Determining the Water Resource Classes and Resource Quality Objectives in the Thukela River Catchment

Project Steering Committee 3
Background Information Document
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PURPOSE OF THIS DOCUMENT

The purpose of this background information document (BID) is to assist members of the Project Steering Committee (PSC) in preparing for the third meeting to be held online on 26 November 2020.

This BID contains information regarding:

- Results of the quantification of the Ecological Water Requirements (EWRs); and
- A short description of the process undertaken to prioritize sub-components and indicators selection for the Resource Quality Objectives (RQOs) component.

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STUDY OBJECTIVE

Chapter 3 of the National Water Act, (Act 36 of 1998) provides for the protection of water resources through the implementation of Resource Directed Measures (RDM) which include the classification of water resources, setting the Reserve and determining Resource Quality Objectives (RQOs).

The key aims of this study are, therefore, to co-ordinate the implementation of the Water Resource Classification System (WRCS) published as Regulation 810 in September 2010 for the determination of water resource classes and associated RQOs in the Thukela catchment. The study is linked to the preliminary Reserve determination studies and other water resource management initiatives. Where the preliminary Reserve is available and relevant, the information has been adopted and where needed, within the ambit of this study, gaps have been filled.

The water resource classes and associated RQOs will assist the Department of Water and Sanitation (DWS) in ensuring that water resources within the Thukela catchment are protected to achieve equitable share in a sustainable manner. In determining classes and associated RQOs, socio-economic factors and ecological goals will be considered by evaluating the magnitude of impacts in the present as well as proposed future developments. The water resource classes and associated RQOs will also assist the Department in the authorisation of future water uses, operation and management of the system and the evaluation of the magnitude of the impacts of the present and proposed developments, as well as ensure the economic, social, and ecological goals are attained.

WHERE ARE WE IN THE PROCESS?

Figure 1 outlines the process being followed illustrating the integrated framework of the Gazetted steps for Classification, Reserve and RQO Determination (DWS, 2017). The current study has completed Step 3 and is moving onto Step 4. This BID outline the processes involved in quantifying the Ecological Water Requirements (EWR) – Step 3.

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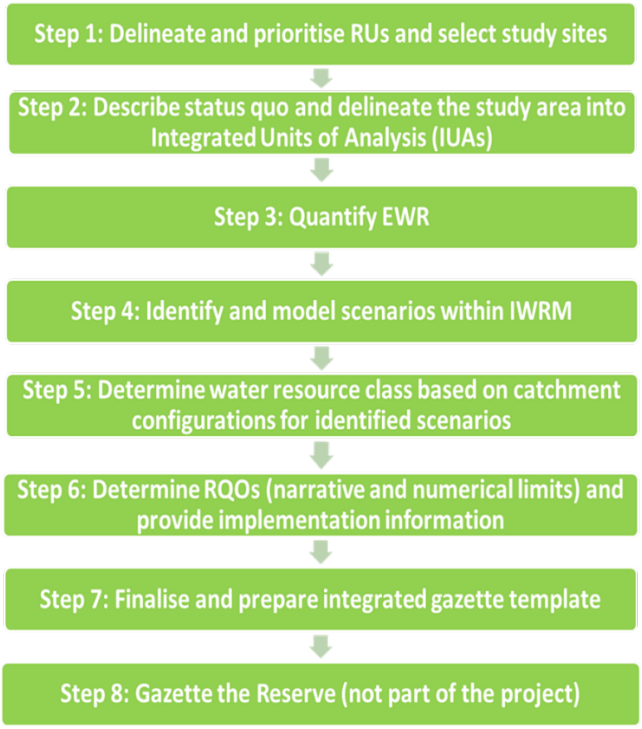


Figure 1: Integrated RDM Process

QUANTIFICATION OF THE EWRs

The process of quantifying ecological water requirements entailed assessment of preliminary Reserves undertaken in the Thukela catchment, evaluation of the existing data and undertaking field visits at prioritised sites in an attempt to fill the gaps identified.

Figure 2: Cross section measurements and fish shocking in the Buffalo River

The assessments undertaken at new and existing sites included determination of cross sections, flow measurements, fish and macroinvertebrate assessments, water sampling for chemical and diatoms analyses, as applicable in terms of the gap in information that existed.

The approach undertaken for the quantification of the Ecological Water Requirements (EWRs) included the application of different levels of ecological Reserve assessments at the existing and new sites identified and extrapolation:

(i) New rapid 1, 2 and 3 assessments (surveys in September 2020) including:
- Information collected during the field surveys;
- Results from the Eco-classification process, Present Ecological State (PES), Ecological Importance (EI), Ecological Sensitivity (ES) and Recommended Ecological Category (REC);
- Desktop Reserve Model (DRM) within SPATSIM (an integrated hydrology and water resource information management and modelling system) for the integration of data produced from the surveys and Eco-classification to quantify the EWRs;
- Results from the hydraulic modelling (cross-sectional profile and discharge) to evaluate the DRM requirements; and
- Evaluation of the water quality at specific selected sites where quality was identified as an issue.

(ii) Revisit of existing EWR sites from previous studies (mainly 2003 comprehensive sites). The biological surveys at these sites were undertaken to assess the PES due to increased or proposed new water uses in the upper catchments, e.g. Mooi River with the Spring Grove Dam that was constructed after the 2003 study.

(iii) River reaches where no existing EWR sites are present (e.g. Upper Thukela after Thukela and Little Thukela confluence, Blood River IUA). These assessments have been undertaken at a desktop level, using the desktop PES/EI/ES results, as no additional information was available.

(iv) IUA14 has been defined as the Escarpment IUA with most of the river reaches in protected areas. The EWR for these have been assessed on a

desktop level, using the desktop PES/EI/ES results as no additional information was available.

(v) Extrapolation to the biophysical nodes at the outlets of IUAs where EWR sites are not present at the outlet. The information from the lowest EWR site most similar to the relevant reach in the IUA has been used for the extrapolation.

(vi) The results from all the other existing EWR sites where no additional information was required have been adopted as is and the adjustments were made where the hydrology used in this study differed significantly.

Figure 3: Macroinvertebrate sampling with community interest in the Bushman's River

EWR SITES

The Thukela preliminary Reserve study that was undertaken in 2003, included 17 EWR sites, nine in the upper Thukela Catchment and tributaries and eight sites in the Lower Thukela Catchment.

A number of rapid Reserve determinations were undertaken between 2002 and 2005. However, no reports were available for these studies.

Rapid assessments were undertaken for the Ngagane (upper and lower), Horn and Ncone Rivers in 2013 and for the Mooi River just upstream of the existing comprehensive site Thukela_10 in V20E during 2019.

An intermediate assessment was undertaken during 2017 for the lower Thukela River at Thukela_16 and two additional sites just downstream of the new abstraction weir in quaternary catchment V50D. A map of the catchment including the sites is included with this BID.

The results from the preliminary Reserves, together with the additional surveys undertaken in September 2020, have been used to quantify the EWRs per priority river and at the outlet of each Integrated Unit of Analysis (IUA).

The overall results are included as Table 5 at the end of this BID.

FIELD VISIT

In September 2020, surveys were undertaken at some of the selected EWR sites, where gaps had been identified.

The following aspects were assessed at the new sites surveyed:

Hydraulics

- A survey of the cross-sectional profile of the EWR site was carried out - shown in Figure 4;
- Longitudinal water slope was surveyed;
- Discharge was measured – set out in Table 1;
- GPS co-ordinates of the site were captured; and
- EWR site photographs were taken.

Table 1: EWR sites with hydraulics data from the site visit

EWR site	River	Discharge Q (m^3/s)	Maximum flow depth (m)
THU_EWR23	Upper Buffalo	1.240	0.580
THU_EWR19	Ncandu	0.083	0.175
THU_EWR20	Nsonge	0.082	0.120
THU_EWR22	Klip	0.089	0.245
THU_EWR12A	Lower Mooi	0.189	0.190
THU_EWR6A	Bushman's	0.189	0.385
THU_EWR21	Mnyamvubu	0.972	0.89
THU_EWR13A	Middle Buffalo	0.026	0.105
THU_EWR7A	Sundays	1.240	0.580

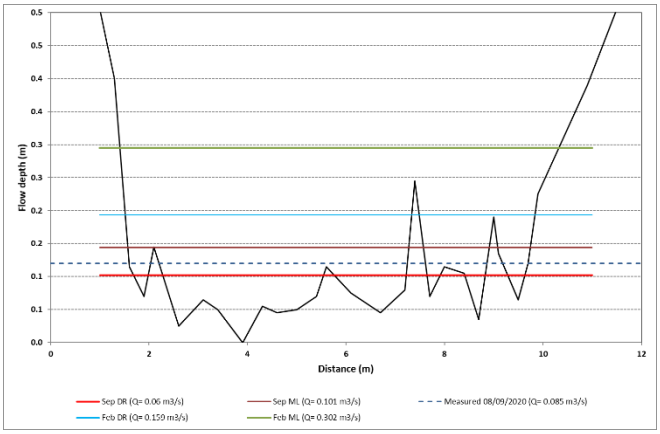


Figure 4: Example - water levels on cross-section for the Nsonge River (THU_EWR20)

Fish, macroinvertebrates, instream and riparian habitats

Fish are widely used as ecological indicators in the assessment of the integrity of riverine ecosystems.

Some of the benefits of using fish as ecological indicators include that fish are well known and easily related to by people; the requirements and responses of fishes to changes in the state of environmental variables is well documented, and used in a range of measures or indices that can be applied to manage the ecosystems in which they live and are relatively easy to sample and identify in the field.

Figure 5: Fish shocking in the Sundays River

Macroinvertebrate diversity and abundances were measured by a DWS SASS5 accredited practitioner at the EWR sites using the South African Scoring System Version 5 (SASS5).

Table 2 summarises the ecological status for fish, macroinvertebrates, instream, and riparian habitats.

Figure 6: Example of macroinvertebrates and fish collected

Table 2: Ecological status of fish, macroinvertebrates, instream, and riparian habitat determined

EWR site	River	Fish	Macro-invertebrate	Instream	Riparian
THU_EWR23	Upper Buffalo	C	C	D	B
THU_EWR19	Ncandu	C/D	B/C	B	B
THU_EWR20	Nsonge	C	C/D	C	B
THU_EWR22	Klip	C	C	C	C/D
THU_EWR12A	Lower Mooi	C/D	C	D	C/D
THU_EWR6A	Bushman's	D	C/D	D	D
THU_EWR21	Mnyamvubu	C/D	C	D	B
THU_EWR13A	Middle Buffalo	C/D	D	D	E
THU_EWR7A	Sundays	C	C	C	D

Water quality

Water samples were taken at all the sites and analysed for a set of chemical parameters and diatoms (Table 3).

Water quality was only assessed at a baseline level in order to provide an interpretation of biological responses at an EWR site to determine whether water quality as a driver is a problem.

Table 3: Overall water quality condition and diatom results

Sample site	Water quality condition and driver (Water chemistry)		Diatoms (Specific Pollution Index)	
Buffalo River EWR13a	E	Nutrients	D	Poor
Mooi EWR12a	B	Nutrients	C/D	Moderate
Mnyamvubu EWR21	B	Nutrients	B	Good
Nsonge EWR20	B	Nutrients	B	Good
Bushmans EWR6a	C	Nutrients	C	Moderate
Klip Upstream EWR22	C	Nutrients	C/D	Moderate
Tugela EWR4C	C	Toxics	C/D	Moderate
Sundays EWR7a	C/D	Toxics	C	Moderate
Buffalo River EWR23	D	Nutrients, Toxics	C	Moderate
Ncandu EWR19	B	Nutrients	Not sampled	

OUTCOME OF EWR QUANTIFICATION

Based on the preliminary Thukela Reserve studies, the update with new information and additional assessment undertaken as part of this study, the EWRs rivers in the Thukela catchment have been quantified.

Proposed Target Ecological Categories (TEC) at each site have been defined for the scenario analysis and determination of ecological consequences, taking into account the system requirements (dam release capacities, user requirements and yields of dams) at each of the EWR sites (Table 5).

It should be noted that the TECs are the proposed base case categories and will be finalised once the ecological consequences of the various scenarios have been evaluated in the scenario evaluation step.

SUBCOMPONENTS PRIORITISATION AND INDICATORS SELECTION

As described previously, RQOs have to be determined for a significant water resource as the means to ensure a desired level of protection.

RQOs are important management objectives against which resource monitoring will be assessed and compliance monitoring will provide an indication of whether the water resource class is being maintained.

RQOs will form important sustainability indicators for water quantity; water quality; habitat integrity; and biotic characteristics for water resource management.

In determining the RQOs, it is important to recognise that different water resources will require different levels of protection.

Now that the Integrated Units of Analysis (IUA) and Resource Units (RUs) have been defined, the selection of components and the identification of proposed sub-components and indicators must be undertaken.

This next process has two key objectives:

- To identify and prioritise sub-components including habitat, quantity, quality, and biota that may be important to users or the environment; and
- To select those sub-components and associated indicators such as flow, salinity, fish, and invertebrates, for which RQOs and numerical limits should be developed.

As part of this study, RQOs for rivers, groundwater, dams, estuary, and wetland resources will be determined. While there are a wide range of sub-components and indicators for which RQOs can be set, it is not practical or necessary to set RQOs for all sub-components in a resource unit.

A rationalisation process is therefore required to evaluate and prioritise the sub-components for RQO determination.

A map of those Resource Units prioritised for RQO determination is included with this BID.

This next step of the RQO procedure allows for a process of rationalisation in order to determine which RQOs should be formulated for water resources within the prioritised resource units.

In other words, sub-components that may be important to either the users or the environment are prioritised.

This step also requires consideration of the impacts of land-based activities on the water resource.

Sub-components include:

- Quantity: Low Flows, High Flows.
- Quality: Nutrients, Salts, Systems variables, Toxics and Pathogens.
- Habitat: Instream and Riparian habitat.
- Biota: Fish, Aquatic and Riparian plant species, Mammals, Birds, Amphibians and Reptiles, Periphyton, Aquatic invertebrates and Diatoms.

The five water resource components that will be addressed for the Thukela catchment include rivers, dams, groundwater, wetlands, and the estuary.

The sub-components and indicators for RQO determination will be selected as the next step of the RQO process.

NEXT STEPS

The EWRs quantified will now be taken forward as the Base Case Ecological Configuration to assess various scenarios including:

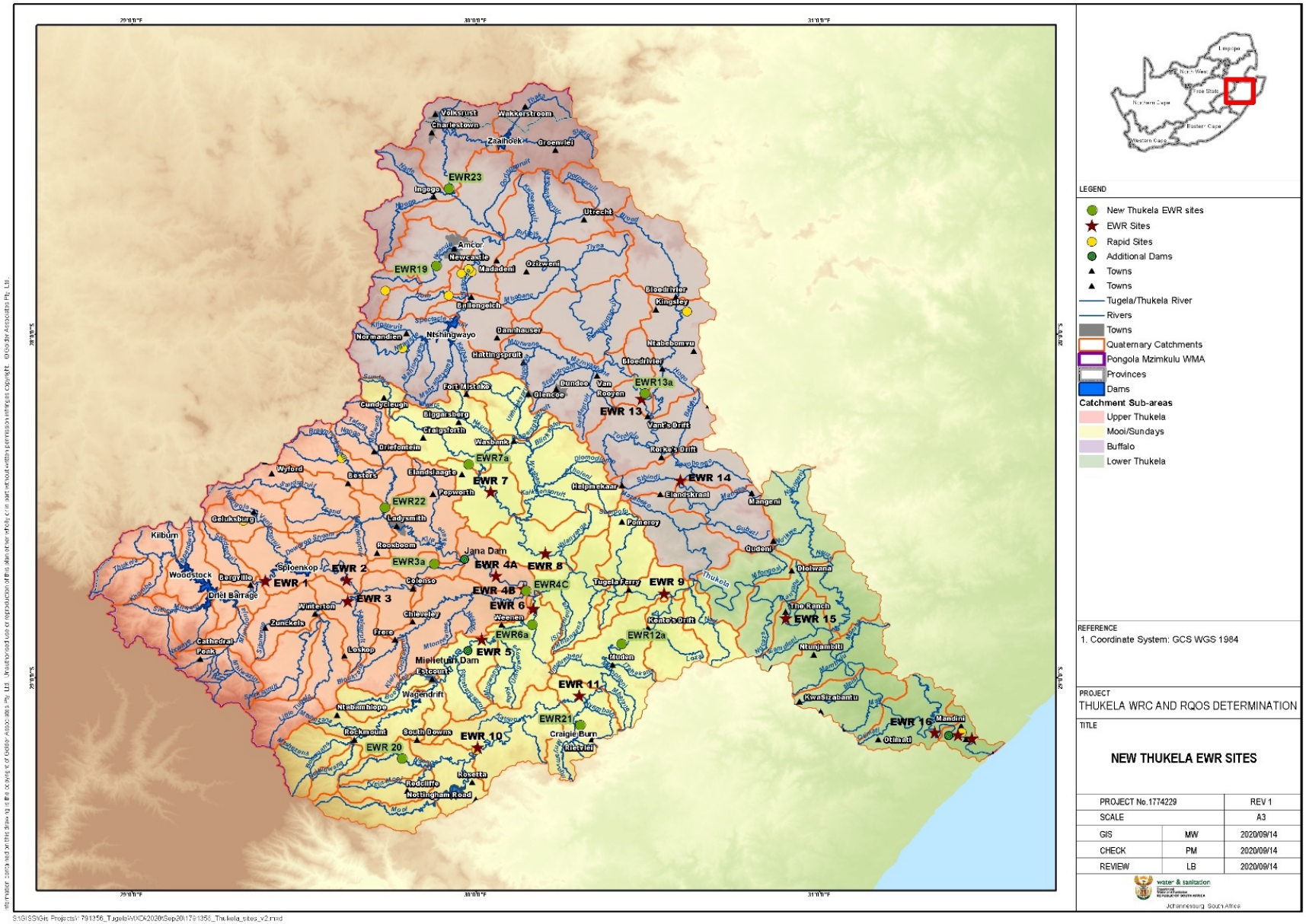
Table 4: Proposed scenarios to be assessed

Present: Scenario 1	
Scenario 1a (Sc 1a)	Mooi 2017; Upper Bushman's 2015; WR 2012 for the rest – development levels (water use); no EWR.
Scenario 1b (Sc 1b)	Present with full EWR.
Future: Scenarios 2, 3 and 4	
Scenario 2 (Sc 2a)	Pre 2030: future water use (Development levels) with no new water resource development (eg Jana and Mielietuin); no EWR.
Scenario 2 (Sc 2b)	As above with full EWR.
Scenario (Sc 3a)	2030: as above and including Polihali (less stress to increase) and Smithfield (from Umkomaas); no EWR.
Scenario (Sc 3b)	2030: as above and including Polihali (less stress to increase) and Smithfield (from Umkomaas); full EWR.
Scenario 4 (Sc 4a)	2050: As above but with Mielietuin and Jana included (domestic / irrigation?); no EWR
Scenario 4 (Sc 4b)	2050: As above but with Mielietuin and Jana included (domestic / irrigation?); baseflows only.

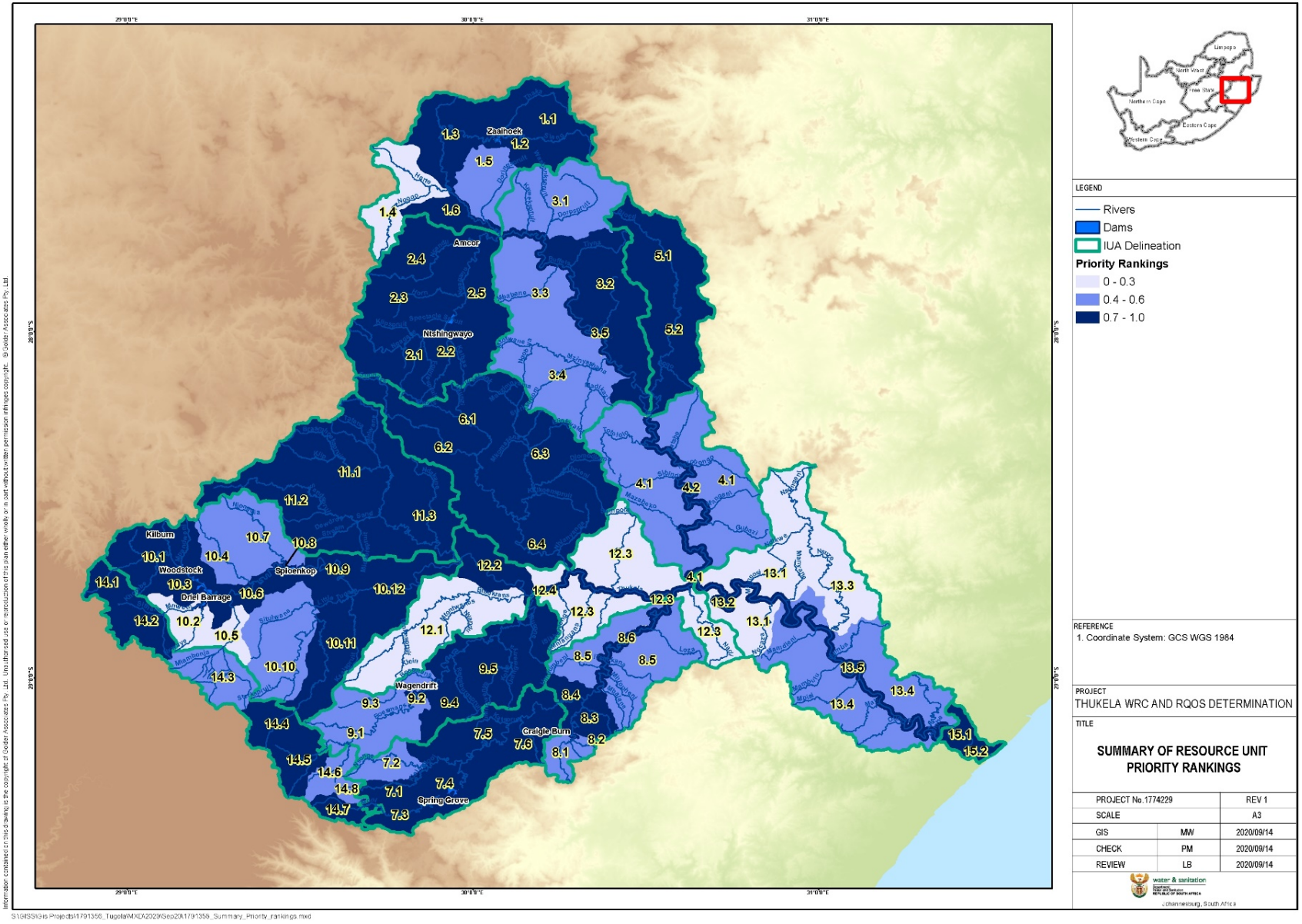
Table 5: EWR sites with PES and TEC categories

IUA	EWR site name	River	Natural MAR (10^6m^3)	EI/ES	PES	TEC
1: Upper Buffalo	THU_EWR23	Upper Buffalo	221.96	High	C	**C**
2: Ngagane River	May13_EWR2	Horn	21.61	Low	C	**C**
	THU_EWR19	Ncandu	50.83	Very high	C	**B/C**
	May13_EWR3	Ngagane	160.12	Low	C	**C**
	Ngagane_dsk	Lower Ngagane	240.84	Moderate/ High	C	**C**
3: Middle Buffalo	THU_EWR13A	Middle Buffalo	626.68	Moderate/ High	D	**C/D**
	Thukela_EWR13	Middle Buffalo	695.05	Moderate	D	**C/D**
4: Lower Buffalo	Thukela_EWR14	Lower Buffalo	831.09	High	B/C	**B/C**
5: Blood River	Blood_dsk	Blood	94.71	High	C	**B/C**
6: Sundays	THU_EWR7A	Upper Sundays	50.69	High	C/D	**C**
	Thukela_EWR7	Upper Sundays	90.28	Moderate	B/C	**C**
	Thukela_EWR8	Lower Sundays	197.03	Moderate	D	**D**
7: Upper Mooi	THU_EWR20	Nsonge/ Hlatikulu	27.13	Very high / High	C	**B/C**
	EWR_Mooi_N3	Mooi	265.81	Moderate	E*	**D**
	Thukela_EWR11	Mooi	301.14	Moderate	B/C	**B/C**
8: Lower Mooi	THU_EWR21	Mnyamvubu	31.71	High	C	**B/C**
	THU_EWR12A	Mooi	361.85	High	C/D	**C**
	Mooi_dsk	Mooi	388.66	High	C	**C**
9: Middle/ Lower Bushmans	Thukela_EWR5	Middle Bushman's	281.45	Moderate	B/C	**C/D**
	THU_EWR6A	Lower Bushman's	298.37	High	D	**C/D**
	Thukela_EWR6	Lower Bushman's	303.14	High	B/C	**C/D**
10: Upper Thukela	Thukela_EWR1	Upper Thukela	705.42	Moderate	D	**D**
	Thukela_EWR2	Upper Thukela	798.40	Moderate	C	**C**
	Thukela_EWR3	Little Thukela	285.20	Moderate	C/D	**C/D**
	Thukela1_dsk	Thukela	1145.20	High	B	**C**
11: Klip	THU_EWR22*	Klip	52.44	High / Very high	C	**C**
	Klip_dsk	Klip	253.09	High	C	**C**
12: Middle Thukela	Thukela_EWR4A, B, C	Middle Thukela	1423.83	High	C	**B/C**
	Thukela_EWR9	Middle Thukela	2050.76	Moderate	D	**D**
	Thukela2_dsk	Middle Thukela	2461.22	High	C	**C**
13: Lower Thukela	Thukela_EWR15	Lower Thukela	3424.00	High	C	**C**
	THU_EWR16	Lower Thukela	3679.97	High / Moderate	C	**C**
14: Escarpment	V11A_dsk	Thukela	66.90	High / Very high	B	**B**
	V11B_dsk	Sithene, Thonyelana	142.69	Moderate/ High	B	**B**
	V11G_dsk	Mlambonja, Mhlwazini	191.99	Moderate / High	B	**B**
	V13A_dsk	Little Thukela	82.32	High/ Very high	C	**B**
	V70A_dsk	Bushman's	113.46	High	B	**B**
	V70B_dsk	Nsibidwana	44.16	High	B	**B**
	V20A_dsk	Mooi	42.90	High	C	**B**
	V20B_dsk	Little Mooi	10.32	High	C	**B/C**
15: Estuary	THU_EWR17	Lower Thukela	3690.53	High	C	**C**

*MAR: Mean annual runoff



Map of the Thukela catchment and EWR sites



Map showing the summary of the Prioritisation ratings of RUs (Dark blue being of higher priority in terms of setting RQOs)