water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

The Determination of Water Resources Classes and Associated Resource Quality Objectives for the Berg Catchment

Technical Task Group meeting 2: Presentation and workshopping of draft Resource Quality Objectives

Overview of the RQOs Process

Presented by: James Cullis

30-31st May 2018
Venue: El Lions Venue, West Coast Road (R304), Dassenberg – map attached

Study Objectives

Co-ordinate implementation of the Water Resources Classification System (WRCS):

- **Determine Water Resources Classes (WRCs)**
- **Determine Resource Quality Objectives (RQOs)**
- **Support Gazetting of Recommended Water Resources Classes and RQOs**

for the water resources in the Breede-Gouritz WMA:

- Rivers - Estuaries - Groundwater
- Dams - Wetlands

Objectives of the TTG Meeting

- Provide overview of:
  - Study progress to date
  - Approach followed to determine RQOs
- Present and workshop RQO findings:
  - Prioritisation of Resource Units (RUs)
  - Evaluation of Resource Units (prioritised RUs)
  - RQOs for Resource Units (prioritised RUs)

TTG Meeting arrangements

- Wed 30th May
  - Rivers
  - Estuaries
  - Dams
- Thu 31st May
  - Groundwater
  - Wetlands

Overview of Study Progress

Classification and RQOs Steps

7-step process to determine WRCs

1. Delineate IUA's and describe status quo
2. Link value & condition of water resource
3. Quantify EWRs and changes in non-water quality EGSAs
4. Determine scenarios
5. Evaluate scenarios within IWRM process
6. Evaluate scenarios with stakeholders
7. Gazette & Class configuration

Aligned

7-step process to determine RQOs

1. Delineate Resource Units (RUs)
2. Establish Vision for Catchment
3. Prioritise & select prelim RU for RQO
4. Prioritise sub-components for RQO & select indicators
5. Draft RQOs & Numerical limits
6. Agree to RU, RQOs and numerical limits with stakeholders
7. Gazette WRC & RQO

Defined Integrated Units of Analysis (IUAs)

- Identified **significant resources**:
  - Based on Physical, Biological & Socio-economic factors
- Each IUA represents a similar area requiring a Water Resources Class (WRC)
- Why do we need these?
  - Broad-scale units to assess socio-economic implications of scenarios *(possible future situations)*
  - Report on ecological conditions at a sub-catchment scale
  - Set WR Classes for different parts of a catchment
- 12 IUAs delineated

Determining the Water Resource Class

Description of the meaning for each Water Resource Class

Water Resource Class	Description
Class I	Minimally used
Class II	Moderately used
Class III	Heavily used

Guidelines for determining the IUA class based on ecological condition

	Percentage (%) of nodes in the IUA falling into the indicated groups				
	A or A/B	B or B/C	C or C/D	D	< D
Class I	60	40	20	1	-
Class II		60	30	5	-
Class III Either:			70	20	-

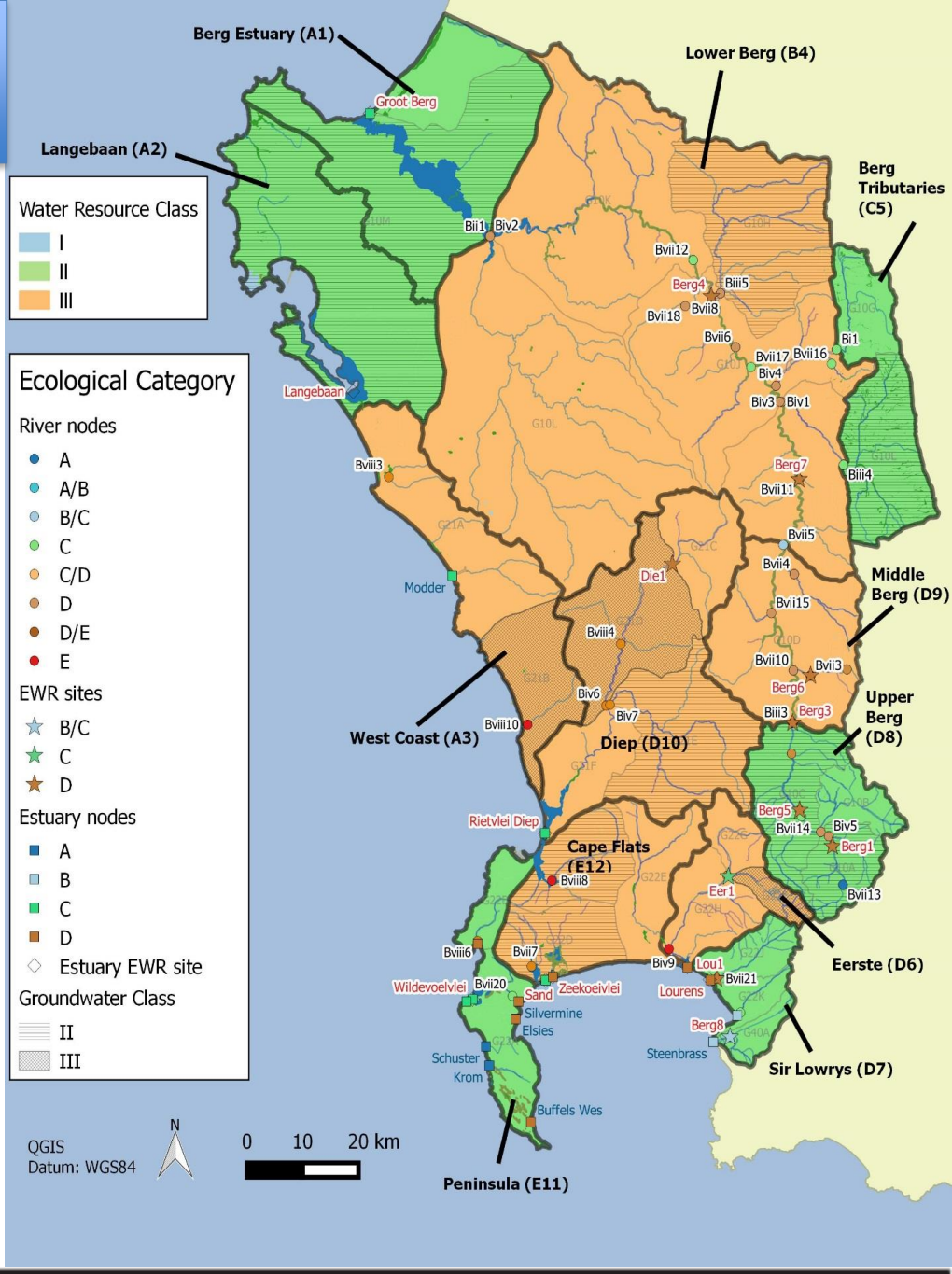
Defined Resource Units (RUs) and Nodes

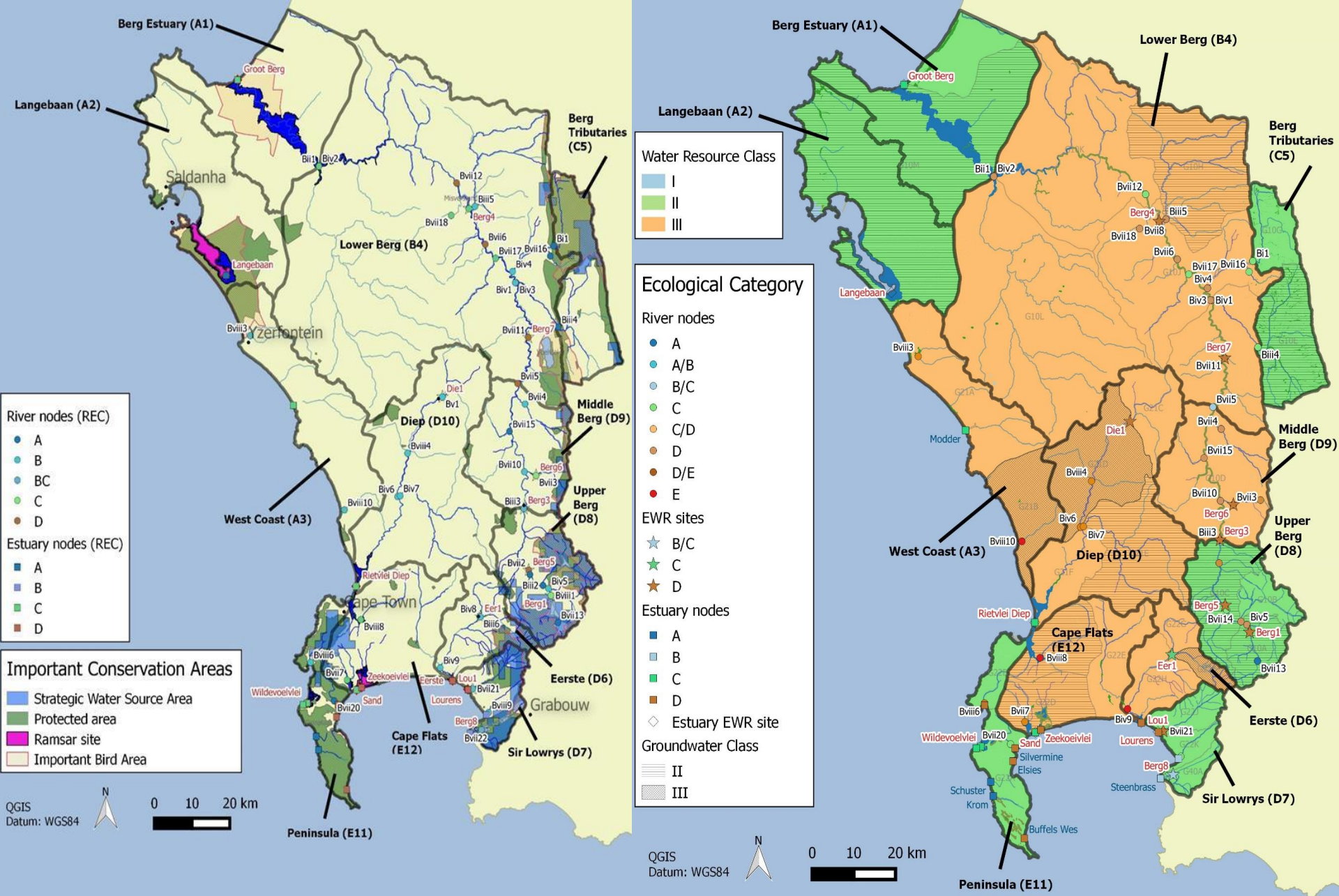
- **Resource units (RUs)** are grouped areas e.g. river basins, deemed similar in terms of various characteristics
- Are used to transfer information between catchments
- Groundwater

- **Nodes** are locations of interest (points) in a water resource (rivers, dams, wetlands, estuaries)
- Are sited using:
  - Water infrastructure
  - Aquatic ecosystem attributes
- Are used to allocate water for environment and development

Water Resource Classes for the Berg Catchment

IUA Name	IUA Code	Recommended Class
Berg Estuary	A1	II
Langebaan	A2	II
West Coast	A3	III
Lower Berg	B4	III
Berg Tributaries	C5	II
Eerste	D6	III
Sir Lowry's	D7	II
Upper Berg	D8	III
Middle Berg	D9	III
Diep	D10	III
Peninsula	E11	II
Cape Flats	E12	III





Management Considerations for Water Resource Classes

Overview of RQO Progress

Comments on draft RQO Reports

- Three RQO Reports disseminated for comment:
  - Resource Unit Prioritisation Report
  - Evaluation Resource Units Report
  - Outline of RQOs Report

Study Status: RQOs

STEP 1: DELINEATE CATCHMENT

Outcome: Integrated Units of Analysis and Resource units as defined in the Water Resource Classification System approach.

Complete

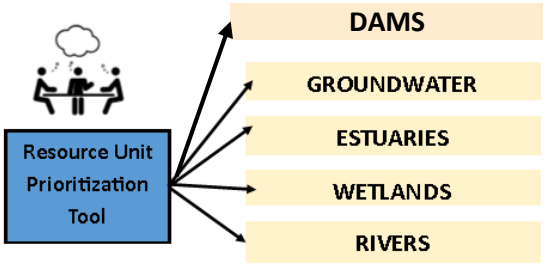
STEP 2: ESTABLISH VISION FOR CATCHMENT

Outcome: Align the diverse and competing interests in the resource into a collective desired future state. This involves multiple stakeholders in the strategic planning process.

Complete

STEP 3: PRIORITISE & SELECT PRELIMINARY RESOURCE UNITS FOR RQO

Outcome: Use the resource unit prioritization tool to sect priority resource units.

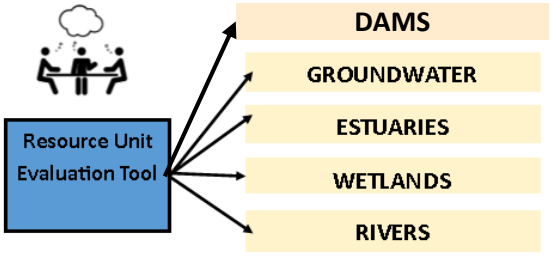


Draft

STEP 4: PRIORITISE SUB-COMPONENTS FOR RQO & SELECT INDICATIORS FOR MONITORING

Outcome: Identify and prioritize sub-components that may be important to users or environment. Select sub-components and associated indicators for RQOs and Numerical Limits.

Draft



STEP 5: DEVELOP DRAFT RQOs & NUMERICAL LIMITS

Outcome: RQOs are essentially narrative but sometimes broadly quantitative descriptions of the resource. These are gazette, whilst Numerical Limits are not. These should be set for discussion with stakeholders.

Draft

STEP 6: AGREE RESOURCE UNITS, RQOs AND NUMERICAL LIMITS WITH STAKEHOLDERS

Outcome: .Stakeholders who were involved in the setting of the vision are involved in reviewing how their input has been considered and taken forward. Decide on Resource Units, RQOs and Numerical Limits.

STEP 7: GAZETTE RESOURCE QUALITY OBJECTIVES

Outcome: A Water Resource Class configuration and associated RQOs for the entire catchment is published by the Minister in the Government Gazette as required in the National Water Act of 1998.

Overview

Classification:

- Proposed Scenario
  (RUs with Targeted ECs (TECs) for water resources, per IUA class)

RQOs:

- Resource Unit prioritisation (using RUPT Tool, where applicable)
- Resource Unit evaluation (using RUET Tool, where applicable)
- Define RQO and Numerical Limits
- Define Monitoring Program

Overview

- **Prioritised Resource Unit per IUA**
  - i.e. grouped areas e.g. river basins, deemed similar in terms of various characteristics
- **Target Ecological Category (TEC)**
  - Ecological Category taken forward from the proposed scenario
- **Component/Sub-component**
  - E.g. Quantity/Flow
- **Indicator**
  - Representation of trend tracking the measurable change in a system over time. Focuses on a small manageable set of information to get a sense of the "bigger picture"
- **Resource Quality Objective (RQO)**
  - Descriptive broad statements describing overall objectives for the Resource Unit
- **Numerical limit**
  - Quantitative descriptors of different components of the Resource Unit

Example of indicators: River Example

Component	Sub-Component	Indicator example
QUANTITY	Flow	Water level recovers from abstraction impact during wet season, under consideration of climate change and drought cycles
QUALITY	Nutrients	NO_3/NO_2
HABITAT	Geomorphology	Sediment particle size (D_{50})
BIOTA	Macroinvertebrates	SASS and ASPT scores

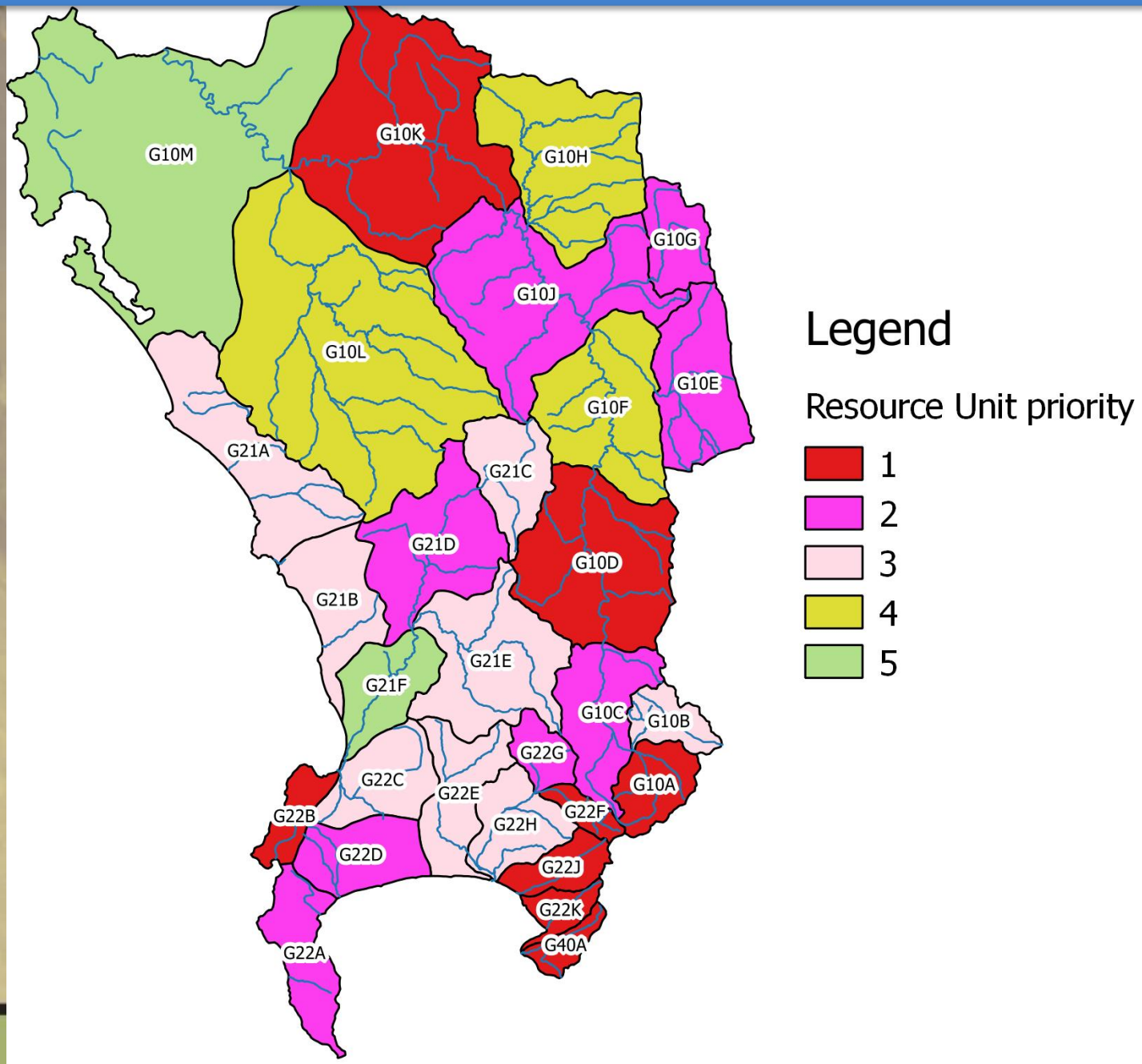
Rivers

- Resource Unit prioritisation
- Resource Unit evaluation
- Define RQO and Numerical Limits
- Worked example

Resource Unit Prioritisation

- DWS Resource Unit prioritisation tool used
- All quaternary catchments were prioritised
  - Common unit of measure for all disciplines
  - Nodes used if present or river selected if absent
- Prioritisation based on
  - Position in Integrated Unit of Analysis, NB to users (social, international, power, regulating services), NB to economy, WQ, environment (NFEPA, CBA, EC)
  - Threat posed to the above, management actions, practical considerations

Resource Unit Prioritisation



Resource Unit Prioritisation

IUA	QUAT	NODE	COMMENT	RIVER	Score
Peninsula	G22B	Bviii6	At EWR site	Hout Bay	0.75
Sir Lowrys	G40A	Bvii22	At EWR 8, u/s of estuary mouth - B/C	Steenbras	0.73
Upper Berg	G10A	Bviii1	D/s of Berg River dam at EWR 1 - C	Berg	0.71
Eerste	G22F	Biii6	At EWR Eer1	Jonkershoek	0.66
Sir Lowrys	G22J	Bvii21	At EWR Lou1	Lourens	0.62
Sir Lowrys	G22K	Bviii9	Cumulative at outlet G22K	Sir Lowry's Pass	0.56
Upper Berg	G10A	Bvii13	Gauge	Berg	0.55
Middle Berg	G10D	Bvii5	At gauging weir G1H036 and u/s of EWR 3 - D	Berg	0.52
Lower Berg	G10K	Bvii12	3.5 km d/s of Misverstand reservoir, at EWR 5 - D	Berg	0.52
Middle Berg	G10C	Bviii11	At EWR 7 u/s of confluence with Kromme - C	Pombers	0.51
Middle Berg	G10D	Bvii3	North of Wellington, G1H037, d/s EWR 6 - D	Kromme	0.51
Berg Tributaries	G10E	Biii4	At gauging weir G1H008	Klein Berg	0.50
Peninsula	G22A	Bvii20	Town	Silvermine	0.49
Upper Berg	G10C	Biii3	At gauging weir G1H020	Berg	0.49
Cape Flats	G22D	Bvii7	At EWR site	Keysers	0.46
Eerste	G22G	Biv8		Klippies	0.46
Diep	G21D	Bv1		Diep	0.45
Berg Tributaries	G10G	Bi1	At gauging weir G1H028, pristine wilderness 100%	Vier-en-Twintig	0.44
Lower Berg	G10J	Bvii6	D/s of EWR 4, above Misverstand Dam G1H013 - D	Berg	0.42
Diep	G21D	Biv6	At EWR Die1	Diep	0.42

Resource Unit Evaluation

- The DWS Resource Unit evaluation tool was used to select indicators for RQOs based on:
  - Activities that impact on the water resource
    - Dams, Inter-Basin Transfers, afforestation, agriculture, etc.
    - User requirements
    - Conservation and ecosystem characteristics (including PES, trajectory of change)
    - Industry, agriculture, ecotourism, real estate (including fitness for use and trajectory of change)

Example of indicators

QUANTITY: flow

low flows and high flows, monthly average volume (MCM)

QUALITY:

nutrients, salinity, system variables, toxins and pathogens

HABITAT: condition/geomorphology/vegetation

IHI, PAI, GAI, VEGRAI

sediment particle size (D_{50}), channel width/depth

% cover of indigenous and alien cover in 3 zones

BIOTA: macroinvertebrates/fish

MIRAI, FRAI

SASS and ASPT scores, # of families present, key indicator families

CPUE of fish species present, FROC

Resource Unit Evaluation

Component	Sub-component	Reason for selection	Example of indicator
QUANTITY	Low flows	Component selected as part of original Reserve baseline information and standard for measuring all other ecosystem responses	Flow RQOs given are a monthly average volumes (MCM) that include maintenance low and high flows combined i.e. they include the inter-annual floods with a return period greater than 1:2 years
	High flows		
QUALITY	Nutrients	WQ influences habitat quality for organisms and also fitness for use for users	Water quality fitness-for-use categories, ranging from Ideal, Acceptable, and Tolerable. If in Unacceptable category the quality should be improved to a Tolerable category. Limits are specified for the different categories, for different uses.
	Salts	High salt concentrations affect crops yields, unpalatable drinking water, and interferes with the osmoregulation of aquatic organisms.	
	System variables (temperature, salinity, oxygen, pH, turbidity)	System variables such as pH, water temperature, suspended sediment, affect aquatic biota and uses.	
	Toxic substances	Agrochemicals (pesticide & herbicides residues) can have chronic or acute impacts on aquatic biota.	Conservative approach followed, no agrochemicals present in water.
	Pathogens	Water-borne diseases negatively affect domestic water supplies.	Fitness for use categories for domestic water supply and contact recreation.
CONDITION	Index of Habitat Integrity	Provides an overall score for ecological condition.	Scores are ranked as: A natural B near natural C moderately modified with natural functions still in place D moderately modified with a loss of natural functions E severely modified F critical modified with a total loss of biota and function
	PAI	Provides a score for the water quality condition.	
	GAI	Instream habitat influences aquatic biota. Riparian habitat influences river channel structure and also protects agricultural land from erosion and provides habitat to riparian organisms.	
	FRAI	Provides a score for the fish condition (see below).	
	VEGRAI	Provides a score for the vegetation condition (see below).	
	MIRAI	Provides a score for the macroinvertebrate condition (see below).	
BIOTA	Fish	Indigenous fish are of conservation importance	Catch per Unit Effort (CPUE) of fish species present. Frequency of occurrence (FROC) of key fish species.
	Aquatic and Riparian vegetation	Riparian habitat influences river channel structure and also protects agricultural land from erosion and provides habitat to riparian organisms	% cover of indigenous and riparian plant species.
	Macroinvertebrates	Invertebrates provide a useful measure of aquatic biodiversity and also are indicators of water quality.	SASS and ASPT scores from SASS. The number of macroinvertebrate families present. Presence of key families.

RQOs – G1

- Target Ecological Category from scenario analysis
- Monthly average volume (MCM) that include inter-annual floods (return period > 2 years)
- Annual volume (MCM) – sum of months
- %nMAR – annual flow as a % of natural

IUA	Node	River	REC		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tot
UpperBerg	Bvii13	Berg		A	4.94	2.39	1.42	1.05	1.02	1.50	3.76	9.97	15.59	17.33	14.72	9.62	83.32
UpperBerg	Bviii1	Berg	C	B/C	3.10	2.03	1.30	0.75	0.61	0.74	2.02	4.54	14.06	19.04	9.94	7.31	65.44
UpperBerg	Biv5	Franschhoek		D	2.38	0.59	0.06	0.01	0.00	0.02	0.44	2.37	5.58	7.53	7.28	4.71	31.01
UpperBerg	Biii2	Wemmershoek		D	1.04	0.32	0.05	0.02	0.01	0.03	0.34	1.36	3.84	8.04	7.11	3.63	25.77
UpperBerg	Bvii14	Dwars		C	2.07	0.93	0.46	0.25	0.19	0.26	1.16	2.81	5.68	7.20	6.77	4.06	31.85
UpperBerg	Biii3	Berg		E	9.51	5.88	9.25	15.67	12.77	12.12	9.93	13.02	38.80	58.10	48.20	28.35	261.61

EXAMPLE: Bvii13 – u/s of Berg River Dam

- RQOs

EXAMPLE: Berg River u/s of Berg River Dam (Bvii13)

QUANTITY: Flow – excludes inter-annual floods

Table Error! No text of specified style in document.**.1** **Bvii13: Hydrology RQOs**

Source: DWS (2018)
Model: DRM (Hughes and Hannart 2003).
Monitor at: G1H076

```
        Desktop Version 2, Generated on 02/03/2017
        Summary of Desktop (Version 2) estimate for Quaternary Catchment Area
:
        Total Runoff :           Bvii13

        Annual Flows (Mill. cu. m or index values):
        MAR                =   84.848
        S.Dev.             =   26.677
        CV                 =    0.314
        Q75                =    0.980
        Q75/MMF            =    0.139
        BFI Index          =    0.351
        CV(JJA+JFM) Index  =    1.833

        Ecological Category = A

        Total IFR          =   41.016 (48.34 %MAR)
        Maint. Lowflow     =   29.177 (34.39 %MAR)
        Drought Lowflow    =    3.637 ( 4.29 %MAR)
        Maint. Highflow    =   11.839 (13.95 %MAR)

        Monthly Distributions (Mill. cu. m.)
        Distribution Type : W.Cape(wet)

        Month    Natural Flows           Modified Flows (IFR)
                                         Low flows    High Flows Total Flows
               Mean     SD       CV     Maint.  Drought    Maint.    Maint.
         Oct   5.006    3.762    0.751    3.209   0.000     0.440     3.649
         Nov   2.415    1.778    0.736    2.041   0.000     0.073     2.115
         Dec   1.429    1.715    1.201    1.149   0.000     0.000     1.149
         Jan   1.065    1.473    1.384    0.771   0.000     0.000     0.771
         Feb   1.035    1.416    1.368    0.640   0.000     0.000     0.640
         Mar   1.528    1.820    1.191    0.695   0.000     0.000     0.695
         Apr   3.853    4.035    1.047    1.107   0.170     0.000     1.107
         May  10.210    7.126    0.698    2.328   0.429     2.022     4.350
         Jun  16.035   10.635    0.663    3.706   0.659     3.153     6.859
         Jul  17.661    8.978    0.508    4.569   0.803     4.160     8.729
         Aug  14.893    5.724    0.384    4.707   0.826     0.664     5.371
         Sep   9.718    6.300    0.648    4.255   0.750     1.327     5.582
```

From RQOs to limits and TPC

The water must be safe for me to swim in.

The water must be safe for recreational use

User requirements

Narrative RQO
Maintain the river in a state that is **Ideal** for recreation water users.

Indicators
Escherichia coli
Faecal coliforms

SA Recreation Water Quality Guidelines
Intermediate contact
E coli < 1000 cfu/100ml
Full contact
E coli < 130 cfu/100ml

I don't want to get sick when I canoe in the river

Vision Management class

Ecological requirements

Numerical Limits
95% of the time < 130 cfu/100ml

Reality check
Compare to present water quality

TPC (early warning)
100 cfu/100ml

Monitoring requirements

Upper Berg IUA - Berg River u/s of Berg River Dam (Bvii13)

Sub-component	TEC	RWQO	Indicator	Numerical Limits	Present state (50/95%tile) G1H038 Wolwekloof
Nutrients	A	Maintain in an oligotrophic (unenriched) condition.	Phosphate (PO_4-P) Total inorganic nitrogen (TIN)	Median ≤ 0.025 mg/l PO_4-P Median ≤ 0.70 mg/l TIN	PO4 0.005 / 0.005 TIN 0.03 / 0.09
Salts		Salt concentrations should be maintained in an Ideal state for aquatic organisms.	Electrical conductivity (EC)	95th %tile ≤ 30 mS/m EC	EC 3.3 / 4.3
System variables		pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	pH Dissolved oxygen	5 ≥ pH ≤ 7 (5th %tile / 95th %tile) 5th %tile DO ≥ 8 mg/l	pH 5.7 / 6.5 No DO data
Toxins		Natural catchment, no concerns about toxins	No RQO or limits set		No data
Pathogens		Natural catchment, no concerns about microbial pollution	No RQO or limits set		No data

Middle Berg IUA - Berg River at Hermon (Bvii5)

Sub-component	TEC	RWQO	Indicator	Numerical Limits	Present state (50/95%tile) G1H036 @ Hermon
Nutrients	?	Improve the river to a mesotrophic or better condition.	Phosphate (PO_4-P) Total inorganic nitrogen (TIN)	Median ≤ 0.075 mg/l PO_4-P Median ≤ 1.75 mg/l TIN	PO4 0.105 / 0.318 TIN 1.08 / 2.39
Salts		Salt concentrations need to be maintained at levels that do not adversely affect aquatic ecosystems.	Electrical conductivity (EC)	95th %tile ≤ 55 mS/m EC	EC 21.4 / 30.2
System variables		pH, temperature, and dissolved oxygen are important for the maintenance of ecosystem health.	pH Dissolved oxygen	6.5 ≥ pH ≤ 8.5 Median DO ≥ 6 mg/l	pH 7.5 / 7.9 No DO data
Toxins		Pesticide & herbicide residues should not pose a threat to aquatic ecosystems.	Atrazine Endosulfan	95th %tile ≤ 78.5 µg/l 95th %tile ≤ 0.13 µg/l	No data
Pathogens		Improve quality to an Acceptable category for full contact recreation.	E coli Faecal coliforms	95%tile ≤ 165 cfu/100ml E coli / Faecal coliforms	2100/25600 @ Wellington

Dams

- Resource Unit prioritisation
- Resource Unit evaluation
- Define RQO and Numerical Limits
- Worked example

Resource Unit Prioritisation

- 2 levels of ranking of resource units (RUs)
- First level of screening:
  - Filter National List of Registered Dams (DWS Dam Safety Office) for the WMA - ~900 dams
  - Select dams with High or Significant Hazard potential
  - Select Category 2 or 3 dams in terms of dam safety legislation
  - Select (significant) dams with a capacity of more than 3 million m^3
  - 8 dams selected following screening

Resource Unit Prioritisation

- Then the DWS **RU Prioritisation Tool** (RUPT) steps were followed that ranks RUs against one another based on 4 grouped criteria with sub-criteria:
  - Position in IUA
  - Concern for users
  - Concern for environment
  - Management and practical considerations

Resource Unit Prioritisation

Prioritisation Criteria evaluated in RU Prioritisation Tool:

- **Location** in river system
- **Importance to users**, such as recreational use, tourism, scientific benefits, aesthetic, cultural or spiritual benefits
- Does it **support** the **livelihoods** of significant vulnerable communities, such as water, food or grazing and raw materials
- **Strategic or international obligations**, for the generation of power, or for water-related agreements, such as the RAMSAR convention
- Provision of **supporting or regulating services**, such as water supply, flood attenuation, water quality control, stream flow regulation, and sediment retention, apart from the common function of water storage
- **Contribution to economy**
- **Ecological importance** of RU, linked to flow releases for ecological purposes
- Level of **threat** posed to the **water quality** for the environment
- **Practical considerations**, such as the existence of EWR sites and DWS gauging weirs

Resource Unit Prioritisation Tool

RESOURCE UNIT PRIORITIZATION TOOL				IUA / Resource Unit					
Criterion	Rationale for altering standardized weigthings	Sub-criteria	Rating Guideline	Ranking	Relative weighting	Sum to 1	Rationale for altering standardized weigthings	Voelvlei Dam	Berg River Dam
Position of resource unit within IUA		Resource units located on a large mainstem river	1 - Resource unit on large mainstem river 0 - RUs not located on large mainstem river	1	50	1		0	1
Importance for users (Current & anticipated future use)		Resource units which provide important **cultural services** to society	0 - RUs with no known / limited provision of cultural services 0.5 - RUs providing some cultural services 1 - RUs providing very important or numerous cultural services	1	50	0.13		1	0.5
		Resource units which are important in **supporting livelihoods of significant vulnerable communities**	0 - RUs which do not support / provide limited support for vulnerable communities 0.5 - RUs providing some support for vulnerable communities 1 - RUs playing an important role in supporting vulnerable communities	1	100	0.25		0	0
		Resource units which are important in meeting **strategic requirements and international obligations**	0 -RUs not used for strategic purposes or to meet international obligations 0.5 -RUs moderately important for strategic purposes or are somewhat useful for verifying compliance with international obligations 1 - RUs extremely important for strategic purposes or are idealy suited for verifying compliance with international obligations	1	100	0.25		0.5	0.5
		Resource units that provide **supporting and regulating services**	0 - RUs which supply limited supporting and regulating services 0.5 - RUs which supply moderate supporting and regulating services 1 - RUs which supply extensive supporting and regulating services	1	60	0.15		1	1
		Resource units most important in supporting activities **contributing to the economy** (GDP & job creation) in the catchment (e.g. commercial agriculture, industrial abstractions and bulk abstractions by water authorities)	0 - RUs which do not directly support any activities which contribute to the economy 0.5 - RUs which support activities which provide a moderate contribution to the economy 1 - RUs which support activities which contribute significantly to the economy	1	90	0.23		1	1

RUPT Priority scores for dams (RUPT) :

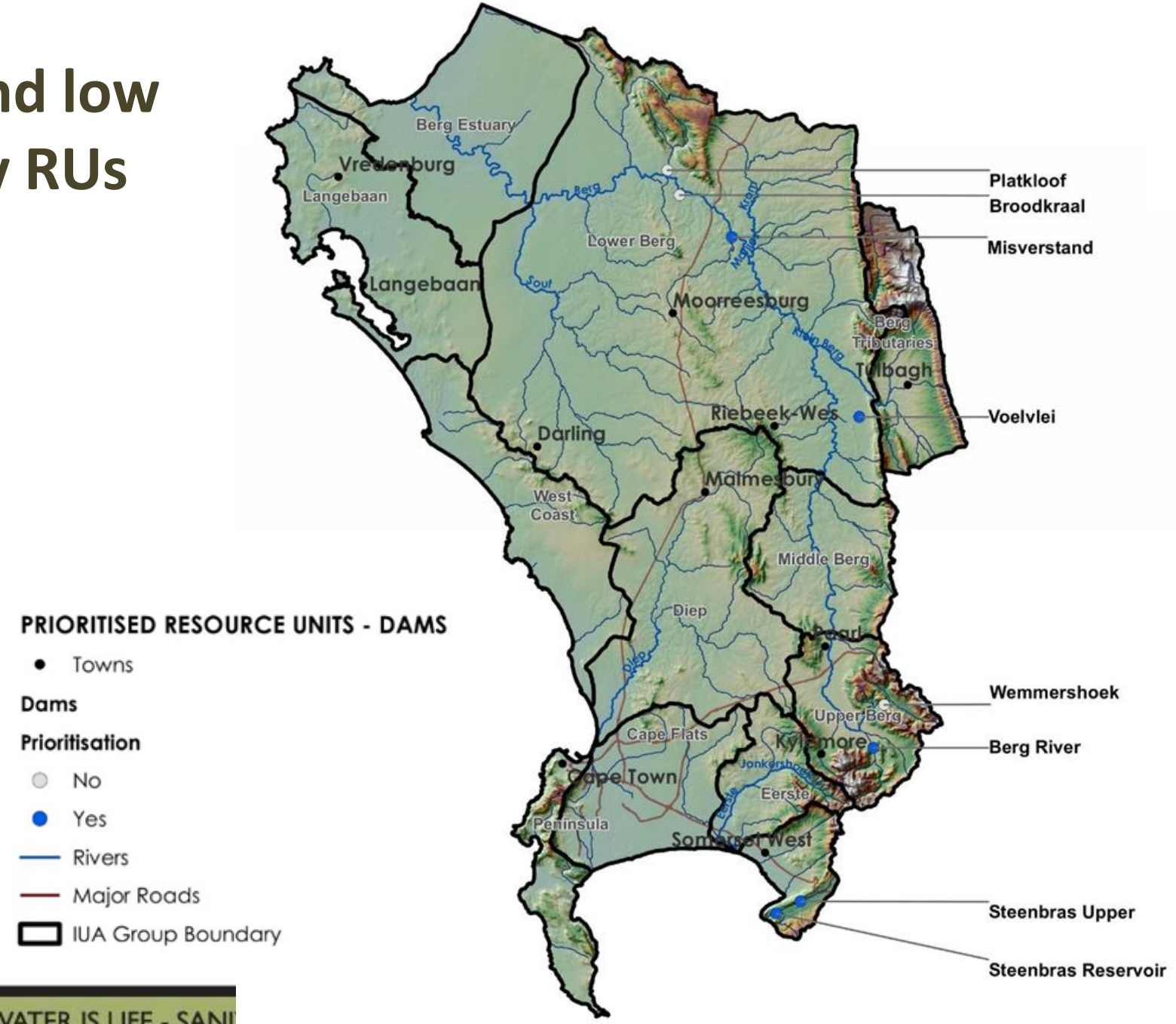
Dams with “Priority Rating” ≥ 0.6 are prioritised

	Voelvlei	Berg River	Wemmershoek	Steenbras Reservoir	Steenbras Upper	Broodkraal	Misverstand	Platkloof
Position in IUA	0.00	0.13	0.00	0.13	0.13	0.00	0.13	0.00
Concern for users	0.22	0.14	0.12	0.12	0.14	0.03	0.13	0.05
Concern for environment	0.06	0.25	0.00	0.06	0.06	0.00	0.06	0.00
Management and practical considerations	0.13	0.13	0.08	0.13	0.13	0.08	0.13	0.08
Total Prioritization Score	0.41	0.64	0.20	0.43	0.45	0.11	0.44	0.12
Relative Priority Rating	0.63	1.00	0.31	0.68	0.71	0.16	0.68	0.19

Prioritised dams

- Berg River Dam
- Voëlvlei Dam
- Misverstand Weir
- Steenbras Upper Dam
- Steenbras Reservoir (Lower Steenbras Dam)

High and low priority RUs



Resource Unit Evaluation

- Customised DWS **RU Evaluation Tool** used to identify selected indicators *for prioritised RUs* for which RQOs (descriptive and numerical) will be written, by identifying:

Components

Sub-components

Indicators

Resource Unit Evaluation

The **evaluation criteria** (applied in the **RU Evaluation Tool**) for each of the above indicators are:

- **Cumulative level of impact**: This is the anticipated level of impact of current and future use/activities in the upstream catchments on the inflows to the dam and the quality, habitat and biota in the dam
- **Protection of the Resource**: Rating of importance of components for the protection of the water resource, i.e. importance to releases of water for downstream EWRs
- **Water Resource Dependent Activities**: Rating of importance of components for protection of in-dam activities and releases of water for downstream use (irrigation, domestic/rural supply, etc.)

Components with importance scores of 0.5 and higher were selected

Resource Unit Evaluation

ECOSYSTEM NAME: Voëlvlei Dam RU

EVALUATION CRITERIA	Quantity		Quality					Habitat		Biota	
	Low Flows (Maintenance Flows)	High Flows (Floods)	Nutrients	Salts	System variables (pH, temperature, sedimentation)	Toxics	Pathogens	Lake habitat	Shoreline habitat	Fish	Phytoplakton
Cumalative level of impact	0.25	0.00	-0.50	-0.25	-0.25	-0.25	-0.50				-0.50
Protection of the resource/river downstream (EWR releases)	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
Water Resource Dependent Activities (in-lake & other releases)	0.75	0.00	0.75	0.75	0.50	0.50	0.50			0.75	1.00
Trajectory of change	→	→	↑	→	→	→	→			↓	↑
Confidence in data	Moderate	High	Moderate	Moderate	Moderate	Low	Low			Low	Moderate
Select for RQO Determination	Y	N	Y	Y			Y			Y	Y
Indicators Selected for RQO determination	Dam levels		Ortho-phosphate, total phosphate, total inorganic nitrogen	Electrical conductivity	pH, suspended sediment, turbidity		E coli, Faecal coliforms			Index of Reservoir Habitat Impairment (IRHI) (2011), fish health evaluation	Chlorophyll a, algal species composition

Examples of:

Components-sub-components-indicators

Quantity ➡ low/high/maintenance flows, dam level

EWR

Quality ➡ nutrients, salts, system variables, toxics, pathogens

Ortho-phosphate, nitrogen, ammonium, EC

Habitat ➡ riparian habitat, in-dam habitat

None selected for dams

Biota ➡ fish, phytoplankton

Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011), fish health evaluation, chlorophyll a

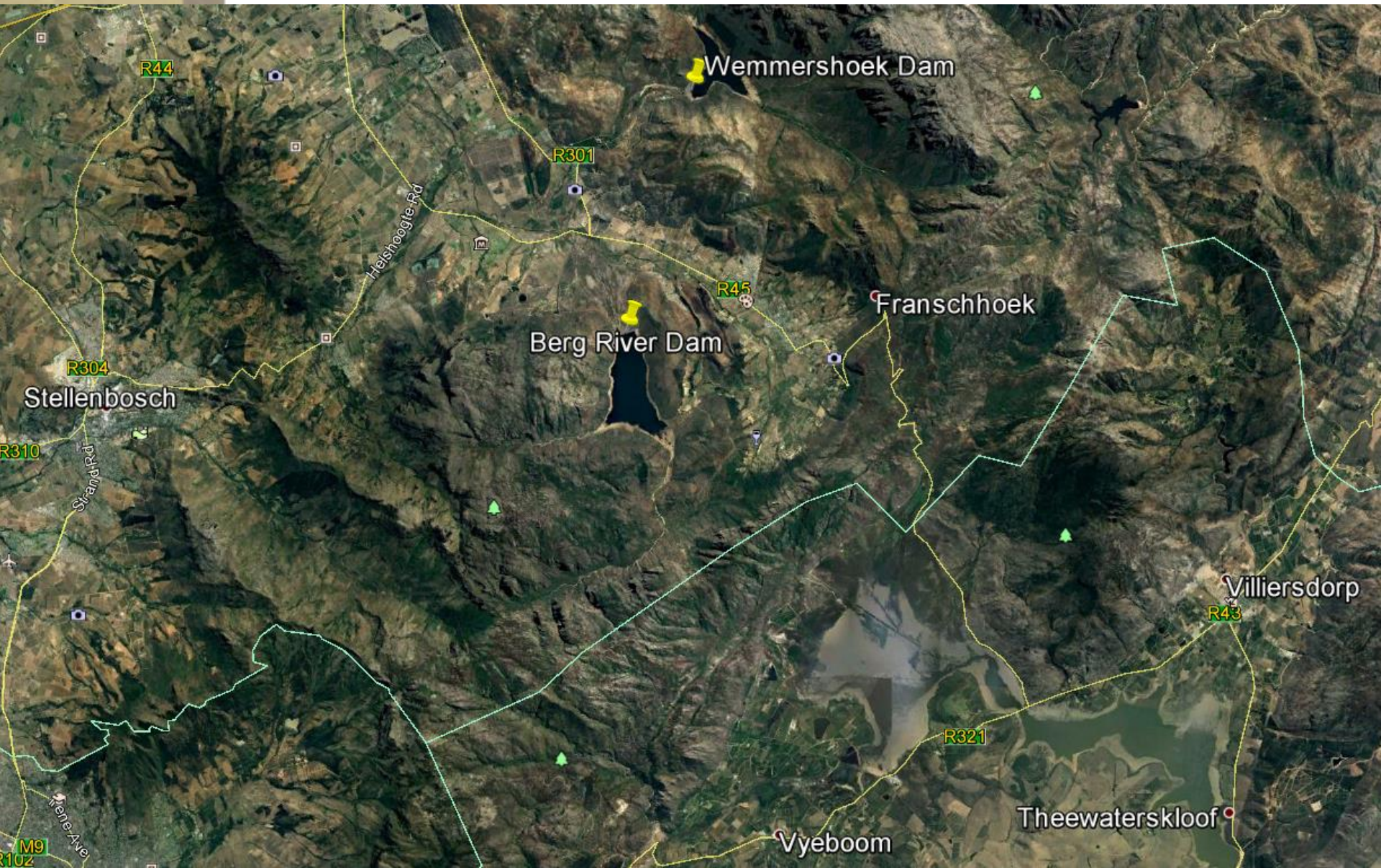
EXAMPLE: Berg River Dam

(IUA D8 Upper Berg)

- Located on the upper Berg River.
- Largely natural upstream of the dam.
- Key water supply dam in the Western Cape Water Supply System, providing urban water supply to the City of Cape Town.
- Transferred water for irrigation is released downstream, along with compensation releases for irrigation.
- Regulation: the dam is operated as in integral part of the WCWSS and the downstream Supplement Scheme, with transfers made to and from Theewaterskloof Dam.
- Berg EWR1 site located immediately downstream of the dam and upstream of the Franschhoek River junction.
- Outlet works able to make high flow release; 1:2 year flood
- EWR releases made according to DSS tool.

Resource Quality Objective

Berg River Dam (IUA D8 Upper Berg)



Resource Quality Objective

Berg River Dam (IUA D8 Upper Berg)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows (QUANTITY)	Dam levels must remain sufficient to provide for transfers and releases for irrigation, urban & industrial water use, as well as ecosystem function downstream. Water intake temperatures to be managed.	Dam levels EWR
High flows (QUANTITY)	During the wet season high flow ecological releases should be made according to the EWR decision-support system.	EWR
Nutrients (QUALITY)	The system must be maintained in a mesotrophic (moderately enriched) state or better to protect against nuisance algal blooms and excessive water treatment costs.	Ortho-phosphate, total inorganic nitrogen
Salts (QUALITY)	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, are maintained in an Ideal category for domestic and irrigation water supply.	Electrical conductivity
System variables (QUALITY)	The water in the dam is naturally acidic and it should be maintained within the historical range	pH
Fish (BIOTA)	The wellbeing of the fish community of Berg River Dam must be maintained in a suitable condition to contribute to, or not impact negatively on regional biodiversity. Consumption of fish must not pose a health risk to users.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)
Phytoplank-ton (BIOTA)	The system must be maintained in a mesotrophic state or better.	Chlorophyll a

Resource Quality Objective

- Targeted Ecological Category (TEC) = Spatially Targeted Scenario, where info is available
- 5 high priority RUs in the Berg area
  - Evaluate present status and suitability of data
- For the selected sub-components and indicators of each dam:
  - **Write descriptive RQOs (narratives)**
  - **Set numerical limits**
  - **Set Thresholds of Potential Concern (TPCs)**

Quantity & Biota RQOs for Berg River Dam

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	During the dry season dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream. Water intake temperature to be managed.	Flow releases: Berg EWR1 in G10A nMAR = 141.68 million m^3/a pMAR = 126.00 million m^3/a REC = C category	Berg EWR 1 site in upper Berg River – specified flows	Not applicable
High flows	During the wet season high flow ecological releases are made according to the decision-support system.			
Fish	The wellbeing of the fish community of Berg River Dam must be maintained in a suitable condition to contribute to, or not impact negatively on regional biodiversity.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	Habitat suitability and fish wellbeing (FRAI) in a state which is equivalent to a B or better ecological category.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a B ecological category (low impairment).

Quantity Numerical Limits for Berg River Dam

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	VOL ($X10^6$ m^3)	MAR %
	TRN	*TRN*	*DRY*	*DRY*	*DRY*	*DRY*	*TRN*	*TRN*	*WET*	*WET*	*WET*	*TRN*		
MAINTENANCE														
CAPPING FLOWS	**3.1**	**3.1**	**3.1**	**3.1**	**3.1**	**3.1**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**		
LOW FLOWS m^3s^{-1}	**0.8**	**0.5**	**0.4**	**0.3**	**0.3**	**0.3**	**0.8**	**1.2**	**1.6**	**2.1**	**2.1**	**1.5**	**31.3**	23.9
Depth (average in m)	0.25	0.20	0.18	0.15	0.15	0.15	0.25	0.32	0.35	0.40	0.40	0.33		
Flow percentile	80	70	60	50	40	35	40	60	75	70	83	75		
FLOOD m^3s^{-1}		1) 4.5 2) 1.6	1) 4.5 2) 1.6				10.0		30.0	85.0		2.0		
Flood volumes		0.5	0.5				1.6		4.5	12.8		0.2	20.1	15.3
Depth (average in m)		1) 0.68 2) 0.45	1) 0.68 2) 0.45				0.87		1.2	1.65		0.48		
DURATION in days		**1) 0.5 2) 1.0**	**1) 0.5 2) 1.0**				**5.0 peak = 1**		**7.0 peak = 2**	**7.0 peak = 2**		**1.0**		
Return period (years)		1)1:1 2)1:1	1)1:1 2)1:1				1:1		1:1	1:1		1:1		
TOTAL	2.1	1.8	1.6	0.8	0.7	0.8	3.7	3.2	8.6	18.4	5.6	4.1	51.4	39.4
DROUGHT														
LOW FLOWS m^3s^{-1}	0.5	0.30	0.16	0.16	0.16	0.16	0.30	0.50	0.80	0.80	1.0	1.0		
Depth (average in m)	0.20	0.15	0.10	0.10	0.10	0.10	0.20	0.20	0.25	0.25	0.29	0.29		
FLOOD m^3s^{-1}	0.8			0.3					15					
DURATION in days	**1**			**1**					**7.0 peak = 1**					

Quality RQOs for Berg River Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1H077Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	PO4 0.005 / 0.045
		Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N	0.56 mg/ℓ N	TIN 0.162 / 0.25
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 5 / 7.5
System variables	Water is naturally acidic and it should be maintained within the historical range	pH	5.5 ≥ pH ≤ 7.5 (5^{th} & 95^{th} %tiles)	5 ≥ pH ≤ 8	No data
Phytoplanc ton	Maintain in a mesotrophic state or better	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Voëlvlei Dam (IUA B4 Lower Berg)

- Off-channel dam (old pan) with limited natural inflow located along a small mountain catchment & 2nd largest dam in the Western Cape Province
- Supplied via 2 canals, from Klein Berg & 24-Rivers rivers
- Provides urban supply to City of Cape Town and Swartland towns, as part of the WCWSS.
- Releases made to the Berg River via a canal, for abstraction (for use by West Coast and Swartland towns) from the Misverstand Weir and for irrigators along the Berg River.
- Should the Voëlvlei Augmentation Scheme be constructed, releases may need to be made to maintain the baseflow into the estuary.
- Should the Michell's Pass intervention be implemented, this dam would be significantly influenced.

Resource Quality Objective

Voëlvlei Dam (IUA B4 Lower Berg)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows (QUANTITY)	Dam levels must be sufficient for urban and industrial use water supply via the two WTWs, and releases to Berg River for human and irrigation use.	Dam levels
Nutrients (QUALITY)	The reservoir is currently in an Eutrophic state and should be improved to a mesotrophic state or better to protect the water supply to the City of Cape Town and Swartland towns against harmful algal blooms and taste & odour problems in treated domestic water.	Ortho-phosphate, total inorganic nitrogen
Salts (QUALITY)	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic water use and for irrigation water use.	Electrical conductivity
Pathogens (QUALITY)	The system must be maintained in a state that is in an Ideal category for contact recreation	E coli, Faecal coliforms
Fish (BIOTA)	The wellbeing of the fish community of Voëlvlei Dam must be maintained in a suitable condition to support the local recreational angling industry. Consumption of fish must not pose a health risk to consumers.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011), fish health evaluation
Phytoplank-ton (BIOTA)	The system must be maintained in a mesotrophic state or better.	Chlorophyll a

Quantity & Biota RQOs for Voëlvlei Dam

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	During the dry season dam levels must be sufficient for releases for irrigation and human use and protection of ecosystem function downstream.	Dam levels	% of dam volume	Not applicable
Fish	The wellbeing of the fish community of Voëlvlei Dam must be maintained in a suitable condition to support the local recreational angling industry. Consumption of fish must not pose a health risk to consumers.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011). Fish health evaluation.	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category. Fish health must not deviate significantly from the baseline state. Toxicants in fish tissue must not exceed guideline thresholds.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a D ecological category.

Quality RQOs for Voëlvlei Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1R001
Nutrients	Current eutrophic – should be improved to mesotrophic state	Ortho-phosphate (PO_4-P)	Median ≤ 0.025 mg/ℓ P	0.020 mg/ ℓ P	PO4 0.012 / 0.028
		Total inorganic nitrogen (TIN)	Median ≤ 1.00 mg/ℓ N	0.8 mg/ℓ N	TIN 0.043 / 0.155
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and in Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 11.5 / 13.7
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 20 µg/ℓ Chl a	Chl a ≤ 15 µg/ℓ	>20 µg/ℓ

Misverstand Weir

(IUA B4 Lower Berg)

- Located on the lower Berg River.
- Important infrastructure component for domestic and industrial water supply to the West Coast District.
- Water is abstracted and treated at the Withoogte WTW for supply to West Coast towns.
- Water spills over the weir to irrigators downstream.
- Important for recreation.

Resource Quality Objective

Misverstand Weir (IUA B4 Lower Berg)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows (QUANTITY)	Water levels in the weir must be sufficient for supply for human use via the Withoogte WTW.	Weir levels
Nutrients (QUALITY)	The reservoir is currently in an Eutrophic state and should be improved to a mesotrophic state or better to protect the water supply to the City of Cape Town and Swartland towns.	Ortho-phosphate, total inorganic nitrogen
Salts (QUALITY)	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use, and for irrigation water use.	Electrical conductivity
Pathogens (QUALITY)	The reservoir must be maintained in a state that is safe for domestic water use (with treatment) and for contact recreation as the dam is a popular recreation venue.	E. Coli and Faecal coliforms
Fish (BIOTA)	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011), fish health evaluation
Phytoplank-ton (BIOTA)	The system must be maintained in a mesotrophic state or better.	Chlorophyll a

Quantity & Biota RQOs for Misverstand Weir

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	Water levels in the weir must be sufficient for supply for human use via the Withoogte WTW.	Weir levels	% of dam volume	Not applicable
Fish	The wellbeing of the fish community of this artificial ecosystem must be maintained in a suitable condition to contribute to regional biodiversity and to support local recreational angling. Consumption of fish must not pose a health risk.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011), Fish health evaluation	Habitat suitability and fish wellbeing in a state which is equivalent to a D or better ecological category. Fish health must not deviate significantly from the baseline state. Toxicants in fish tissue must not exceed guideline thresholds.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a D ecological category.

Quality RQOs for Misverstand Weir

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1R003Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.025 mg/ℓ P	0.020 mg/ ℓ P	PO4 0.022 / 0.055
		Total inorganic nitrogen (TIN)	Median ≤ 1.00 mg/ℓ N	0.80 mg/ℓ N	TIN 0.4 / 1.19
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 70 mS/m	56 mS/m	EC 34.9 / 52.7
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 20 µg/ℓ Chl a	15 µg/ℓ	>20 µg/ℓ

Upper Steenbras Dam

(IUA D7 Sir Lowry's)

- Located on the upper/middle Steenbras River.
- Supplies domestic and industrial water to the City of Cape Town via the Faure WTW.
- Releases are made as needed to the Lower Steenbras Dam, situated just downstream.
- The dam is also used for hydropower energy generation (180 MW) via the Steenbras Pumped Storage Scheme.

Resource Quality Objective

Upper Steenbras Dam (IUA D7 Sir Lowry's)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows (QUANTITY)	Dam levels must be sufficient for releases to the Lower Steenbras Dam for urban and industrial use and protection of ecosystem functioning downstream of the Lower Steenbras Dam, hydropower energy generation via the Steenbras Pumped Storage Scheme as well as for water supply to the Western Cape Water Supply System (City of Cape Town) via the Faure WTW.	Dam levels
Nutrients (QUALITY)	The system must be maintained in a mesotrophic state or better.	Ortho-phosphate, total inorganic nitrogen
Salts (QUALITY)	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use, and for hydropower generation.	Electrical conductivity
Pathogens (QUALITY)	The system must be maintained in a state that is safe for municipal use (with treatment).	E. Coli and Faecal coliforms
Fish (BIOTA)	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)
Phytoplank-ton (BIOTA)	The system must be maintained in a mesotrophic state or better.	Chlorophyll a

Quantity & Biota RQOs for Upper Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	Dam levels must be sufficient for releases to the Lower Steenbras Dam for urban and industrial use and protection of ecosystem functioning downstream of the Lower Steenbras Dam, hydropower energy generation via the Steenbras Pumped Storage Scheme as well as for water supply to the Western Cape Water Supply System (City of Cape Town) via the Faure WTW.	Dam levels	% of dam volume	Not applicable
Fish	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	Habitat suitability and fish wellbeing in a state which is equivalent to a B or better ecological category.	Habitat suitability and fish wellbeing (FRAI) in a state worse than a B ecological category (low impairment index).

Quality RQOs for Upper Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) -
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	No data
		Total inorganic nitrogen (TIN)	Median ≤ 1.50 mg/ℓ N	1.3 mg/ℓ N	No data
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	No data
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Lower Steenbras Dam

(IUA D7 Sir Lowry's)

- Located on the lower Steenbras River.
- The dam supplies domestic and industrial water to the City of Cape Town via the Steenbras WTW
- Provides ecological flows to the lower Steenbras River and estuary for the protection of ecosystem functioning downstream.

Resource Quality Objective

Lower Steenbras Dam (IUA D7 Sir Lowry's)

Sub-comp.	Rationale for sub-component choice	Indicator selection
Low flows (QUANTITY)	Dam levels must remain sufficient to provide for supply to the Western Cape Water Supply System (City of Cape Town) via the Steenbras WTW, and low flows to the lower Steenbras River and estuary for the protection of ecosystem functioning downstream.	Dam levels, spills from dam
High flows (QUANTITY)	High flow ecological releases should be made during the wet season to meet flood requirements, but within the constraints of the existing outlet structure, and utilising spills where possible.	EWR
Nutrients (QUALITY)	The system must be maintained in a mesotrophic state or better.	Ortho-phosphate, total inorganic nitrogen
Salts (QUALITY)	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem, and are in an Ideal category for domestic and industrial water use.	Electrical conductivity
Pathogens (QUALITY)	The system must be maintained in a state that is safe for contact recreation.	E. Coli and Faecal coliforms
Fish (BIOTA)	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)
Phytoplank-ton (BIOTA)	The system must be maintained in a mesotrophic state or better.	Chlorophyll a

Quantity & Biota RQOs for Lower Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator/ measure	Numerical limits	TPC
Low flows	Dam levels must remain sufficient to provide for supply to the Western Cape Water Supply System (City of Cape Town) via the Steenbras WTW, and low flows to the lower Steenbras River and estuary for the protection of ecosystem functioning downstream.	Flow releases: Berg EWR8 in G40A nMAR = 54.88 million m^3/a pMAR = 0.00 million m^3/a REC = B/C category	Berg EWR8 site in the lower Steenbras River – specified flows	Not applicable
High flows	High flow ecological releases should be made during the wet season to meet flood requirements, within the constraints of the existing outlet structure, and utilising spills where possible.			
Fish	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.	Implementation of the Index of Reservoir Habitat Impairment (IRHI) by Miranda and Hunt (2011)	Fish	The wellbeing of the fish community must be maintained in a suitable condition to contribute to regional biodiversity.

Quantity Numerical Limits for Lower Steenbras Dam

Desktop Version 2, Generated on 2009/07/09
Summary of Desktop (Version 2) estimate for Quaternary Catchment Area:
Total Runoff : R002.NATG4R00

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

MAR	=	54.876
S.Dev.	=	18.443
CV	=	0.336
Q75	=	0.930
Q75/MMF	=	0.203
BFI Index	=	0.397
CV(JJA+JFM) Index	=	1.527

Ecological Category = B/C

Total IFR	=	7.404	(13.49 %MAR)
Maint. Lowflow	=	6.073	(11.07 %MAR)
Drought Lowflow	=	4.095	(7.46 %MAR)
Maint. Highflow	=	1.331	(2.42 %MAR)

Monthly Distributions (Mill. cu. m.)
Distribution Type : W.Cape(wet)

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	4.030	3.196	0.793	0.673	0.440	0.000	0.673
Nov	2.136	1.330	0.623	0.509	0.345	0.000	0.509
Dec	1.488	1.203	0.809	0.370	0.253	0.000	0.370
Jan	1.018	1.032	1.013	0.284	0.196	0.000	0.284
Feb	0.773	0.448	0.579	0.235	0.164	0.000	0.235
Mar	0.864	0.813	0.941	0.227	0.150	0.000	0.227
Apr	1.972	2.103	1.066	0.273	0.189	0.000	0.273
May	4.352	4.180	0.960	0.390	0.266	0.121	0.511
Jun	8.480	7.360	0.868	0.605	0.408	0.121	0.726
Jul	11.189	6.818	0.609	0.798	0.535	0.484	1.281
Aug	11.715	6.676	0.570	0.918	0.615	0.484	1.402
Sep	6.861	4.713	0.687	0.792	0.532	0.121	0.913

Quantity Numerical Limits for Lower Steenbras Dam

Flood requirements

Month	Peak daily Q (m^3s^{-1})	Duration (Days)	Volume (MCM)	%MAR
October	0.000	0	0.000	0.000
November	0.000	0	0.000	0.000
December	0.000	0	0.000	0.000
January	0.000	0	0.000	0.000
February	0.000	0	0.000	0.000
March	0.000	0	0.000	0.000
April	0.000	0	0.000	0.000
May	1.000	2	0.121	0.220
June	1.000	2	0.121	0.220
July	4.000	2	0.484	0.880
August	4.000	2	0.484	0.880
September	1.000	2	0.121	0.220

Quality RQOs for Lower Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G4R001Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	PO4 0.012 / 0.032
		Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N	0.56 mg/ℓ N	TIN 0.086 / 0.181
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 8.77 / 11.1
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Thank you!

ADDITIONAL SLIDES

Prioritisation Criteria evaluated in RU Prioritisation Tool

- Location in river system
- Importance to users
- Level of support of livelihoods of vulnerable communities,
- Strategic or international obligations
- Provision of supporting or regulating services
- Contribution to the economy
- Ecological importance of RU i.t.o. flow releases
- Level of threat posed to water quality
- Practical considerations

Quality RQOs for Berg River Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1H077Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	PO4 0.005 / 0.045
		Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N	0.56 mg/ℓ N	TIN 0.162 / 0.25
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 5 / 7.5
System variables	Water is naturally acidic and it should be maintained within the historical range	pH	5.5 ≥ pH ≤ 7.5 (5^{th} & 95^{th} %tiles)	5 ≥ pH ≤ 8	No data
Phytoplanc ton	Maintain in a mesotrophic state or	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Quality RQOs for Voëlvlei Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1R001
Nutrients	Current eutrophic – should be improved to mesotrophic state	Ortho-phosphate (PO_4-P)	Median ≤ 0.025 mg/ℓ P	0.020 mg/ ℓ P	PO4 0.012 / 0.028
		Total inorganic nitrogen (TIN)	Median ≤ 1.00 mg/ℓ N	0.8 mg/ℓ N	TIN 0.043 / 0.155
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and in Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 11.5 / 13.7
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 20 µg/ℓ Chl a	Chl a ≤ 15 µg/ℓ	>20 µg/ℓ

Quality RQOs for Misverstand Weir

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G1R003Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.025 mg/ℓ P	0.020 mg/ ℓ P	PO4 0.022 / 0.055
		Total inorganic nitrogen (TIN)	Median ≤ 1.00 mg/ℓ N	0.80 mg/ℓ N	TIN 0.4 / 1.19
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 70 mS/m	56 mS/m	EC 34.9 / 52.7
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 20 µg/ℓ Chl a	15 µg/ℓ	>20 µg/ℓ

Quality RQOs for Upper Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) -
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	No data
		Total inorganic nitrogen (TIN)	Median ≤ 1.50 mg/ℓ N	1.3 mg/ℓ N	No data
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	No data
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Quality RQOs for Lower Steenbras Dam

Sub-comp.	RQO Narrative description	Indicator	Numerical Limits	Threshold of Potential Concern	Present state (50/95%tile) G4R001Q01
Nutrients	The system must be maintained in a mesotrophic state or better	Ortho-phosphate (PO_4-P)	Median ≤ 0.015 mg/ℓ P	0.012 mg/ ℓ P	PO4 0.012 / 0.032
		Total inorganic nitrogen (TIN)	Median ≤ 0.70 mg/ℓ N	0.56 mg/ℓ N	TIN 0.086 / 0.181
Salts	Salt levels must be maintained at concentrations where they do not impact negatively on the ecosystem and are in an Ideal category for domestic water supply	Electrical conductivity	95th percentile ≤ 30 mS/m	24 mS/m	EC 8.77 / 11.1
Pathogens	Maintain in Acceptable cat (contact recreation)	E coli / Faecal coliforms	Median ≤ 130 cfu/100ml	110 cfu/100ml	No data
Phytoplanc ton	The system must be maintained in a mesotrophic state or better	Chlorophyll a	Median ≤ 10 µg/ℓ Chl a	8 µg/ℓ	No data

Thank you, Any discussion?