Dam
  - Future development – Coal mining traversing into the Sand catchment
    - Potential source is proposed Mutamba Dam
    - Savings from irrigation canal losses





A9 - Luvuvhu catchment

- Major developments are urban & rural communities
- Irrigation agriculture is the main economic activity
- Catchment transfers - surface water to neighbouring catchments



B9 – Shingwedzi catchment

- Ecotourism – a core industry of the catchment
- No major dams – limited resources
- No potential surface water developments envisaged for the catchment

Water resource factors – Future1

EWR Site	Increased return flows	New dam storage/increasing dam storage	Incoming inter-basin transfers	Transfers of return flows out of the catchment	Increased water use
1_Lephalala					X
4_Mogalakwena1	X				
5_Mogalakwena2	X				
7_Sand	X		X		X
8_Nzhelele		X			X
9_Nwanedi					X
11_Mutshindudi		X			X
12_Luvuvhu	X			X	X
13_Mutale1		X			X
14_Mutale2		X			

Scenarios

- PES (2022), the climatic period of 1925-2021 and water-resource developments, population, land use, etc. at 2022 levels.
- Naturalised, the climatic period of 1925-2021 and water-resource developments, population, land use, etc. at *c.* 1900 levels.
- Future1 is PES (2022) and water-resource developments at 2050 levels.
- Future2 is Future1 with a dry future climate.

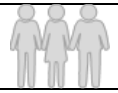
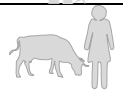
DRIFT hydrological indicators

4_Mogalakwena1	Baseline	Naturalised	Future1	Future2
Mean annual runoff	0.3	0.8	0.5	0.2
Dry onset	18.0	14.0	16.0	13.0
Dry duration	244.0	240.5	252.0	281.0
Dry Min 5d Q	0.000	0.011	0.006	0.002
Wet onset	15.0	9.0	10.0	10.0
Wet duration	70.5	81.0	57.0	7.0
Wet Max 5d Q	2.0	8.1	3.6	1.3
Wet max inst 5d Q	2.0	11.7	6.1	1.8
Wet max 5d Q-Baseflow	0.7	1.5	1.1	0.5
Wet season volume	0.8	11.0	4.4	0.3
Dry ave daily vol	0.012	0.045	0.031	0.018
T1 ave daily vol	0.044	0.046	0.047	0.029
Wet ave daily vol	0.111	0.200	0.124	0.069
T2 ave daily vol	0.043	0.057	0.058	0.048
T1 duration	31.0	22.0	15.0	29.5
T2 duration	1.0	1.0	1.0	1.0
Zero days per year	134.2	7.6	8.9	10.0
(max)Continuous days>=5 cm deep	161.5	279.5	258.5	241.5
(max)Continuous days>=10 cm deep	119.5	206.5	188.0	183.0

Icons and colour coding - ecological

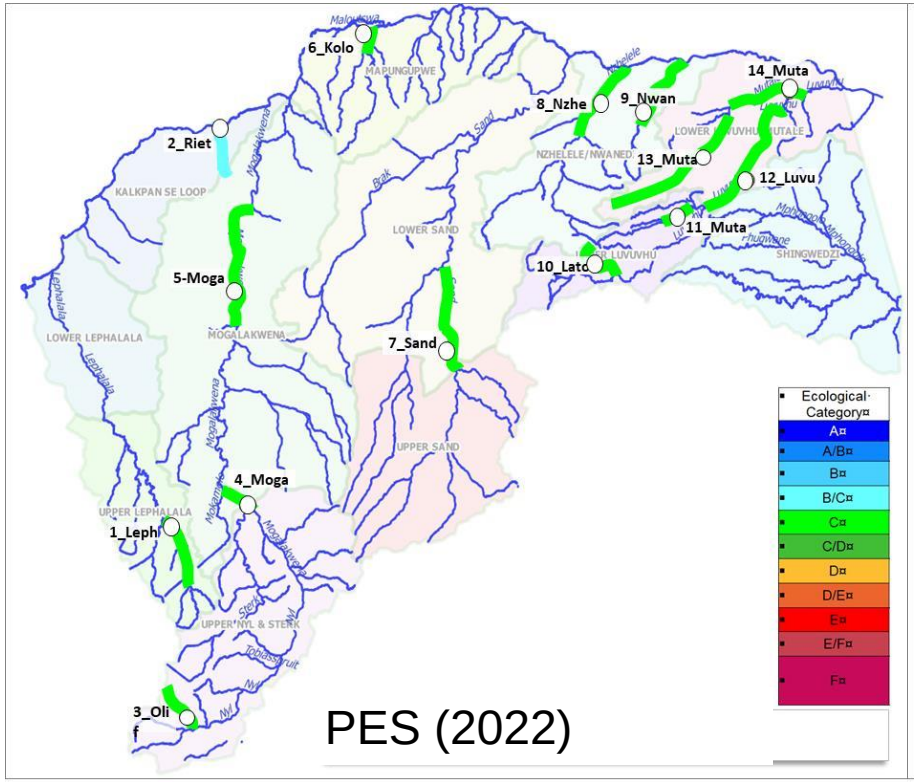
Category	Description	Ecosystem	Geomorph.	Riparian vegetation	Inverte-brates	Fish
A	Unmodified, natural					
A/B						
B	Largely natural					
B/C						
C	Moderately modified					
C/D						
D	Largely modified					
D/E						
E	Completely modified					
E/F						
F						

Icons and colour coding - social

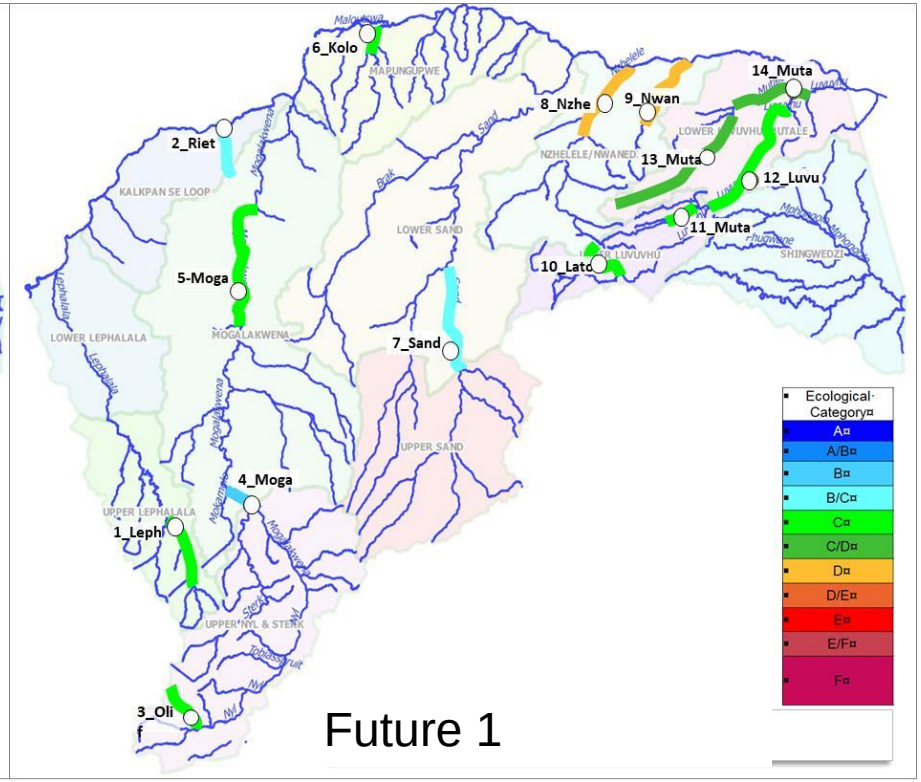
Recreation, culture value	Icon
Overall social well-being	
Nature tourism value	
Fisheries value	
Plant resource value	
Domestic and livestock watering	
Carbon retention value	

Colour	Change relative to baseline
	Marked increase/improvement >+40%)
	Increase/improvement (+20 to +40%)
	Slight increase/improvement (+5 to +20%)
	Little or no change (-5 to +5%)
	Slight decrease/deterioration (-5 to –20%)
	Decrease/deterioration (-20 to -40%)
	Marked decrease/deterioration (<-40%) (a greater than 40% decrease)

Overall Ecological Status

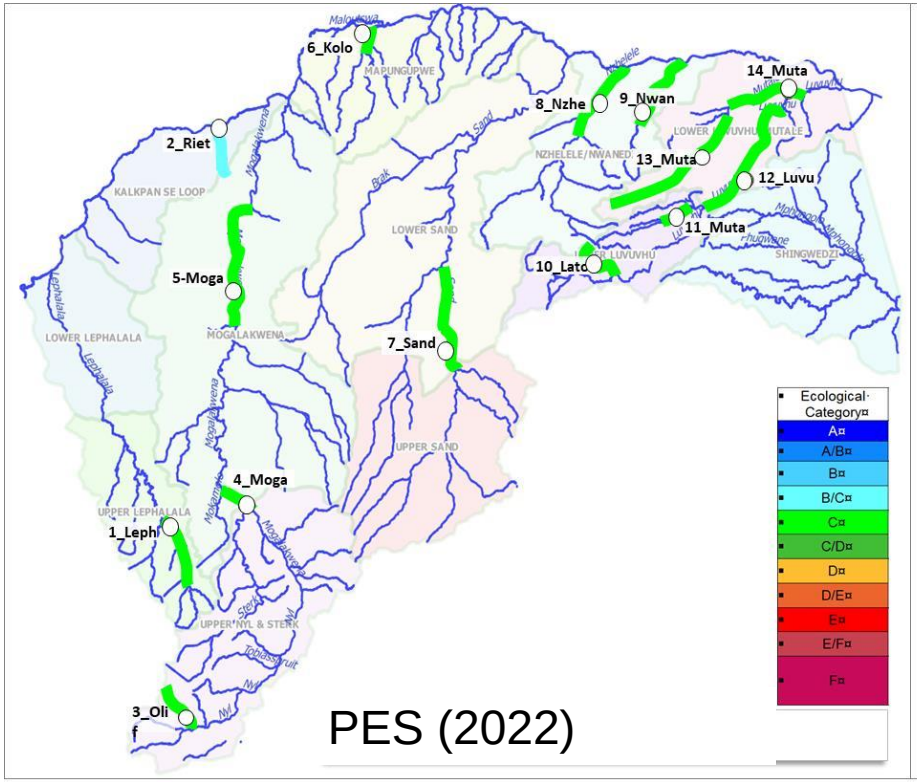


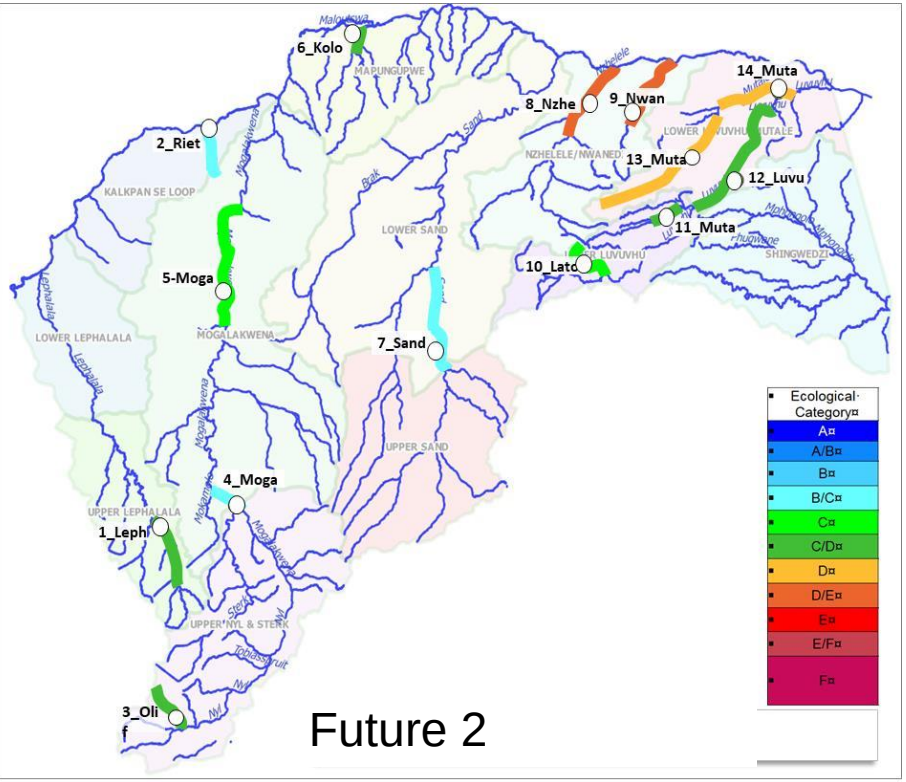
PES (2022)



Future 1

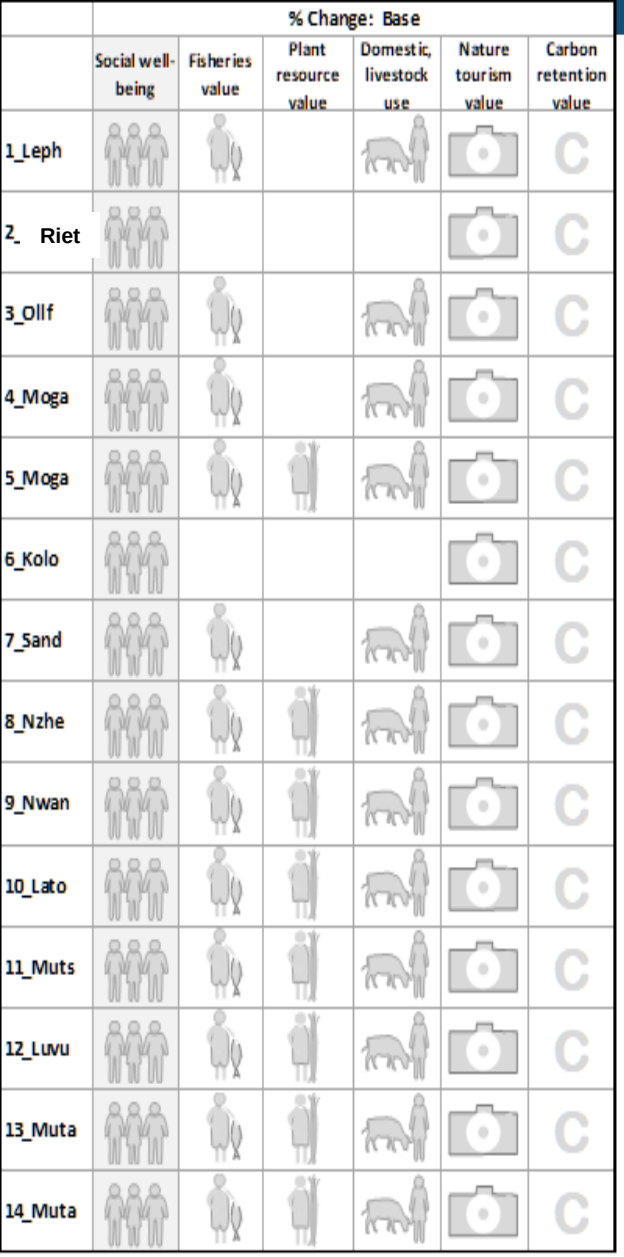
Overall Ecological Status

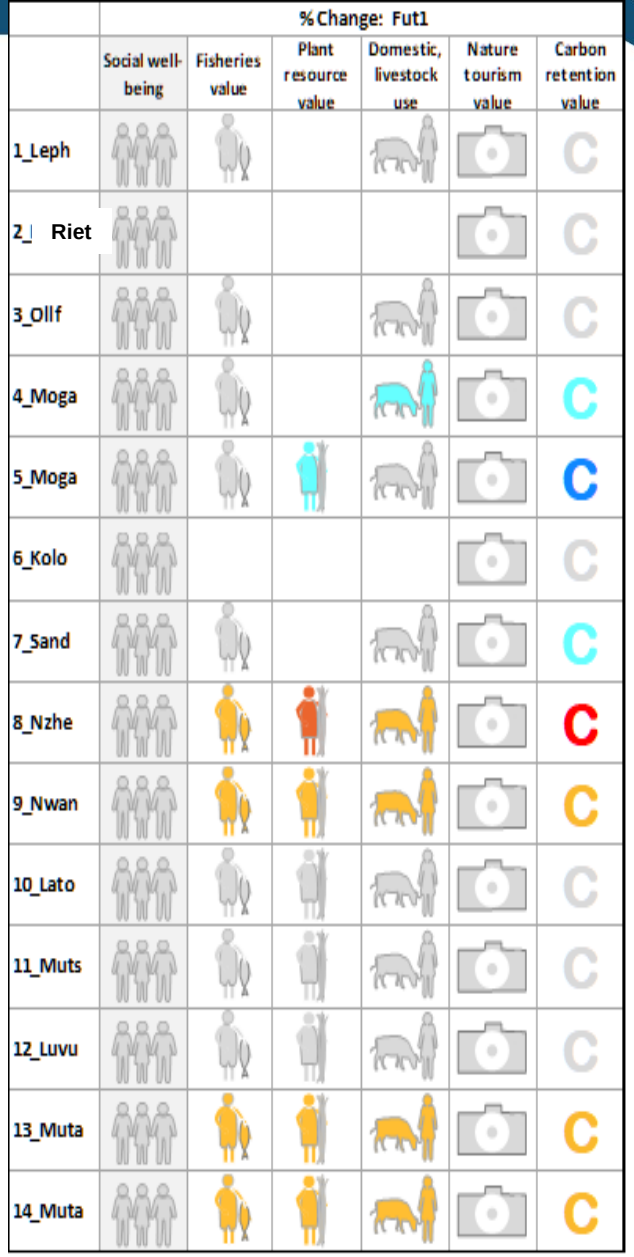


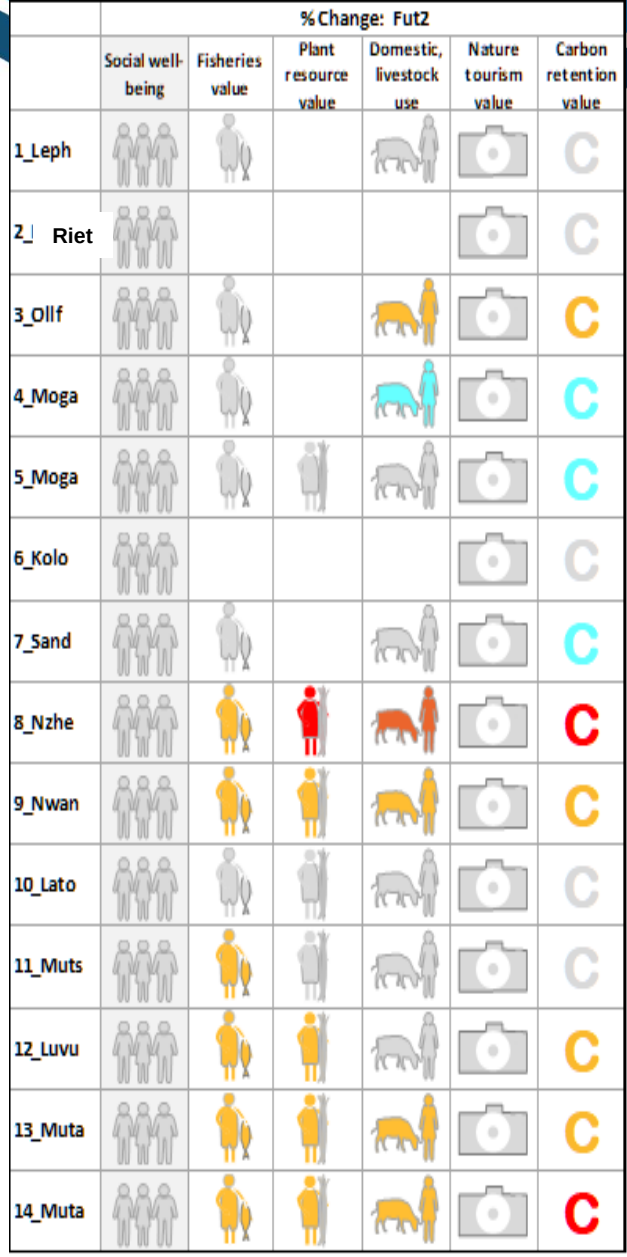


	Ecological Category: PES					
	Overall	Geomor-phology	Water quality	Vege-tation	Inverte-brates	Fish
1_Leph			WQ			
2_ Riet			WQ			
3_Olif			WQ			
4_Moga			WQ			
5_Moga			WQ			
6_Kolo			WQ			
7_Sand			WQ			
8_Nzhe			WQ			
9_Nwan			WQ			
10_Lato			WQ			
11_Muts			WQ			
12_Luvu			WQ			
13_Muta			WQ			
14_Muta			WQ			

	Ecological Category: Fut1					
	Overall	Geomor-phology	Water quality	Vege-tation	Inverte-brates	Fish
1_Leph			WQ			
2_ Riet			WQ			
3_Olif			WQ			
4_Moga			WQ			
5_Moga			WQ			
6_Kolo			WQ			
7_Sand			WQ			
8_Nzhe			WQ			
9_Nwan			WQ			
10_Lato			WQ			
11_Muts			WQ			
12_Luvu			WQ			
13_Muta			WQ			
14_Muta			WQ			


% Change: Base
Social well-being
Fisheries value
Plant resource value
Domestic, livestock use
Nature tourism value
Carbon retention value
1_Leph
2_ Riet
3_Ollf
4_Moga
5_Moga
6_Kolo
7_Sand
8_Nzhe
9_Nwan
10_Lato
11_Muts
12_Luvu
13_Muta
14_Muta
C


% Change: Fut1
Social well-being
Fisheries value
Plant resource value
Domestic, livestock use
Nature tourism value
Carbon retention value
1_Leph
2_ Riet
3_Ollf
4_Moga
5_Moga
6_Kolo
7_Sand
8_Nzhe
9_Nwan
10_Lato
11_Muts
12_Luvu
13_Muta
14_Muta
C


% Change: Fut2
Social well-being
Fisheries value
Plant resource value
Domestic, livestock use
Nature tourism value
Carbon retention value
1_Leph
2_ Riet
3_Ollf
4_Moga
5_Moga
6_Kolo
7_Sand
8_Nzhe
9_Nwan
10_Lato
11_Muts
12_Luvu
13_Muta
14_Muta
C

Ecological Water Requirements

Future development:	EWR site	EIS	REC	PES (2022)	Future1	Synthetic Scenario		Additional mitigation recommended?
Yes / No				Outcome of scenario flow regime				Yes / No
Yes	1_Lephala	Moderate	B/C	C	C			Yes
No	2_Rietfontein	Moderate	B/C	B/C	B/C			No
No	3_Olifantspruit	Moderate	C	C	C			
Yes	4_Mogalakwena1	Moderate	C	C	B			
Yes	5_Mogalakwena2	Moderate	C	C	C			
No	6_Kolope	Moderate	C	C	C			
Yes	7_Sand	Moderate	C	C	B/C			
Yes	8_Nzhelele	Moderate	C	C	D	SS1	C/D	
Yes	9_Nwanedi	Moderate	C	C	D	SS1	C/D	
No	10_Latonyanda	Moderate	B/C	C	C			Yes
Yes	11_Mutshindudi	Moderate	C	C	C			No
Yes	12_Luvuvhu	Moderate	C	C	C			
Yes	13_Mutale1	Moderate	B/C	C	C/D	SS2	C	Yes
Yes	14_Mutale2	Moderate	B/C	C	C/D	SS1	C	

EWRs – Shingwedzi River

Annual Flows (Mill. cu. m or index values):

MAR	=	86.618
S.Dev.	=	200.484
CV	=	2.315
Q75	=	0.32
Q75/MMF	=	0.044
BFI Index	=	0.214
CV(JJA+JFM) Index	=	4.722
REC	=	B/C

Total E-Flows	=	27.639 (31.91 %MAR)
Maint. Low flow	=	13.487 (15.57 %MAR)
Drought Low flow	=	0.806 (0.93 %MAR)
Maint. High flow	=	14.152 (16.34 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type: Lowveld

Month	Natural flows			Modified flows (E-Flows)			
	Mean	SD	CV	Low flows		High flows	Total flows
				Maint.	Drought	Maint.	Maint.
Oct	0.32	0.404	0.472	0.229	0.022	0	0.229
Nov	0.721	1.27	0.68	0.255	0.027	0	0.255
Dec	2.035	5.284	0.969	0.336	0.026	0	0.336
Jan	8.595	27.053	1.175	0.797	0.03	1.51	2.307
Feb	11.65	43.043	1.527	1.079	0.029	2.507	3.586
Mar	7.07	28.174	1.488	0.779	0.03	1.51	2.289
Apr	1.441	5.594	1.498	0.412	0.031	0	0.412
May	0.375	0.409	0.408	0.274	0.022	0	0.274
Jun	0.366	0.407	0.429	0.273	0.023	0	0.273
Jul	0.343	0.381	0.415	0.257	0.022	0	0.257
Aug	0.325	0.364	0.417	0.246	0.022	0	0.246
Sep	0.318	0.355	0.432	0.241	0.023	0	0.241

Thank you

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