water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP
NATIONAL DEVELOPMENT PLAN
Our Future - make it work

CLASSIFICATION OF SIGNIFICANT WATER RESOURCES AND DETERMINATION OF RESOURCE QUALITY OBJECTIVES FOR WATER RESOURCES IN THE USUTU TO MHLATHUZE CATCHMENTS (WP11387)

RQO Workshop, Durban, 22 August 2023

GROUNDWATER RESOURCE QUALITY OBJECTIVES



Groundwater Resource Quality Objectives

Karim Sami

GW CONTRIBUTION TO THE RESERVE AND (RQOs)

GW component of the Reserve for each GRU is calculated by:

Reserve = (EWRgw + BHNgw), where:

- **BHNgw = basic human needs derived from groundwater**
- **EWRgw = groundwater contribution to EWR**

Groundwater contributions for the EWR include:

- **Baseflow to rivers and springs, including high lying springs fed by interflow.**
- **Seepage to wetlands and groundwater dependent ecosystems.**

The allocable groundwater is the difference between recharge and the groundwater component of the Reserve; and should not exceed 65% to ensure sustainability.

HOW DOES WATER USE AFFECT GW

- **Abstraction: Reduction of groundwater baseflow by interception of GW or by drawdown and gradient reversal near rivers.**

- **Alien Invasive Plants (AIPs): increased evaporation of shallow groundwater or reduce interflow from high lying areas.**

AIMS OF GW RQOS

1) Maintain the required groundwater contribution to the EWR
2) Protect groundwater resources for the direct and indirect users

- RQOs may stipulate:
  - the volume of abstraction that would cause an undesirable reduction in baseflow or undue stress on aquifer
  - specific distances from a river
  - flow at gauging stations and maximum baseflow reduction
  - GW levels with caution
  - water quality conditions (linked to potable use)
  - Why not Water levels? Because near rivers or in leaky aquifers abstraction may have large impact but water level remains stable

CRITERIA FOR SETTING RQOS

- **Abstraction: Harvest Potential, Allocable Groundwater, Stress Index, impact on baseflow**
- **Baseflow: Distance of abstraction from river, low flows at gauging stations (i.e <30% reduction from natural, duration curves)**
- **Water level: trends. Problematic: water levels vary by borehole location in terms of topography, pumping rates and aquifer hydraulic parameters. Hence, water level below surface is a site-specific variable which cannot be stipulated for an entire catchment**
- **Within 50 m of a river to ensure water levels do not drop more than 0.5 m", requires having a dense network of *regularly monitored* boreholes within 50 m of a river**
- **Water quality: monitoring where poor quality is an issue**

DATA REQUIREMENTS

Stress Index

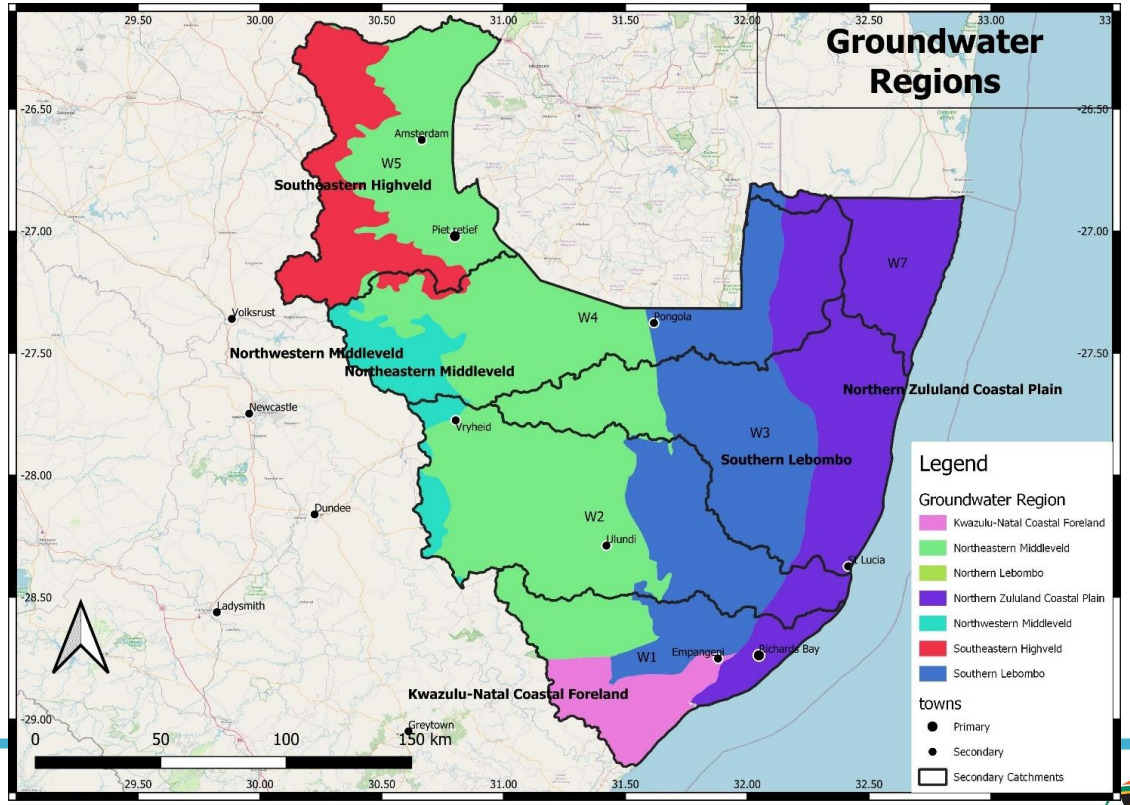
- **Lawful water use incl. Schedule 1 (StatsSA household survey), WARMS, V&V, All Towns etc**
- **Aquifer recharge (Not total Recharge)**

Baseflow

- **Monthly Baseflow**
- **Groundwater baseflow**
- **Groundwater use**
- **Baseflow reduction**

SETTING GRUS –GW REGIONS

Groundwater Region	Description
Northern Zululand Coastal Plain	Primary aquifers of the Maputoland
Southern Lebombo	Karoo SuperGroup, and Natal Group sandstone.
Northwestern Middleveld	Ecca Group to Drakensberg basalt.
Kwazulu-Natal Coastal Foreland	A structural province of NMP, Natal Group sandstone overlain by Dwyka tillite.
Southeastern Highveld	Karoo and Ecca shales, sandstones, mudstones, dolerite.
Northeastern Middleveld	Swazian volcanics and sedimentary, metamorphics, Swazian granites and gneisses, Randian gabbro, granite, quartzite, shale, Natal Group sandstone Dwyka tillite and Ecca shale.



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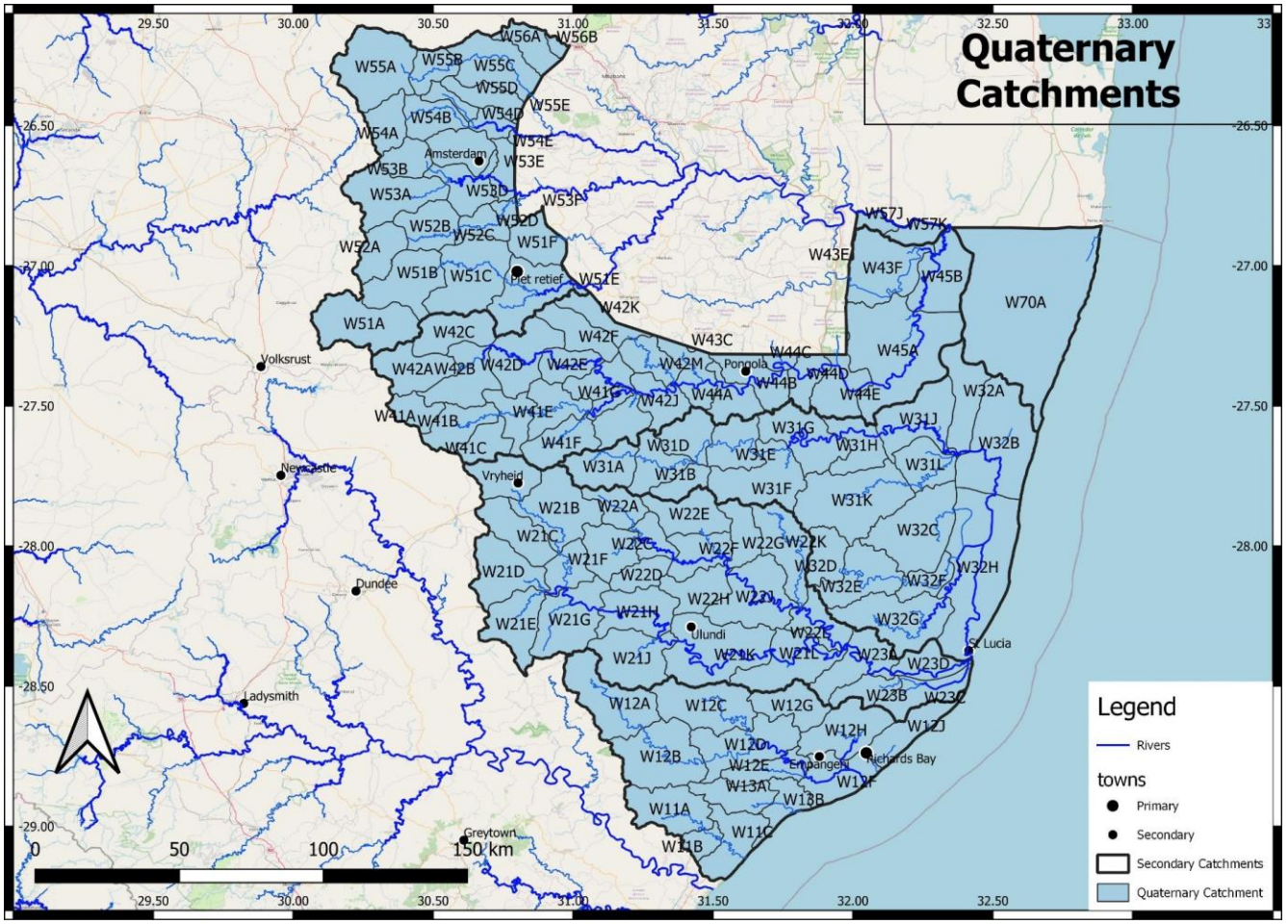
SETTING GRUS

- First step is quaternary catchments.

Grouping by :

- Geology.
- Climate.
- Topography and geomorphology.
- Borehole yield.
- Recharge.
- Groundwater quality.
- Groundwater use (and stress).
- Groundwater-surface water interactions.

SETTING GRUS –QUATERNARIES

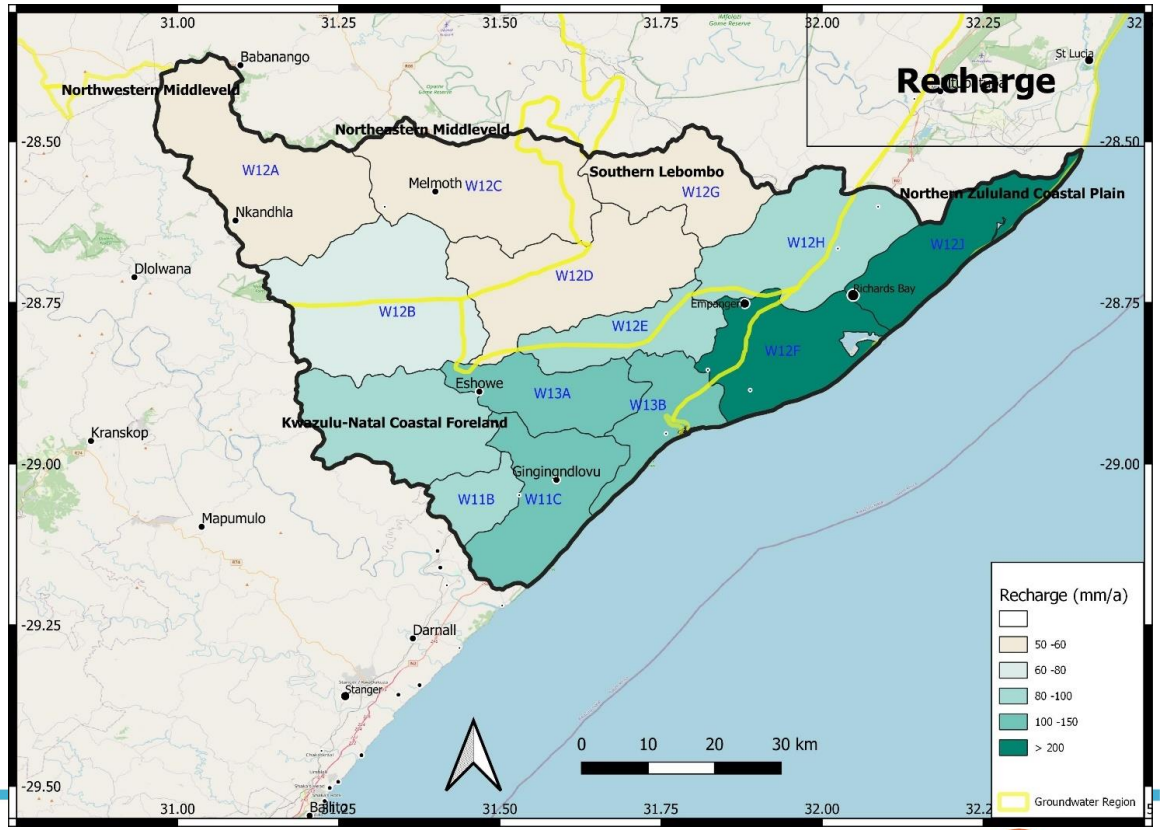


SETTING GRUS – RECHARGE

In catchments with high rainfall, significant relief and geological heterogeneities, a large part of recharge never enters the regional aquifer. Not all recharge is a groundwater resource

Recharge which does not flow through the regional aquifer is not available to boreholes

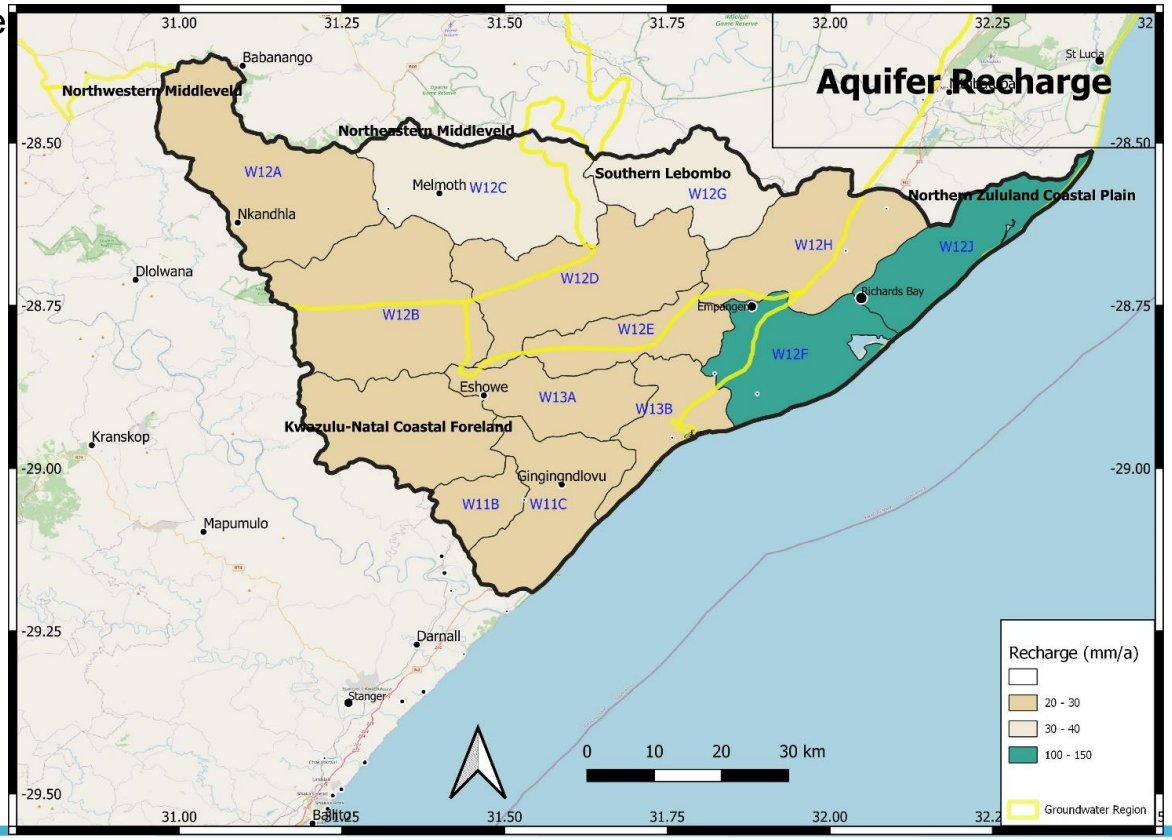
Some catchments with high recharge may have limited groundwater resources



SETTING GRUS – AQUIFER RECHARGE

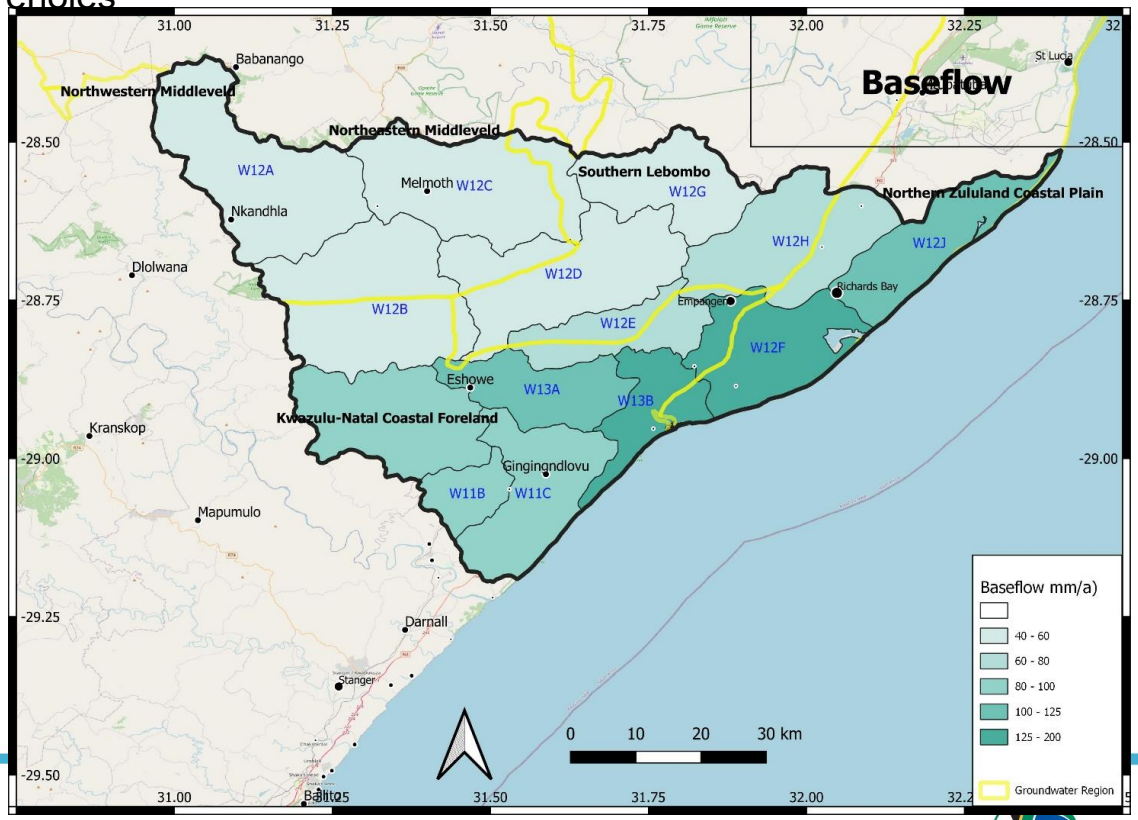
Aquifer recharge: recharge entering the regional aquifer (aquifer recharge) after losses to interflow. Some catchments with high recharge may have limited groundwater resources

Recharge entering the subsurface zone



SETTING GRUS – BASEFLOW

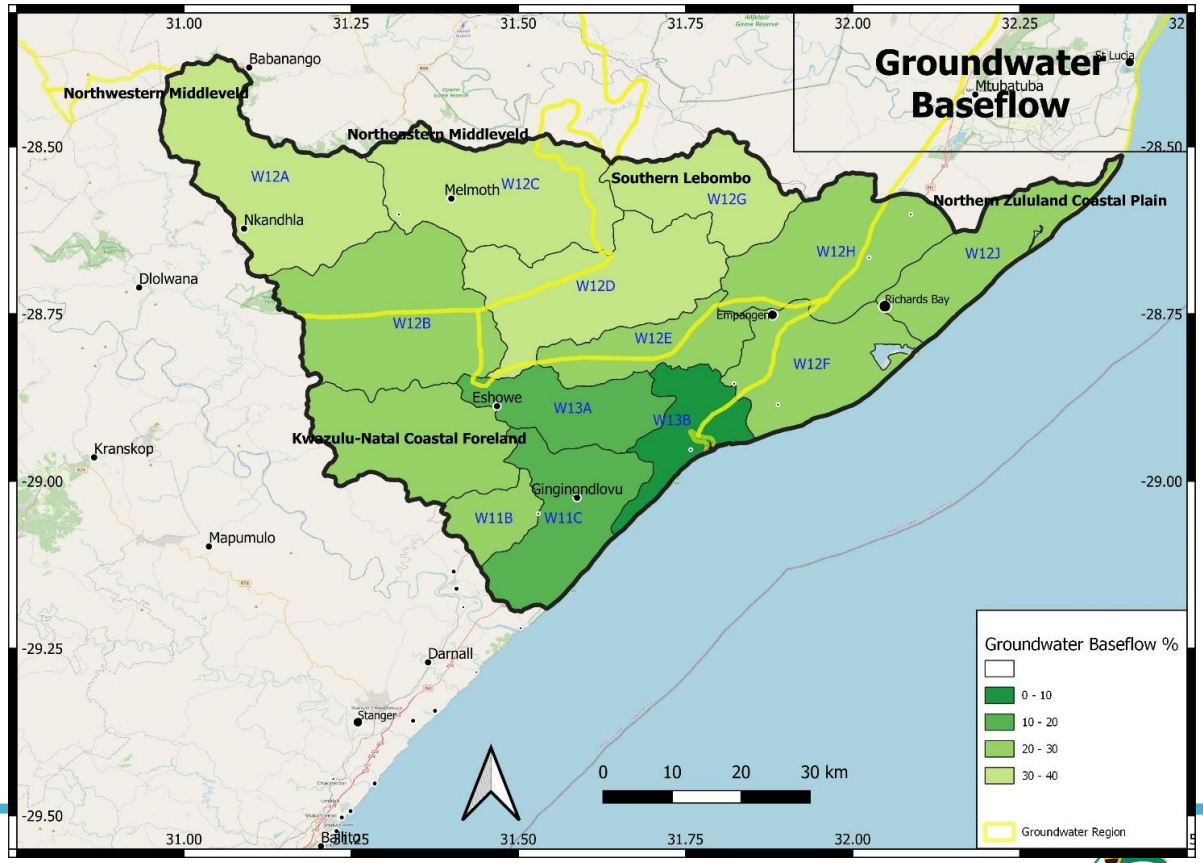
Baseflow: Streamflow originating from subsurface pathways. No differentiation.
not all these pathways incur passage through the regional aquifer.
Subsurface water which does not flow through the regional aquifer (interflow) is not available to boreholes and cannot be impacted by boreholes



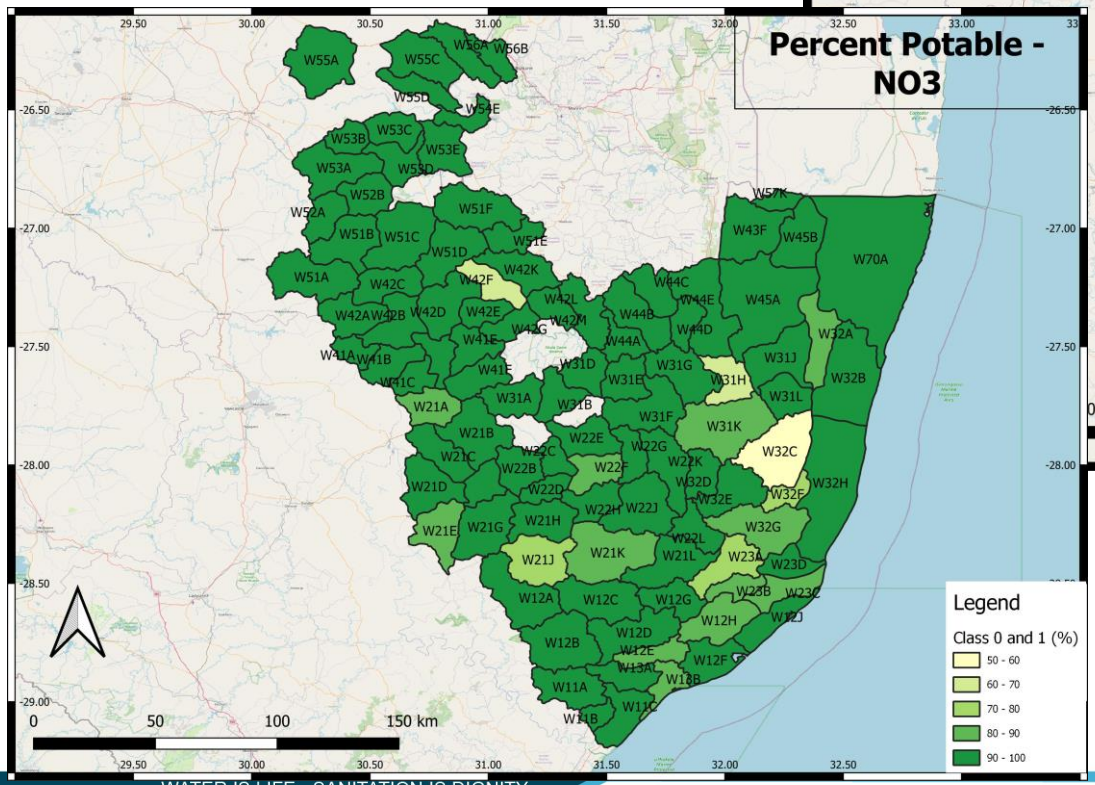
SETTING GRUS – INTERACTION TYPE

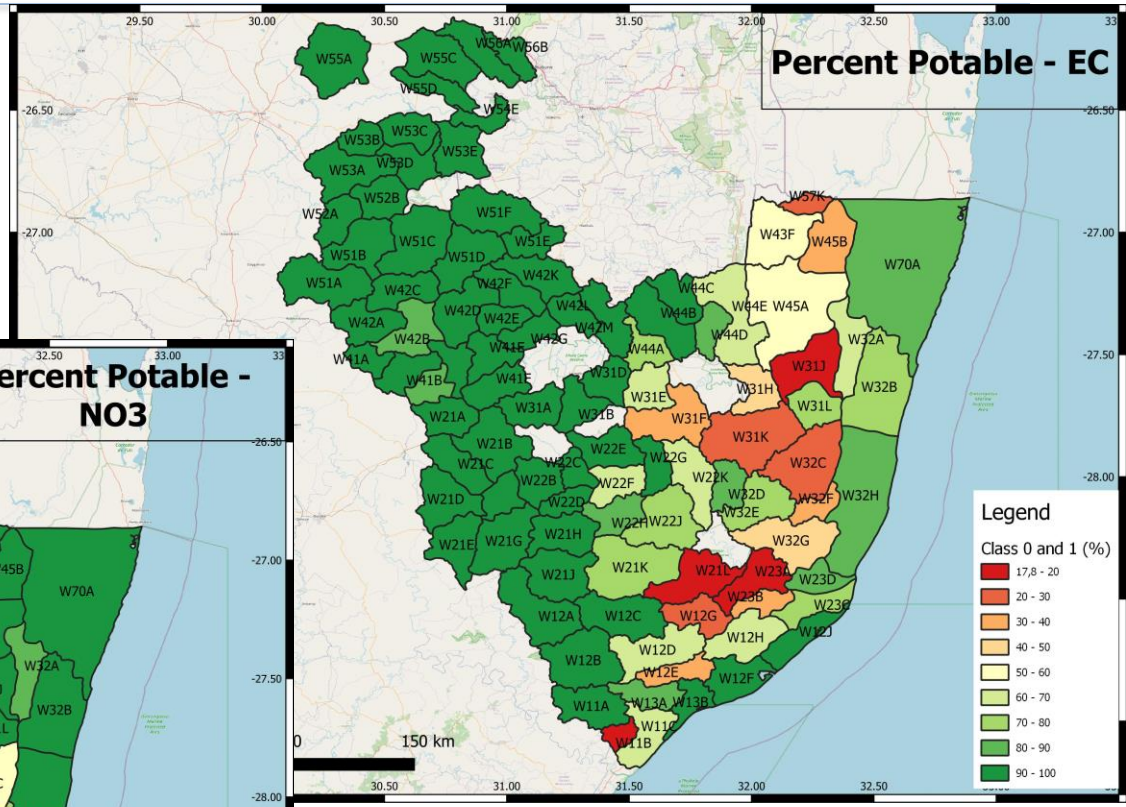
Groundwater baseflow

- Discharge from the regional aquifer to surface water as baseflow to river channels, either to perennial effluent or intermittent streams.
- seepage to permanent or temporary wetlands,
- Seepage to reservoirs and lakes

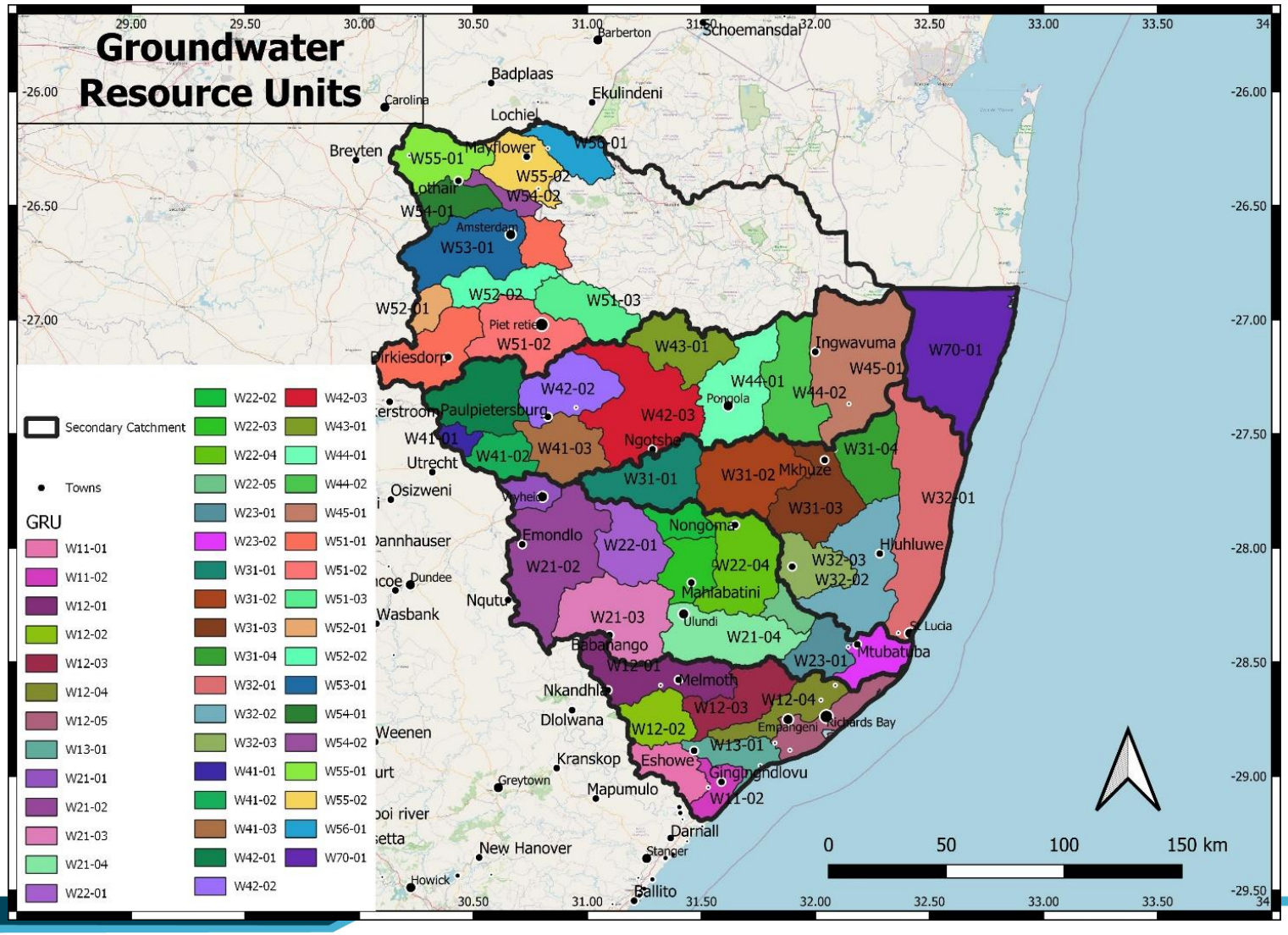


SETTING GRUS- WATER QUALITY

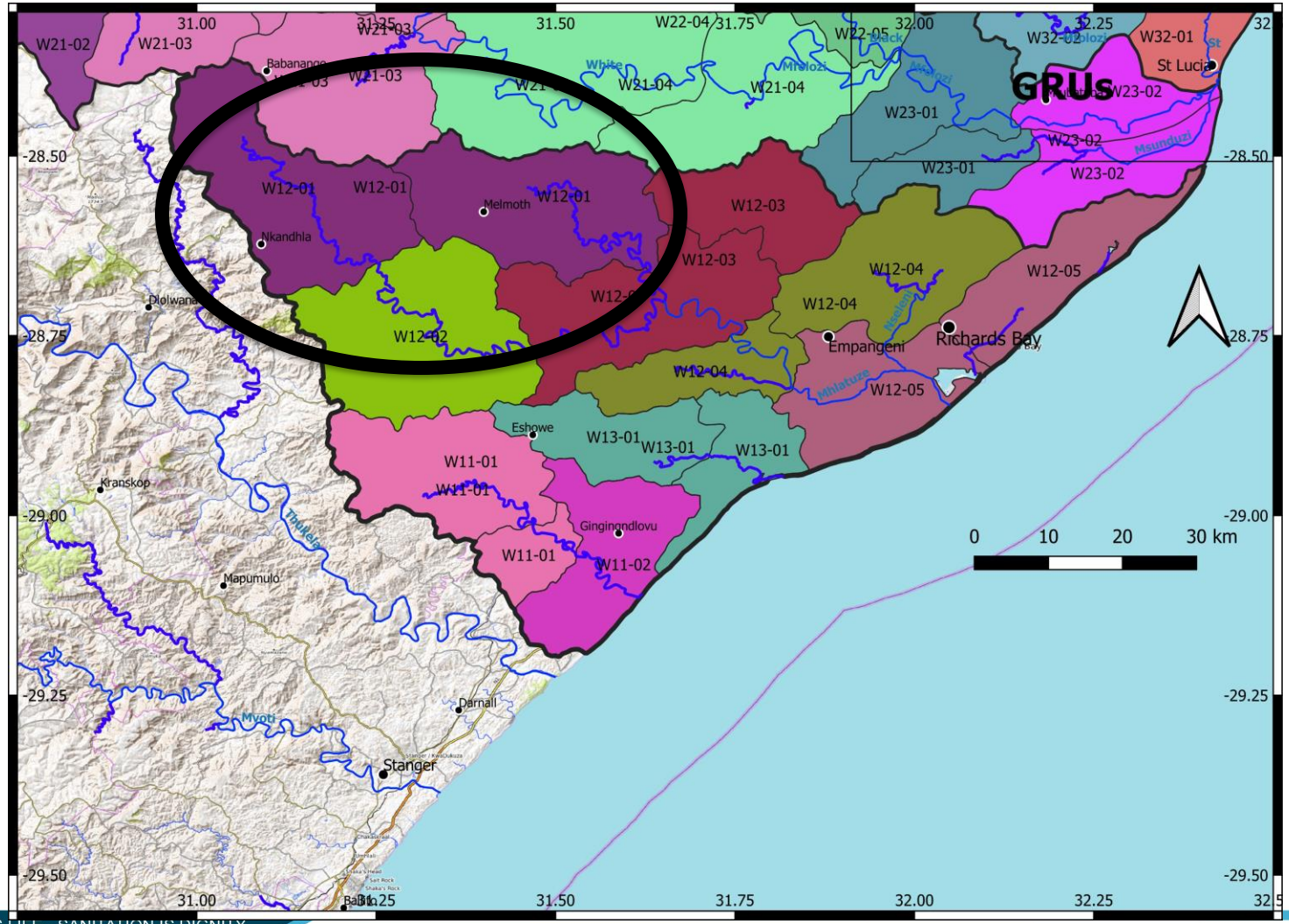




SETTING GRUS – DELINEATION



SETTING GRUS – DELINEATION



STRESS INDEX - USE

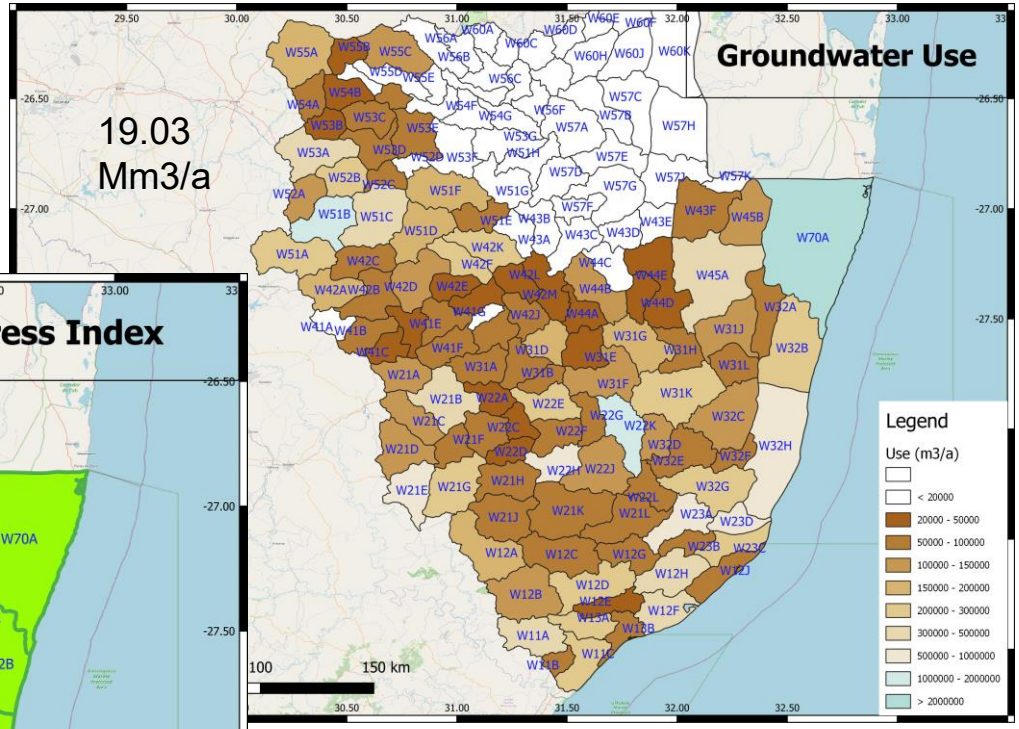
Quat	Irrigation (Mm3)	Industrial (Mm3)	Mining (Mm3)	Water Supply (Mm3)	Livestock (Mm3)	Schedule 1 (Mm3)	Total
W11A	0.1826	0.0000		0.0003	0.0000	0.0863	0.2692
W11B					0.0013	0.0594	0.0607
W11C	0.0900	0.0018		0.0000	0.0078	0.1319	0.2315
W12A	0.0000	0.0000		0.0900	0.0084	0.0592	0.1576
W12B	0.0400	0.0000		0.0000	0.0000	0.0816	0.1216
W12C	0.0326	0.0000		0.0000	0.0001	0.0696	0.1022
W12D	0.0000	0.0000		0.0000	0.0066	0.0858	0.0924
W12E					0.0004	0.0423	0.0427
W12F	0.3600	0.0000		0.0000	0.0028	0.0557	0.4185
W12G	0.0040	0.0000		0.0000	0.0021	0.0578	0.0639
W12H	0.2300	0.0003		1.7832	0.0029	0.1087	2.1251
W12J					0.0000	0.0931	0.0931
W13A	0.1675	0.0000		0.0000	0.0000	0.0485	0.2160
W13B	0.0000	0.0015		0.0000	0.0058	0.0384	0.0456
Total	1.1067	0.0035	0.0000	1.8734	0.0382		4.0402

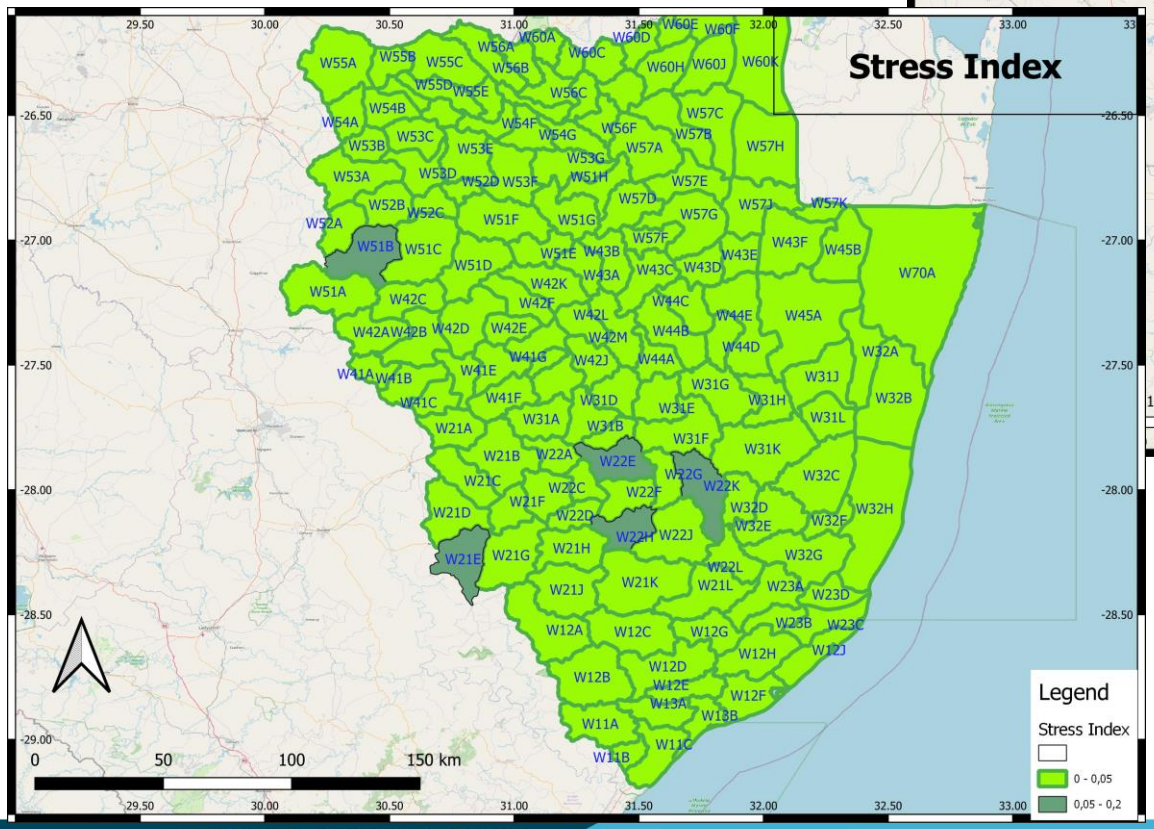
STRESS INDEX - RESOURCE

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W11A	445.15	39.56	12.80	3.12	12.23	34.40	0.2692
W11B	126.82	11.00	3.73	1.28	4.51	5.30	0.0607
W11C	383.02	40.52	10.68	3.82	17.24	8.60	0.2315
W12A	623.31	27.23	18.91	4.64	7.48	21.29	0.1576
W12B	656.33	35.93	18.81	4.96	10.84	34.38/	0.1216
W12C	570.07	23.38	17.82	4.22	5.94	10.52	0.1022
W12D	568.94	25.02	13.32	3.77	8.01	27.30	0.0924
W12E	248.59	20.45	6.71	1.95	6.46	7.02	0.0427
W12F	387.31	53.37	45.38	20.70	18.68	84.99	0.4185
W12G	326.36	14.24	10.01	3.19	4.71	4.33	0.0639
W12H	484.57	44.68	13.02	15.46	14.98	37.23	2.1251
W12J	332.85	46.59	42.57	25.19	22.70	117.31	0.0931
W13A	275.84	28.35	6.47	2.04	9.76	12.16	0.2160
W13B	222.76	31.00	4.75	3.30	10.26	10.42	0.0456

USE

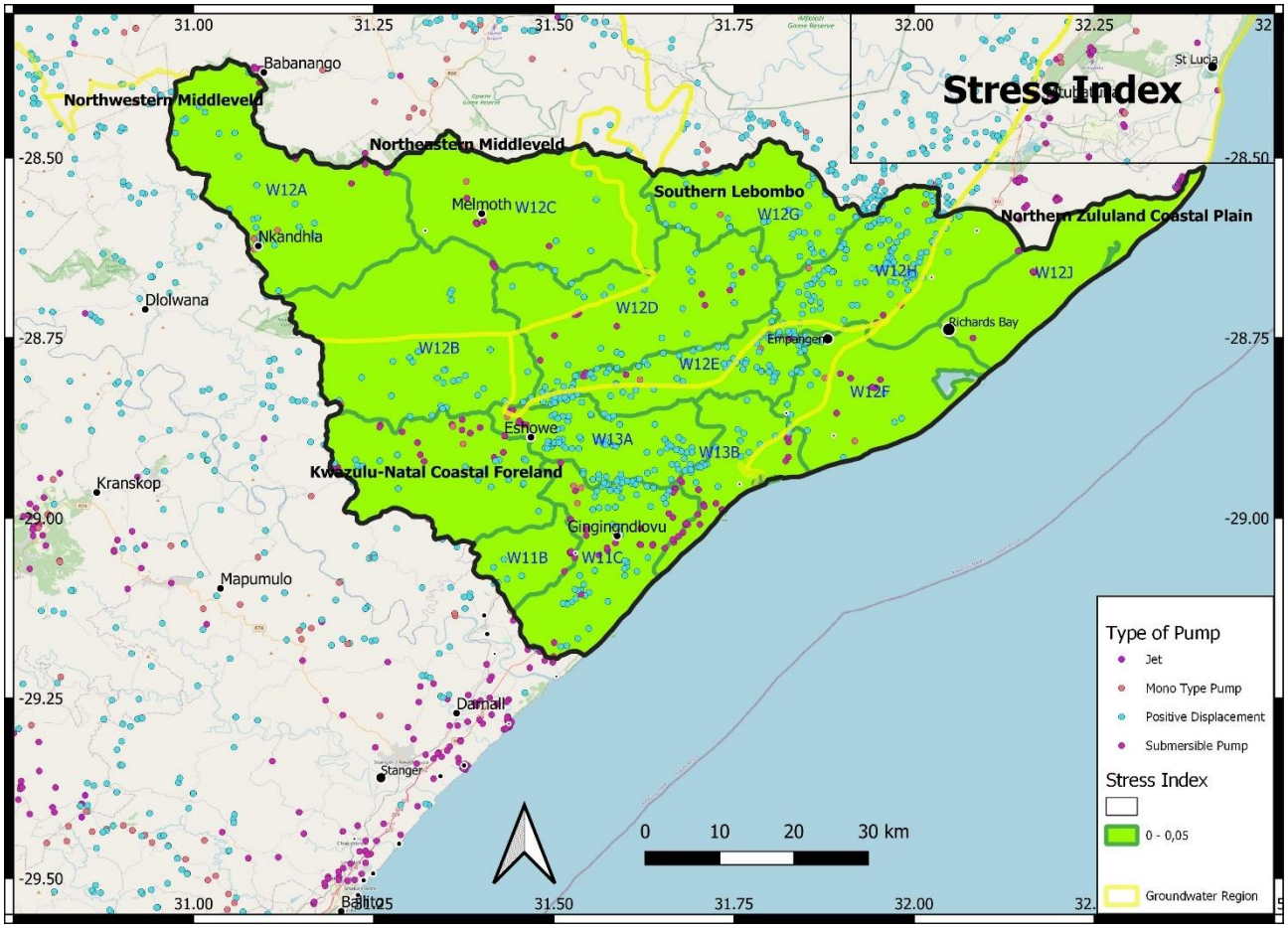
SI = Use/aquifer recharge





Based on WARMS + Schedule 1 Use + Livestock use)

STRESS INDEX



SETTING RQOs – NARRATIVE

- **Hydrogeology: Blah Blah to justify GRU, describe landscape, GW Region, type of baseflow, yield, aquifer type, Quats included, land use, stress index**

- **W12-01: Northestern Middelveld, 400-1200 mamsl, fractured aquifers, W12A and C, 50% > 0.1 l/s, only 10-20% exceed 2 l/s, MAP 700-1000 mm/a, MAE 1300-1500 mm/a, Strategic water source area of Zululand coast MAR >130 mm/a, Dwyka tillite, Natal Group, forest plantations and unimproved grassland, SI <0.05**

Quat	Average (l/s)	Median (l/s)	% > 0.5 l/s	% > 2 l/s	% > 5 l/s
W11A	1.30	0.70	67.3	18.7	3.3
W11B	1.70	1.40	92	36.1	0
W11C	1.66	1.26	81.6	32.7	0.9
W12A	1.64	0.99	70	24.5	6.7
W12B	1.18	0.90	62.7	18.6	0
W12C	1.88	0.76	79	26.4	4.6
W12D	0.89	0.49	49.5	10.2	1.9

SETTING RQOs – RESOURCES AND USE

- **Groundwater Use and Resources: Recharge, Aquifer Recharge., HP, Use and SI by Quat**

Quat	Area (km^2)	Recharge (Mm^3/a)	Aquifer recharge (Mm^3/a)	Exp. Pot (Mm^3/a)	GRAII Exp. Pot. (Mm^3/a)	Harvest Pot. (Mm^3/a)	Use (Mm^3/a)
W11A	445.15	39.56	12.80	3.12	12.23	34.40	0.2692
W11B	126.82	11.00	3.73	1.28	4.51	5.30	0.0607
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W12C	570.07	23.38	17.82	4.22	5.94	10.52	0.1022
W12D	568.94	25.02	13.32	3.77	8.01	27.30	0.0924
W12E	248.59	20.45	6.71	1.95	6.46	7.02	0.0427

SETTING RQOs – QUALITY

- **Groundwater Quality Distribution: description and problems**

Quat	20th percentile	40th percentile	60th percentile	80th percentile	100th percentile	Potable fraction
W11A	25.94	40.48	52	68.76	226	0.958
W11B	156	288	420	432	433	0.19
W11C	63.12	90.44	142.8	198.2	374	0.631
W12A	6.96	7.82	10.46	20.84	49.4	1
W12B	15.8	38.8	48.7	60.8	154	0.981
W12C	25.16	31.72	47.24	70.64	446	0.939

Quaternary	Class 0	Class 1	Class 2	Class 3	Class 4	Classification
W11A	56	11	3	0	0	I
W11B	1	0	1	4	0	III
W11C	5	7	5	3	0	III
W12A	5	0	0	0	0	I
W12B	17	3	1	0	0	I
W12C	31	6	1	2	0	III

SETTING RQOs – GW CONTRIBUTION TO BASEFLOW

- **Baseflow: type, description impact of abstraction, present day baseflow and % baseflow reduction**

Quaternary	Aquifer Recharge	Baseflow	Groundwater baseflow	GWEWR	GW % of Baseflow
W11A	12.80	39.28	8.53	6.35	21.73
W11B	3.73	10.96	2.44	1.81	22.22
W11C	10.68	37.24	7.26	5.47	19.50
W12A	18.91	25.18	9.05	10.08	35.93
W12B	18.81	33.18	9.60	10.34	28.95
W12C	17.82	23.24	8.53	6.47	36.70
W12D	13.32	24.83	8.70	5.19	35.02
W12E	6.71	18.45	3.76	2.52	20.38
W12F	45.38	50.48	13.92	9.76	27.57
W12G	10.01	13.79	4.92	3.43	35.67
W12H	13.02	35.82	7.34	5.32	20.48
W12J	42.57	40.30	11.95	8.27	29.66
W13A	6.47	28.22	3.95	2.54	13.99
W13B	4.75	30.47	3.03	2.52	9.93

SETTING RQOs – CLASSIFICATION AND ALLOCABLE GROUNDWATER

Allocable; description of current state, the Reserve and allocable groundwater as a basis for RQO

Quaternary	Aquifer Recharge	GWEWR	BHN	Use	Stress Index	PSC	Class	Reserve	Allocable
W11A	12.801	6.348	0.261	0.269	0.021	A	I	6.609	1.442
W11B	3.725	1.807	0.121	0.061	0.016	A	I	1.928	0.433
W11C	10.681	5.470	0.329	0.232	0.022	A	I	5.799	0.912
W12A	18.911	10.075	0.176	0.158	0.008	A	I	10.251	1.883
W12B	18.808	10.337	0.278	0.122	0.006	A	I	10.615	1.488
W12C	17.820	6.465	0.197	0.102	0.006	A	I	6.662	4.819
W12D	13.321	5.194	0.261	0.092	0.007	A	I	5.455	3.112
W12E	6.706	2.517	0.158	0.043	0.006	A	I	2.675	1.641
W12F	45.382	9.761	0.073	0.419	0.009	A	I	9.834	19.246
W12G	10.009	3.435	0.075	0.064	0.006	A	I	3.510	2.932
W12H	13.024	5.321	0.111	0.365	0.028	A	I	5.432	2.668
W12J	42.573	8.274	0.087	0.093	0.002	A	I	8.361	19.218
W13A	6.474	2.536	0.201	0.216	0.033	A	I	2.737	1.255
W13B	4.751	2.521	0.119	0.046	0.010	A	I	2.640	0.402

SETTING RQOs – IDENTIFY CRITICAL CONDITIONS

Justify which RQOs are set

GRU	Quat	Catchment	Baseflow	Quality	Groundwater level	Abstraction
W12-01	W12A and C	Mfule	x	x		x

SETTING RQOs – NARRATIVE and NUMERICAL RQO

Quaternaries	Groundwater narrative RQO				Groundwater numerical RQO
	Abstraction	Baseflow	Water Level	Water Quality	
W12A AND C	All users to comply with existing allocation schedules, including GA* and Schedule 1, and individual licence conditions within Allocable groundwater.	Due to the low groundwater use, monitoring not required.	Due to the low groundwater use and low aquifer contribution to baseflow, monitoring not required.	Some boreholes have elevated EC and fluoride levels, so EC and fluoride need to be tested for domestic boreholes.	The remaining Allocable groundwater is 6.7 Mm^3/a. Note allocable = 65% of aquifer recharge – Reserve AND current use.