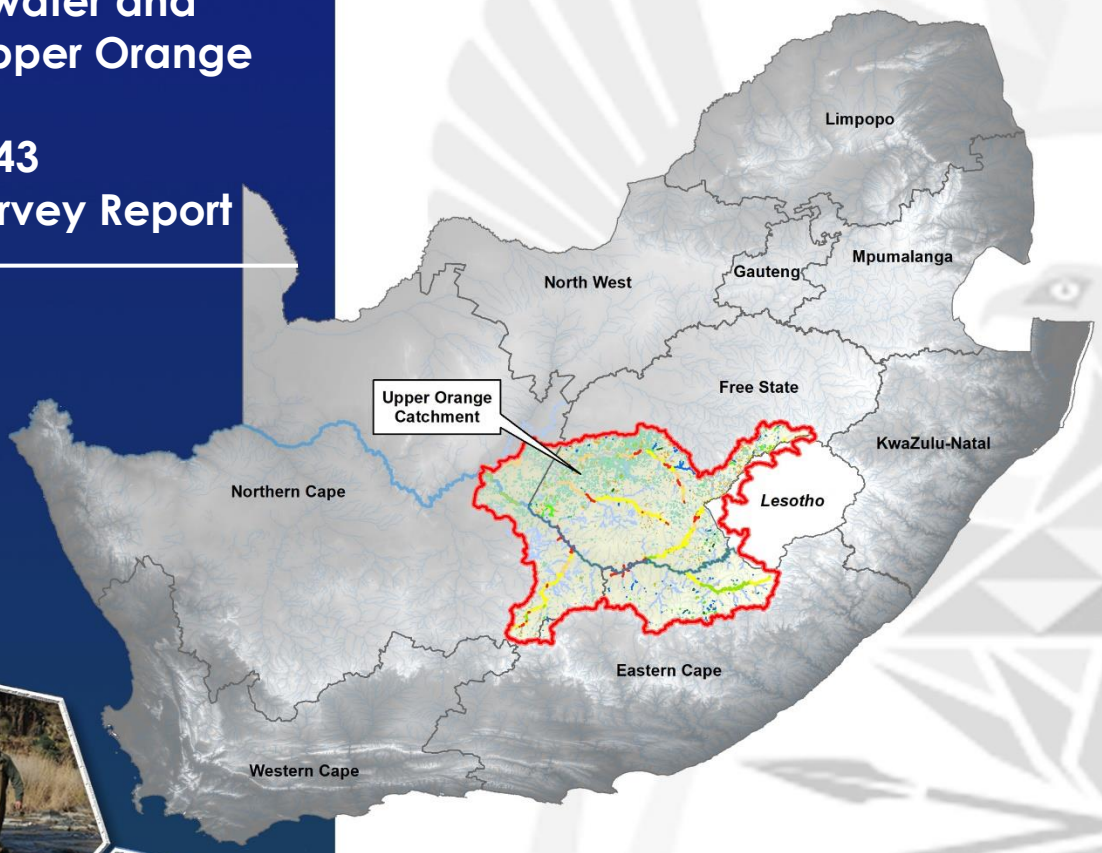
DEPARTMENT OF WATER AND SANITATION

A High Confidence Reserve Determination Study for Surface Water, Groundwater and Wetlands in the Upper Orange

WP11343
Groundwater Survey Report



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DOCUMENT INDEX

Reports as part of this project:

Bold type indicates this report

INDEX	REPORT NUMBER	REPORT TITLE
1.0	RDM/WMA13/00/CON/COMP/0121	Inception Report
2.0	RDM/WMA13/00/CON/COMP/0221	Stakeholder Engagement Plan
3.0	RDM/WMA13/00/CON/COMP/0321	Gaps Analysis Report
4.0	RDM/WMA13/00/CON/COMP/0422	Resource Units Report
5.0	RDM/WMA13/00/CON/COMP/0522	Wetland Survey Report
6.0	**RDM/WMA13/00/CON/COMP/0622**	**Groundwater Survey Report**

LIST OF ACRONYMS

DWS	Department of Water and Sanitation
EC	Electrical Conductivity
GDE	Groundwater Dependant Ecosystem
GPS	Global Positioning System
GW	Groundwater
GRU	Groundwater Resource Unit
MAP	Mean Annual Precipitation
ORP	Oxygen Reduction Potential
RU	Resource Unit
TDS	Total Dissolved Solids
WARMS	Water Authorisation and Registration Management System
WMS	Water Management Systems
WSP	Water Services Provider

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1. INTRODUCTION

1.1 Introduction & Scope of Works

As part of the GroundTruth project team, JG Afrika's Groundwater Division was tasked to conduct the groundwater component of a High Confidence Reserve Determination Study for the Upper Orange Catchment. Following previous contributions to the Inception Report, Gaps Analysis Report and Resource Units Report, respectively, a Groundwater Survey Report was required for the catchment as part of broader Terms of Reference of the study.

The scope of works for the Groundwater Survey Report was as follows:

- Engage with the Regional DWS office to outline the process for the study
- Conduct a hydrocensus at strategic groundwater resources in prioritised Resource Units in the catchment
    - Verify groundwater monitoring sites
    - Confirm water level characteristics at groundwater monitoring sites
    - Confirm basic groundwater quality characteristics at groundwater monitoring sites
- Present and document preliminary results and recommendations

A hydrocensus was scheduled from the 25 April 2022 to 29 April 2022. This report presents the Groundwater Survey, inclusive of a hydrocensus with preliminary results, of the Upper Orange Catchment.

1.2 Information Supplied

The following information has been used in the preparation of this report:

Reports

- Report referenced & titled: Management of a Karoo fractured-rock aquifer system Kalkveld Water User Association (WUA). BH Usher, JA Pretorius and GJ van Tonder Institute for Groundwater Studies, University of the Free State 1 January 2006.
- Report referenced & titled: Free State Economy Strategy Department of Economic development, tourism and environmental affairs DETEA by Bemboni Group (Pty) Ltd 2014.

Maps

- Map Sheets titled, "3126 Queenstown", "2722 Kimberley", "2726 Kroonstad","2924 Bloemfontein","3122 Beaufort West" at a scale of 1:500 000, first editions of the Hydrogeological Map Series of the Republic of South Africa, supplied by the Directorate: Geohydrology, of the Department of Water Affairs and Forestry
- WR (2012) shapefile of 1:1 000 000 geological map
- WR (2012) shapefiles of 1:500 000 geohydrology map

Data

- Water Authorisation and Registration Management System (WARMS) by The Department of Water and Sanitation.
- Water Management Systems (WMS) digital information, as supplied by The Department of Water and Sanitation as at February 2022.
- Hydstra digital information, as supplied by The Department of Water and Sanitation as at February 2022.
- WR 2012, shapefiles of geohydrological parameters, as supplied by The Department of Water and Sanitation

Software

- ArcGIS Desktop 10.5
- Aquiworx Version 2.5.3.0 of 2016

2. PROJECT AREA DESCRIPTION

The catchment spans over 102 840 km^2 west of Lesotho and includes portions of three provinces namely, Free State, Northern Cape, and Eastern Cape provinces. The topography of the study area is dominated by generally flat pans and plains, with grassland biomes mainly towards the west and the mountainous regions of the southern Drakensberg along the east**.** As per DEDTEA (2014), the rainfall in the catchment is influenced by topography along the eastern highlands, which is greater than the western parts of the catchments.

The catchment has an elevation range of approximately 1038mamsl to 2410mamsl and drains in a north-westerly direction via four main river systems. These include the Caledon, Riet, Modder and Orange Rivers.

Based on a variety of geohydrological, management and geo-political criteria, the catchment was subdivided into fourteen (14 No.) groundwater resource units as shown in **Figure 1**.

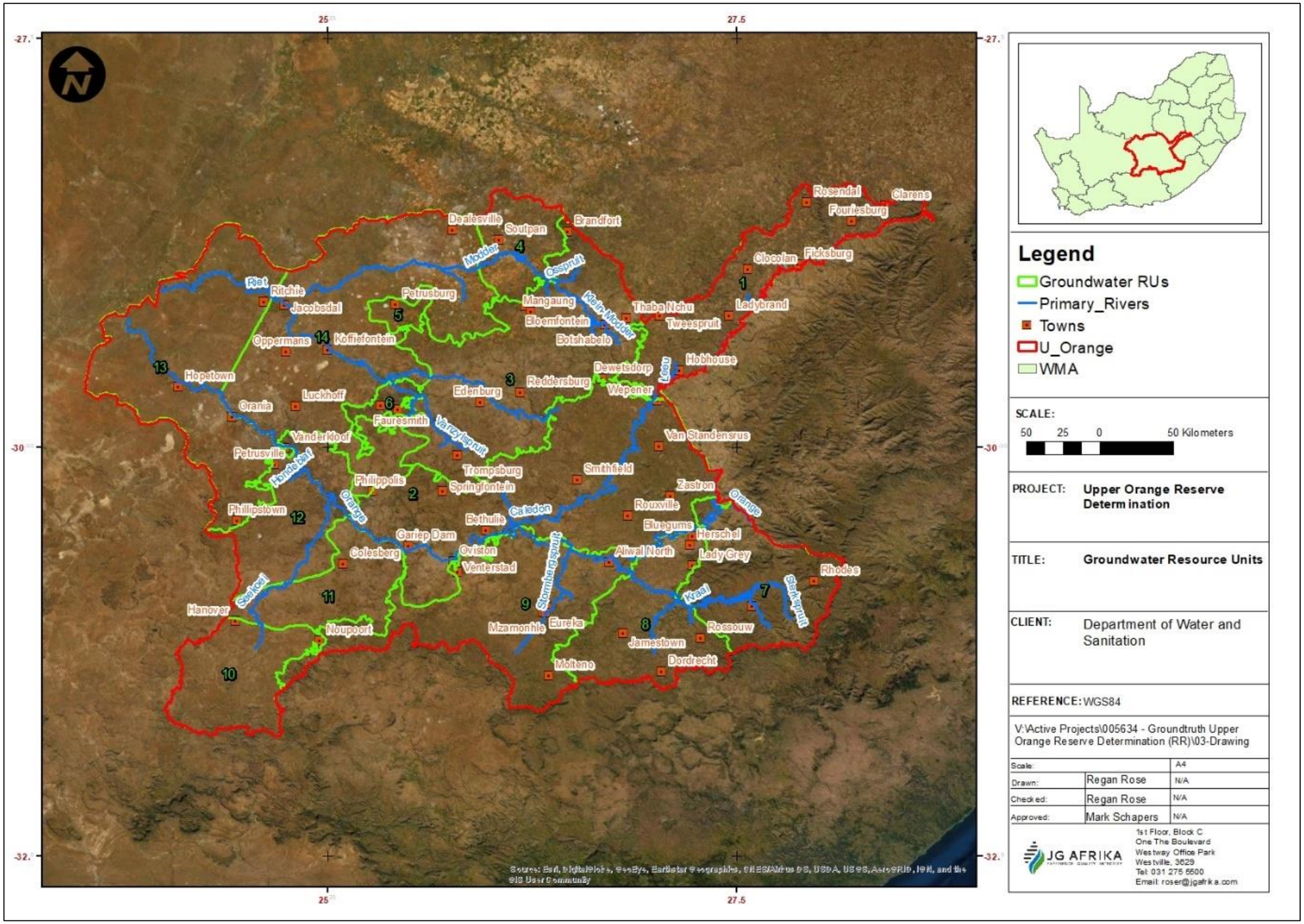


Figure 1: Upper Orange catchment indicating the Groundwater Resource Units

3. DESKTOP REVIEW

3.1 Recharge

Based on WR 2012 recharge was estimated on a desktop level for of the fourteen (14 No.) groundwater resource units. Mean annual precipitation was used to calculate the mean recharge for each groundwater resource unit. A summary of recharge calculations is presented in **Table 1.**

Table 1: Summary of Recharge for Groundwater Resource Units

Resource Units	Recharge Area of Reserve Unit (km^2)	Mean MAP (m/a)	Available for Recharge (Mm^3/year)	Mean Recharge	
				%	Mm^3/year
GW RU 01	6994.0	0.739	31011.40	6.40	1987.42
GW RU 02	15407.0	0.484	44741.93	3.55	1589.08
GW RU 03	12939.0	0.477	37031.42	2.52	934.71
GW RU 04	2863.0	0.468	8039.30	1.87	150.82
GW RU 05	645.74	0.414	1603.92	2.00	32.04
GW RU 06	821.9	0.396	1952.83	2.08	40.68
GW RU 07	6074.0	0.716	26093.90	6.19	1617.02
GW RU 08	6052.60	0.554	20118.84	3.37	679.46
GW RU 09	9526.0	0.448	25605.89	2.54	649.86
GW RU 10	4606.0	0.305	8428.98	3.06	258.12
GW RU 11	4040.0	0.341	8265.84	2.86	236.82
GW RU 12	5194.0	0.334	10408.78	3.78	394.22
GW RU 13	11668	0.307	21492.46	3.07	660.18
GW RU 14	16214	0.378	36773.35	2.84	1045.80

3.2 Regional Geology

The surface geology is dominated by the Karoo Supergroup overlying relative small outcrops of the basement Ventersdorp Supergroup in the northwest. The Karoo Supergroup comprises of sedimentary deposits of alternating sandstone, shale, mudstone, and siltstone, which was intruded by post karoo dolerite dykes and sills in the west and capped by volcanic rocks in the east.

The oldest rocks in the catchment are represented by Randian aged volcanic rocks of the Allanridge Formation, which consists of andesite and basaltic andesite.

The Karoo Supergroup comprises the following lithostratigraphic units in order of decreasing age:

- Dwyka Formation which consists of tillite, mudstone and shale.
- Ecca Formation which consists of shale and mudstone.
- The Permian age Adelaide Formation of the Beaufort Group which consists of mudstone and subordinate sandstone.
- Triassic age Katberg Formation of the Beaufort Group which consists of fine-grained sandstone and red and green-grey mudstone.
- Mid to late Triassic sedimentary deposits occur along the eastern and south-eastern parts of the catchment comprise of three sedimentary formations namely:
    - The Molteno Formation, which consists of sandstone, mudstone, shale and occasional coal seams, which is overlain by,
    - Brownish-red and grey mudstone and sandstone of the Elliot Formation and,
    - Fine-grained sandstone of the Clarens Formation

The Jurassic age Drakensberg Formation, which consists of basaltic lava, tuff, and agglomerate, provides the capping material, whilst widespread dolerite sill and dykes intruded the sedimentary cover rocks.

Quaternary age calcrete and alluvium occupy surface depressions and main drainage regions.

The regional geology is presented in **Table 2** and shown in **Figure 2**.

Table 2: Upper Orange Catchment Regional Geological Succession

Symbol on Map	Geological Time Scale (Period)	Lithological Unit		Description
		Sedimentary & Volcanic Rocks	**Intrusive Rocks**	
Q	Quaternary	Alluvium		Unconsolidated sediments
Jdr	Jurassic	Drakensberg Formation	Dolerite	Dolerite dyke and Sills-
Jd				Basaltic lava, tuff, and agglomerate
Trc	Triassic	Clarens Formation		Yellowish-grey, pale-orange, or pink, very fine-grained sandstone
Tre		Elliot Formation		Brownish-red and grey mudstone, sandstone
Trm		Molteno Formation		Gritty sandstone, grey mudstone, shale, and occasional coal seams
P-Trb		Beaufort Group: Katberg Formation		fine-grained sandstone and red and green-grey mudstone
	Permian	Beaufort Group: Adelaide Formation		Red, purple, grey, and blue green mudstone subordinate sandstone
Pe		Ecca Group		Alternating succession of Sandstone, siltstone and mudstone
C-Pd	Carboniferous	Dwyka Formation		Tillite
R-Val	Randian		Allanridge Formation	Tholeiitic, and andesite; tuff and pyroclastic, Braccia

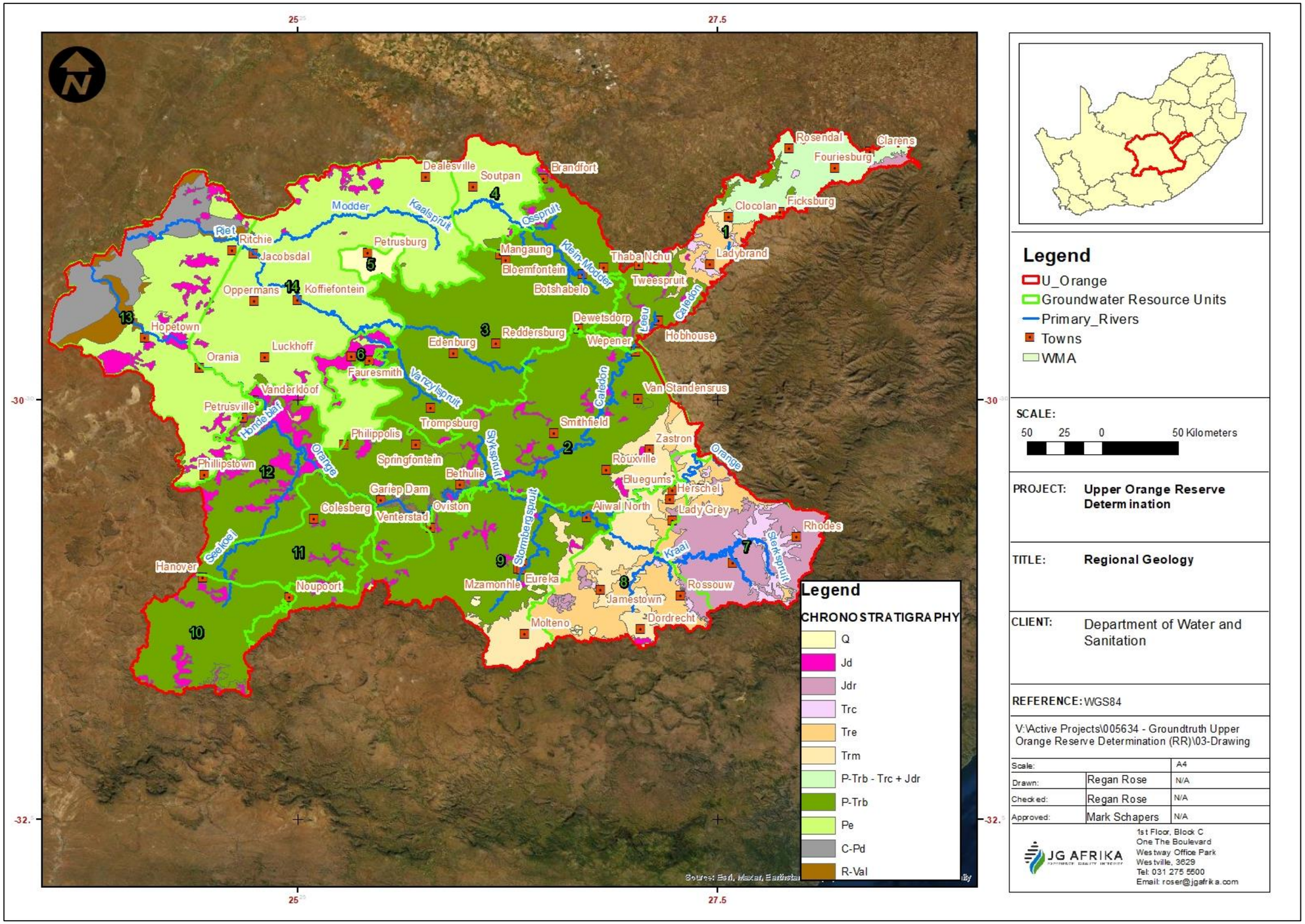


Figure 2: Regional Geology of the Upper Orange catchment

3.3 Regional Geohydrology

The regional geohydrology of the catchment is dominated by fractured aquifers, as well as fractured and intergranular aquifers.

The occurrence of groundwater in fractured aquifers is due to fracturing, faulting, jointing and bedding planes within predominantly arenaceous units in hard rock formations. The geohydrology according to the DWS geohydrological map series infer the principal groundwater occurrences associated with fractured aquifers to be “b3” and “b4”, with median borehole yields in the range of 0.5 to 2.0l/s and 2.0 to 5.0l/s, respectively.

The occurrence of groundwater in intergranular and fractured aquifers is a result of dual porosity properties exhibited by the Drakensberg lavas and dolerite intrusions (sills and dykes), i.e., upper weathered zone and a deeper fractured zone. The geohydrology according to the DWS geohydrological map series infer the principal groundwater occurrences associated with fractured and intergranular aquifers to be “d2” to “d4”, with median borehole yields in the range of 0.1 to 0.5l/s to 2.0 to 5.0l/s.

Elevated borehole yields can occur especially adjacent to defined valleys and near to river channels within the area due to favourable recharge conditions. The regional geohydrology of the catchment is presented in **Figure 3.**

Groundwater quality, as contoured in the DWS geohydrological map series, indicates Electrical Conductivity (EC) to be in the range of 0-70mS/m for the majority of the eastern parts of the catchment, whilst the western parts of the catchment has EC ranging between 70-300mS/m. The regional groundwater quality of the catchment is presented in **Figure 4.** The improved groundwater quality along the eastern parts of the catchment reflects higher rainfall and elevated groundwater recharge conditions.

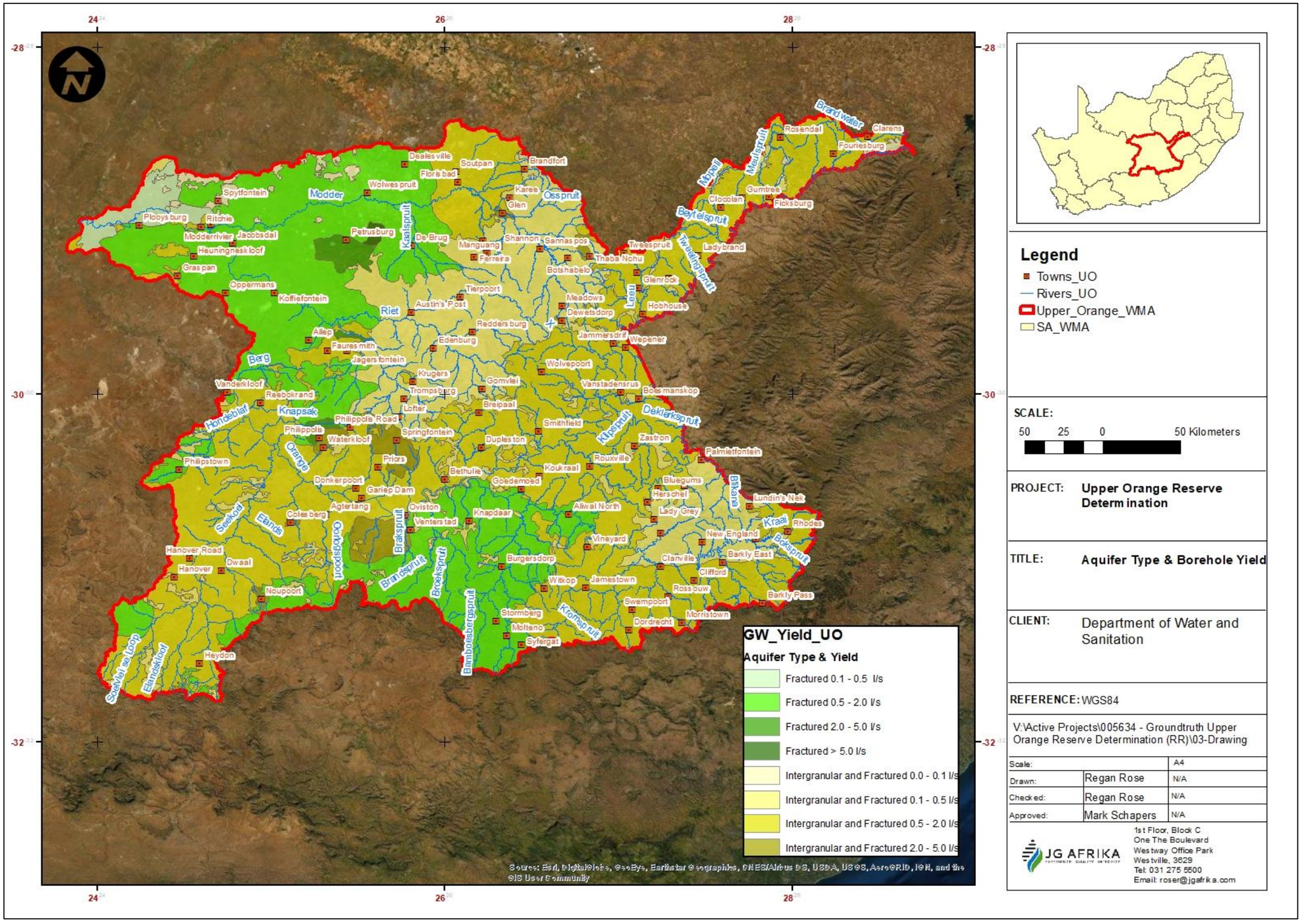


Figure 3: Aquifer type and borehole yield

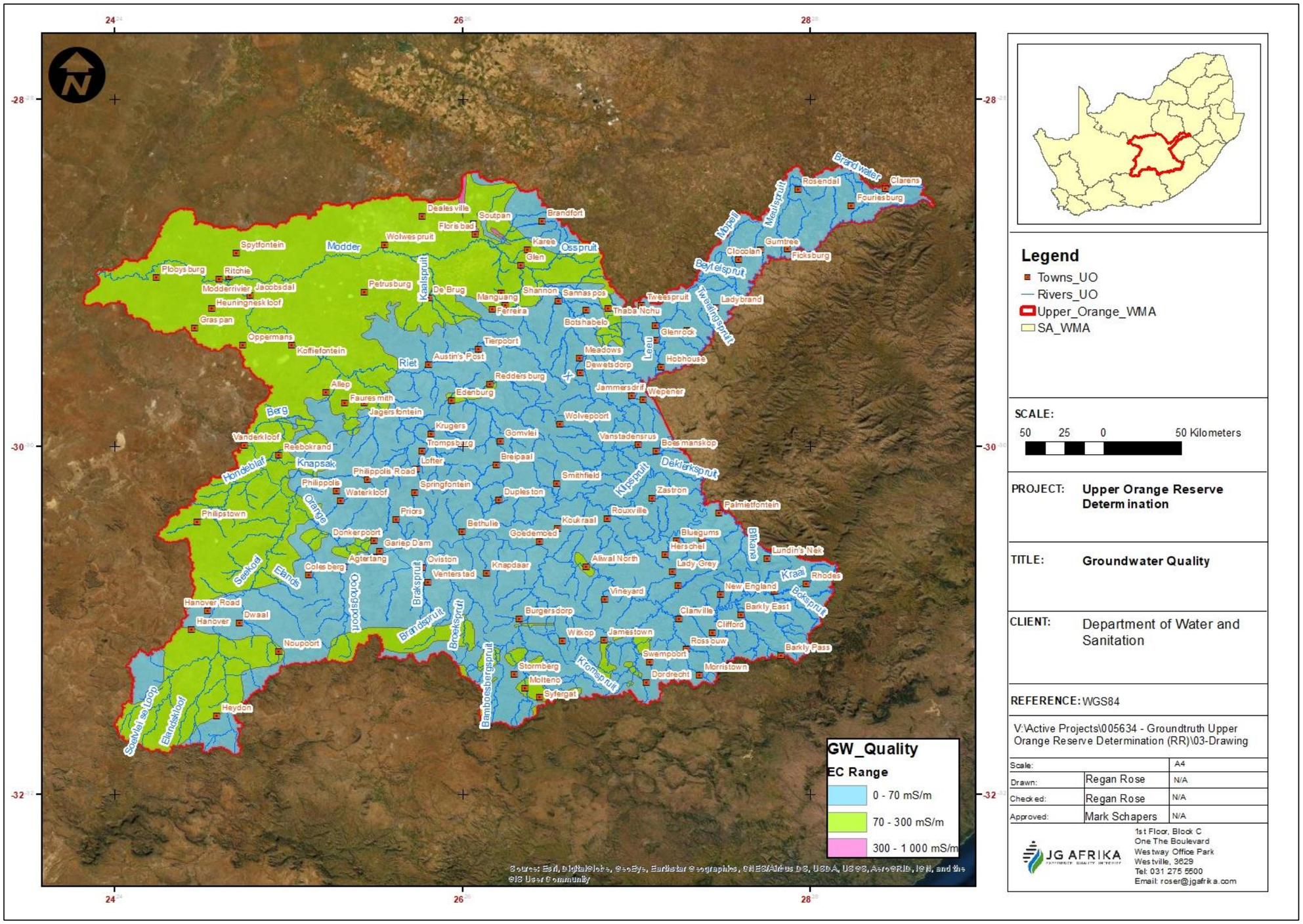


Figure 4: Groundwater Quality

3.4 Existing Groundwater Resources

Existing groundwater data was acquired from DWS databases. These include data from Water Management System (WMS), Hydstra and Water Authorisation and Registration Management System (WARMS) databases, respectively. The WMS database produced twenty three (23 No.) groundwater resources, whilst Hydstra produced two hundred and seven (207 No.) groundwater resources within the catchment. The WMS groundwater resources are presented in **Table 3**. No data is available for borehole depth, discharge and water levels. The Hydstra borehole data is presented in **Annexure A.**

Table 3: WMS Groundwater Resources

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
ZQM_RDG_BH1	89697	C51A	Borehole	-29.664722	26.184444	-	-	-
ZQM_ROW_BH1	89700	D35J	Borehole	-30.866667	25.586944	-	-	-
ZQM_RXL_BH1	89711	D24G	Borehole	-30.419444	26.856389	-	-	-
ZQM_SPN_BH1	89733	C35H	Borehole	-28.724722	26.032500	-	-	-
ZQM_SZS_BH1	89750	CM51	Borehole	-29.292500	24.234444	-	-	-
ZQM_TMG_BH1	89763	C51G	Borehole	-30.04000	25.780278	-	-	-
ZQM_ZAS_BH1	89821	D24B	Borehole	-30.305000	27.064444	-	-	-
ZQM_ALI_BH1	89868	D14A	Borehole	-30.715556	26.714722	-	-	-
ZQM_BUP_BH1	89932	D14E	Borehole	-30.993611	26.324444	-	-	-
ZQM_BYS_BH1	89940	D13D	Borehole	-30.971111	27.593889	-	-	-
ZQM_CCN_BH1	89946	D22G	Borehole	-28.920556	27.570000	-	-	-
ZQM_CCN_BH2	89947	D22G	Borehole	-28.920556	27.570000	-	-	-
ZQM_CCN_BH3	89948	D22G	Borehole	-28.911944	27.567500	-	-	-
ZQM_CDP_BH1	89949	D21E	Borehole	-28.693056	28.236389	-	-	-
ZQM_CDT_BH1	89950	D21E	Borehole	-28.692222	28.236389	-	-	-
ZQM_CPT_BH1	89959	D21E	Borehole	-28.693056	28.236389	-	-	-
ZQM_DDT_BH1	89974	D13H	Borehole	-31.375556	27.044722	-	-	-
ZQM_DWP_BH1	89983	C52A	Borehole	-29.562778	26.680278	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
ZQM_HNR_BH1	90028	D32E	Borehole	-31.216667	24.432222	-	-	-
ZQM_JBL_BH1	90030	C51K	Borehole	-29.125556	24.778611	-	-	-
ZQM_LCF_BH2	90065	C51K	Borehole	-29.119167	24.732222	-	-	-
ZQM_MDG_BH1	90094	D32K	Borehole	-30.425556	24.842222	-	-	-
ZQM_NOU_BH1	90141	D32G	Borehole	-31.222500	24.945000	-	-	-

The WARMS data produced one thousand nine hundred and seventy eight (1978 No.) groundwater resources that are linked to registered users, of which thirty six (36 No.) are related to Water Services Providers. The registered groundwater users related to Water Service Providers is presented in **Table 4**. No data is available for borehole depth, discharge and water levels.

Table 4: Water Service Provider groundwater resources (WARMS)

Municipality Water Supply Provider	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	W L (mbgl)
KOPANONG LOCAL MUNICIPALITY: REDDERSBURG	C51A	Borehole	-29.54361	26.19028	-	-	-
KOPANONG LOCAL MUNICIPALITY: EDENBURG	C51C	Borehole	-29.74167	25.93333	-	-	-
KOPANONG LOCAL MUNICIPALITY: TROMPSBURG	C52J	Borehole	-29.34826	26.13171	-	-	-
KOPANONG LOCAL MUNICIPALITY: JAGERSFONTEIN	C51H	Borehole	-29.75000	25.47000	-	-	-
KOPANONG LOCAL MUNICIPALITY: FAURESMITH	C51H	Borehole	-29.87157	25.62464	-	-	-
KOPANONG LOCAL MUNICIPALITY: FAURESMITH	C51H	Borehole	-29.87157	25.62464	-	-	-
LETSEMENG LOCAL MUNICIPALITY: JACOBSDAL	C51K	Borehole	-29.11667	24.76667	-	-	-
NALEDI LOCAL MUNICIPALITY: DEWETSDORP	C52A	Borehole	-29.59722	26.69222	-	-	-

Municipality Water Supply Provider	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	W L (mbgl)
MANGAUNG METRO: BLOEMFONTEIN	C52F	Borehole	-29.11694	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52F	Borehole	-29.12167	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52F	Borehole	-29.15000	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52E	Borehole	-29.10000	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52F	Borehole	-29.12917	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52E	Borehole	-29.04984	26.39208	-	-	-
MANGAUNG METRO: BLOEMFONTEIN	C52F	Borehole	-29.12000	26.39208	-	-	-
MASILONYANA LOCAL MUNICIPALITY: BRANDFORT	C52G	Borehole	-28.69000	26.46000	-	-	-
TOKOLOGO LOCAL MUNICIPALITY: DEALESVILLE	C52H	Borehole	-28.67500	25.77500	-	-	-
LETSEMENG LOCAL MUNICIPALITY: PETRUSBURG	C52K	Borehole	-29.12222	25.42222	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D12E	Borehole	-30.69233	27.20622	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D13D	Borehole	-30.96667	27.60000	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D13D	Borehole	-30.97764	27.61208	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D12F	Borehole	-30.70384	26.85332	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D12F	Borehole	-30.70384	26.85332	-	-	-
JOE GQABI DISTRICT MUNICIPALITY	D14E	Borehole	-30.99931	26.33359	-	-	-
DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM SANPARKS	D21D	Borehole	-28.51417	28.61833	-	-	-

Municipality Water Supply Provider	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	W L (mbgl)
DIHLABENG LOCAL MUNICIPALITY: ROSENDAL	D22A	Borehole	-28.50069	27.94192	-	-	-
NALEDI LOCAL MUNICIPALITY: VAN STADENSRUS	D24C	Borehole	-29.99167	27.02500	-	-	-
MOHOKARE LOCAL MUNICIPALITY: SMITHFIELD	D24H	Borehole	-30.18333	26.53483	-	-	-
RENOSTERBERG/MASIBAMBANE LOCAL MUNICIPALITY: PHILIPSTOWN	D31B	Borehole	-30.43889	24.48472	-	-	-
EMTHANJENI LOCAL MUNICIPALITY: HANOVER	D32F	Borehole	-31.06667	24.43333	-	-	-
UMSOBOMVU LOCAL MUNICIPALITY: NOUPOORT	D32G	Borehole	-31.18667	24.95222	-	-	-
UMSOBOMVU LOCAL MUNICIPALITY: NOUPOORT	D32G	Borehole	-31.18667	24.95222	-	-	-
UMSOBOMVU LOCAL MUNICIPALITY: NOUPOORT	D32G	Borehole	-31.14586	24.92400	-	-	-
UMSOBOMVU LOCAL MUNICIPALITY: COLESBERG	D34F	Borehole	-30.71972	25.07917	-	-	-
UMSOBOMVU LOCAL MUNICIPALITY: COLESBERG	D34F	Borehole	-30.62500	25.04000	-	-	-
KOPANONG LOCAL MUNICIPALITY: PHILIPPOLIS	D34G	Borehole	-30.26806	25.27794	-	-	-

The groundwater resources for WMS and HYDSTRA, as well as the registered groundwater use for Water Services Providers, are represented in **Figure 5.** The distribution of all WARMS groundwater use for the catchment is provided in **Figure 6.**

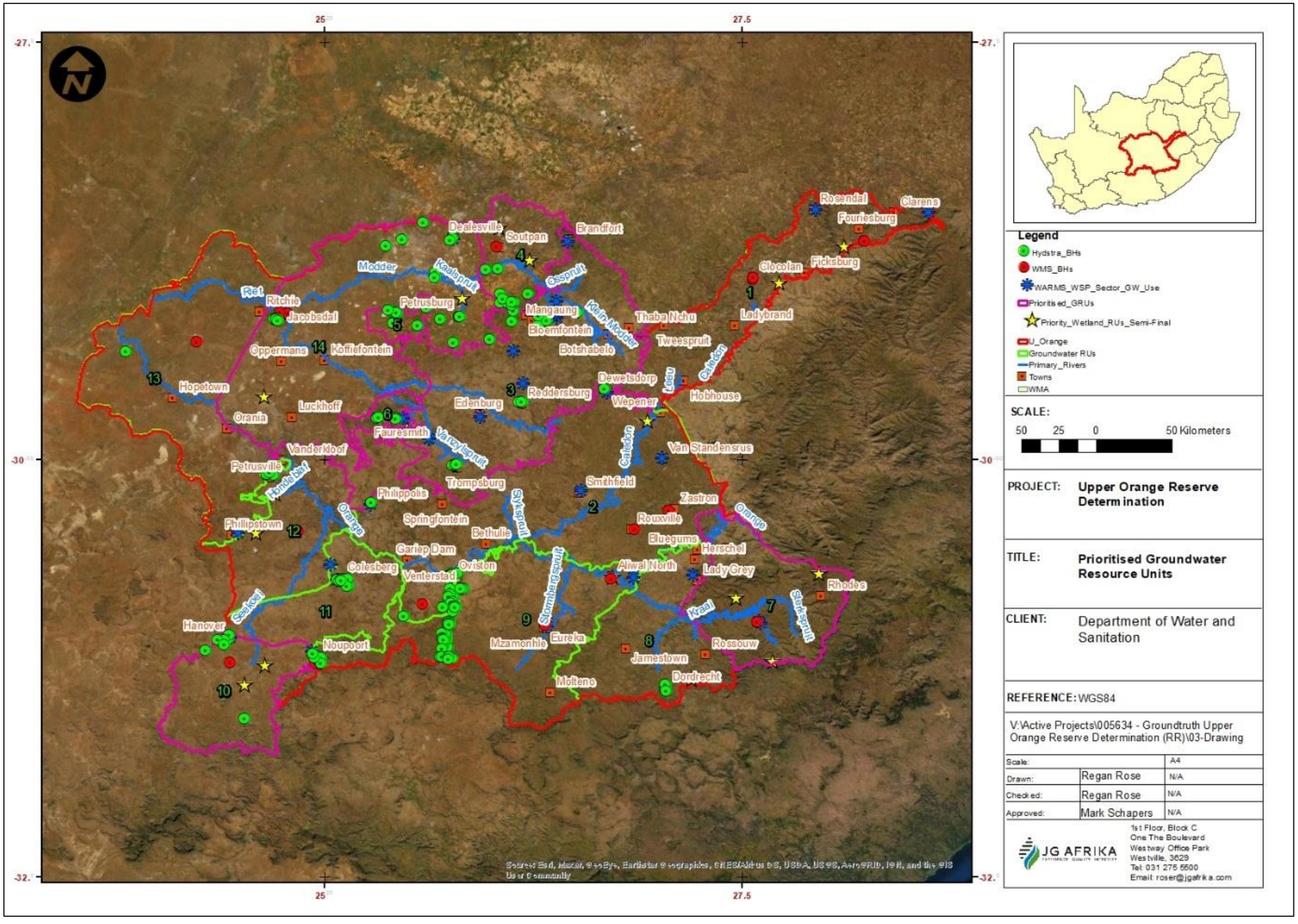


Figure 5: Existing groundwater resources and towns using groundwater

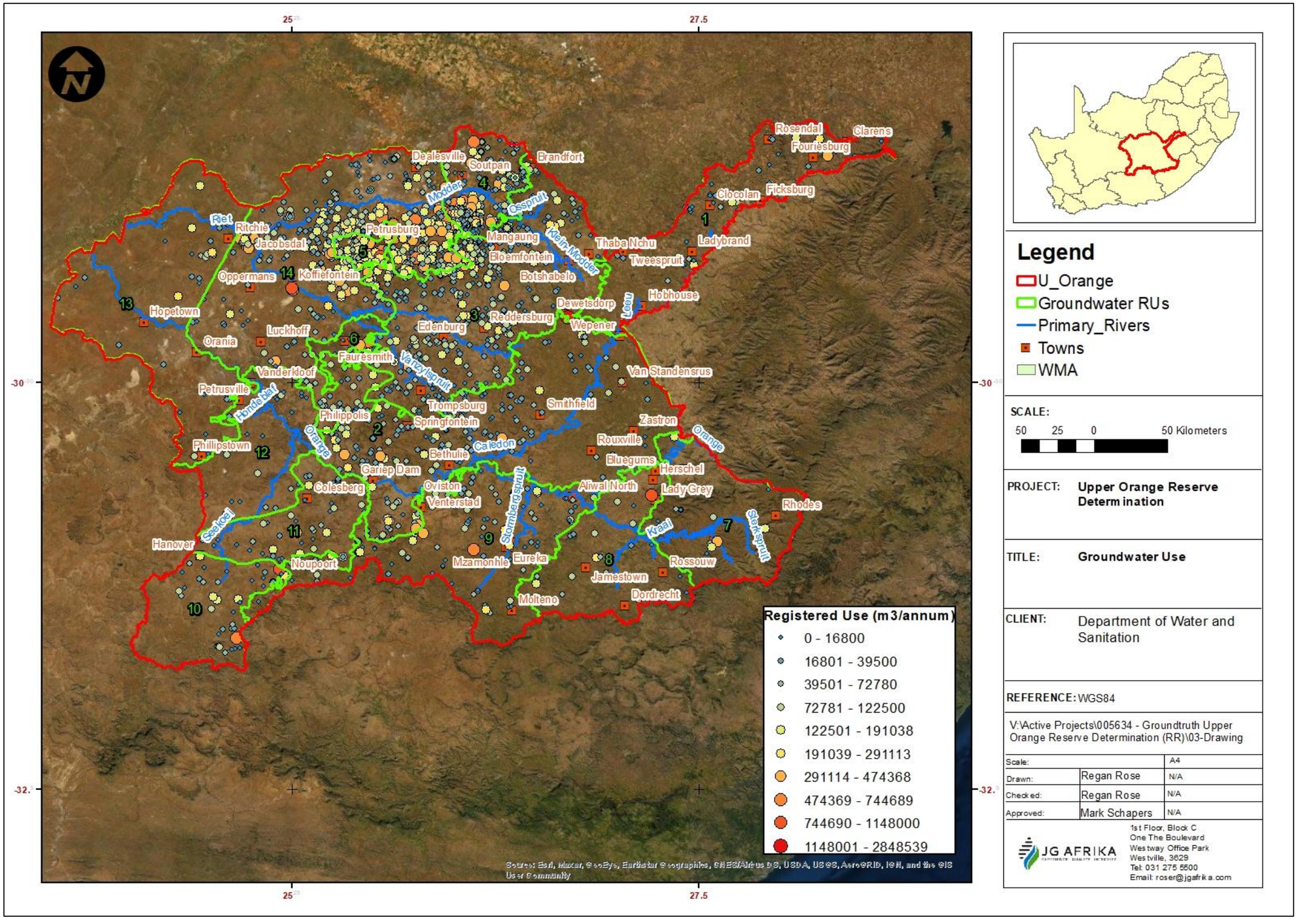


Figure 6: WARMS Groundwater Users

4. HYDROCENSUS

4.1 Site Assessment

A hydrocensus investigation was conducted from 25 April 2022 to 29 April 2022. Due to the size and number of groundwater monitoring resources, the main focus areas were the six (6 No.) prioritised groundwater resource units. These areas are summarised in **Table 5** and provided in **Figure 7.**

Table 5: Summary of Prioritised Groundwater Resource Units

Resource Units	Quaternary Catchment/s	City / Town
GW_RU03	C52G, C52J, C52F, C52D, C51H	Bloemfontein, Jagersfontein
GW_RU04	C52H, C52G	Soutpan,
GW_RU05	C52K	Petrusburg
GW_RU14	C52K, D33K, D33C	Dealesville, Ritchie, Jacobsdal, Luckhoff
GW_RU10	D32A, D32B, D32E	Hanover, Noupoort
GW_RU07	D13D, D13E, D18K, D13K, D13A,	Buckley East, Rhodes, Lady Grey

The hydrocensus focussed on WMS, Hydstra, municipal groundwater resources, as well as a few surface water bodies in proximity to groundwater resources. The objectives of the hydrocensus were as follows:

- To identify and verify groundwater resources in the catchment
- Collect field data, i.e. measurements of borehole depth, water levels, borehole yield and basic water chemistry

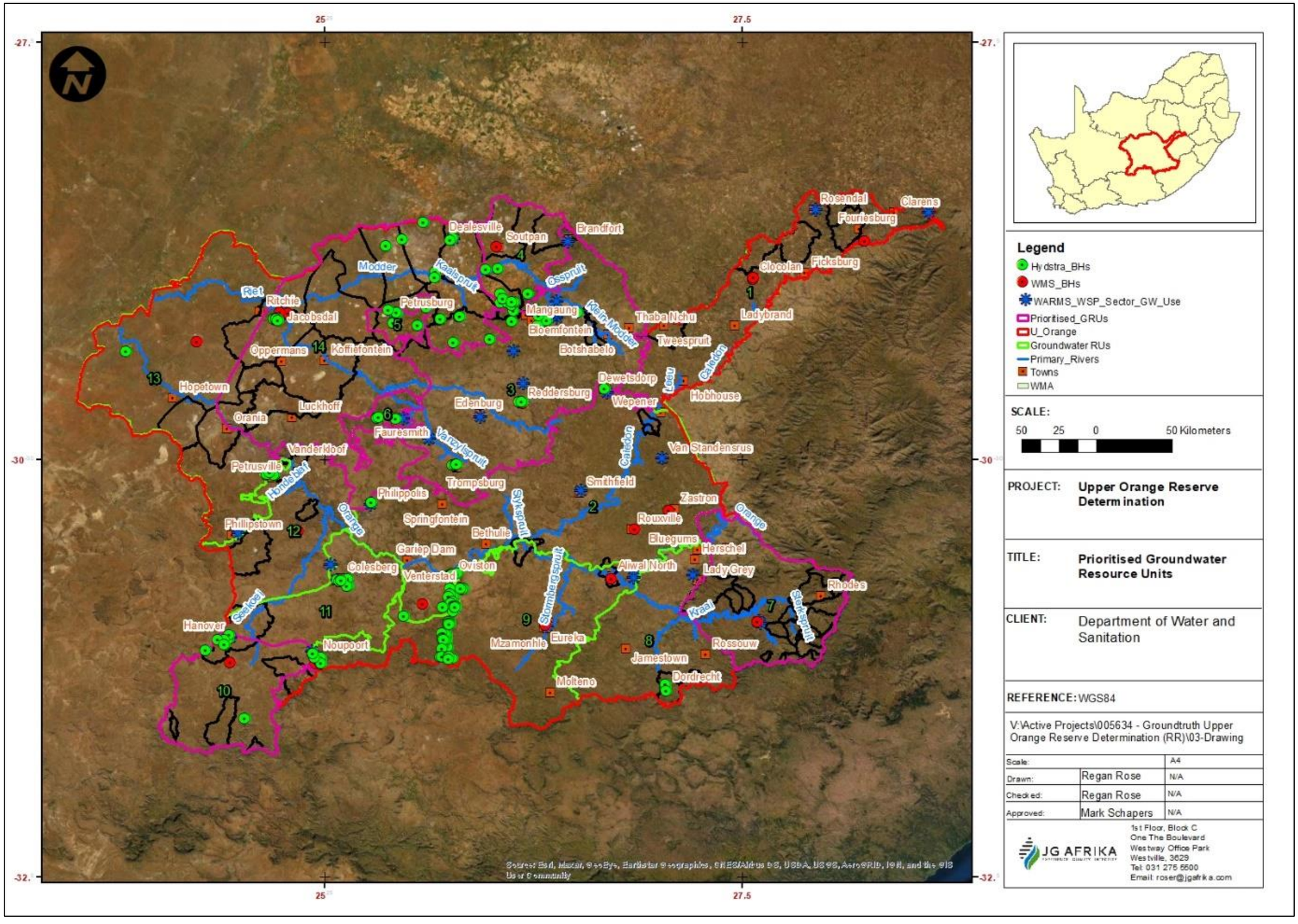


Figure 7: Prioritised Resource Units

Borehole data was collected as follows:

- Site coordinates and elevation by use of a hand-held GPS
- Borehole depths and water levels by use of a dip meter where possible
- Water samples by use of a bailer
- Field measurements of EC, pH, Total Dissolved Solids (TDS), Oxygen Reduction Potential (ORP) and Temperature by use of handheld EC/pH and ORP/Temp multi-meters. Multi-parameter probes were calibrated prior to taking measurements.

The field verified groundwater resources are presented in **Table 6** and the spatial distribution of the field verified groundwater resources is provided in **Figure 8**. The hydrocensus information, detailing each resource and summarised field sheets, is presented in Annexure B and Annexure C respectively.

***Table 6: Field Verified Boreholes*.**

Resource Identifier (No)	Alternative Identifier (No)	Quaternary Catchment	Latitude	Longitude	Elevation (mamsl)	Use Status	SWL (mbgl	Temp (C^0)	pH	EC (uS/cm)	TDS (m/l)	ORP (mV)	Equipment	Comment
UO-BH-01	C5N0628	C52G	-29.00668	26.22134	1343	In Use	7.40	20.1	7.4	650	301.2	44	None	Monitoring Borehole
UO-BH-02	-	C52K	-29.11841	25.43976	1250	In Use	6.10	22.0	7.3	970	470	154	None	Monitoring Borehole
UO-BH-03	-	C52K	-29.11819	25.43551	1252	Not in Use	6.40	-					None	Blocked & destroyed
UO-BH-04	-	C52K	-28.59433	25.59156	1283	In Use	0.80	24.0	7.5	470	230	90	None	Monitoring Borehole
UO-BH-05	-	C52H	-28.68591	25.75362	1257	In Use	2.92	22.9	7.6	550	270	23	None	Monitoring Borehole
UO-BH-06	-	C52K	-29.10295	25.38289	1233	In Use	4.93	7.6	7.6	1490	750	112	None	Monitoring Borehole
UO-BH-07	C5N0641	C52K	29.12718	25.43851	1258	In Use	6.13	21.9	7.5	1120	550	86	None	Monitoring Borehole
UO-BH-08	-	C51K	-29.40719	27.01071	1178	Not in Use	-	-	-	-	-	-	None	Blocked & destroyed
UO-BH-09	-	C51K	-29.16019	24.71239	1149	In Use	4.20	23.9	7.4	780	380	21	None	Monitoring Borehole
UO-PVT-BH-01	-	C51K	-29.15995	24.71268	1149	Not in Use	4.00	21.9	7.5	360	17	62	Pump	Irrigation
UO-BH-11	D3N0572	D32F	-31.0498	24.431060	1401	In Use	3.51	18.9-	7.5	560	270	50	NONE	Monitoring Borehole
UO-BH-12	D3N0574	D32F	-31.07757	24.36136	1421	In Use	0.33	19.40	7.6	710	350	68	None	Monitoring Borehole
UO-BH-13	D3N0573	D32F	-31.07901	24.39899	1404	In Use	10.61	-	-	-	-	-	None	Capped
UO-BH-14	D3N0575	D32F	-31.10766	24.39950	1416	In Use	6.55	21.5	7.3	1060	520	99	None	Monitoring Borehole
UO-BH-15	D3N0571	D32F	-31.14517	24.28910	1484	In Use	5.33	21.4	7.6	500	240	83	None	Monitoring Borehole

Resource Identifier (No)	Alternative Identifier (No)	Quaternary Catchment	Latitude	Longitude	Elevation (mamsl)	Use Status	SWL (mbgl	Temp (C^0)	pH	EC (uS/cm)	TDS (m/l)	ORP (mV)	Equipment	Comment
UO-BH-16		D32G	-31.16179	24.92868	1472	In Use	3.80	21.3	7.6	1230	620	119	None	Monitoring Borehole
UO-BH-17	EC-D13-094	D13D	-30.97672	27.59097	1800	Not in Use	-	15.2	7.6	440	210	112	Submersible Pump	Borehole electrical supply destroyed
UO-BH-18	EC-D13-095	D13D	-30.97812	27.59124	1801	Not in Use	-	14.8	7.6	780	370	113	Submersible Pump	Pump has been stolen and electric supply destroyed
UO-BH-19	-	D13D	-30.97332	27.58939	1805	Not in Use	-	-	-	-	-	-	Submersible Pump	Borehole electrical supply destroyed
UO-Stream-01	-	D13D	-30.97303	27.58864	1800	-	-	15.7	7.5	430	300	41	-	Non perennial stream
UO-Wetland-01	-	D32F	-31.08393	24.36317	1416	-	-	18.8	7.3	660	320	70	-	Dries up in the dry season

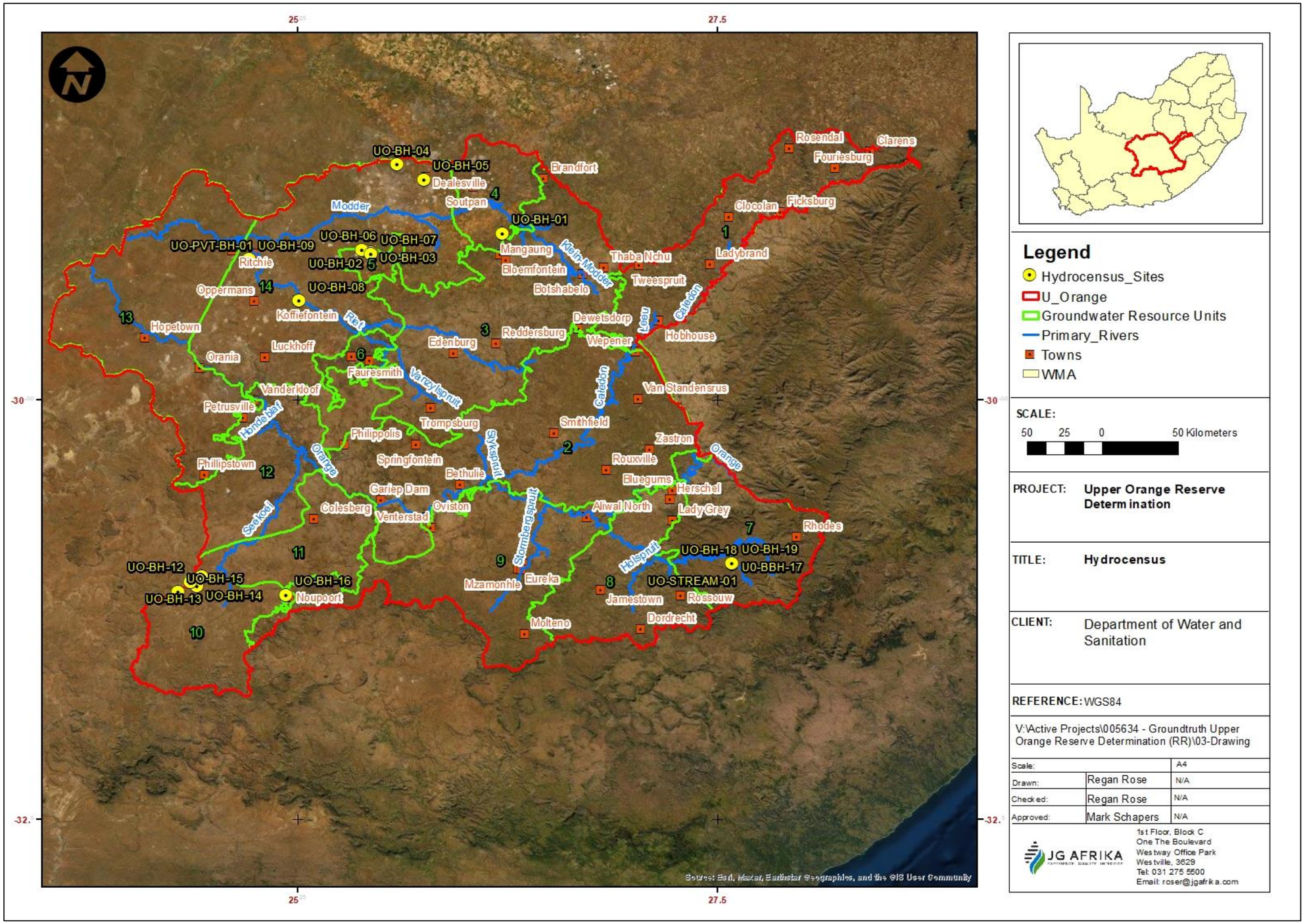


Figure 8: Hydrocensus Sites

5. CAPACITY BUILDING

As a capacity building initiative, the hydrocensus assessment was used as a platform to engage with DWS personnel. DWS personnel from the regions and head office assembled in Bloemfontein on 25 April 2022 together with hydrogeologists from JG Afrika. The team proceeded with a meeting prior to conducting field visits to monitoring boreholes. Refer to **Annexure D** for attendance register.

The objectives of the capacity building initiative are as follows:

- To formalise the team of groundwater stakeholders
- To bring everyone up to speed and involved with the groundwater Reserve process
- To gain an understanding of institutional arrangements and challenges
- To seek ways to synergize activities between the regions and service provider for mutual benefit

The engagement with DWS personnel allowed for detailed discussions relating to the High Confidence Reserve Determination Study (Figure 9 & Figure 10). The discussions focussed on several key elements as follows:

- Data requirements and future data collection
- Regional office duties and database management
- Existing and future groundwater licenses and compliance monitoring
- Groundwater supply at towns and the responsibility of the Water Services Provider to comply with groundwater monitoring and reporting

Figure 9: The team at UO-BH-01 north of Bloemfontein

Figure 10: Groundwater monitoring in Petrusburg

6. CONCLUSIONS

This report details the findings of the Groundwater Survey conducted in the Upper Orange catchment. The Groundwater Survey was required as part of the broader Terms of Reference for the High Confidence Reserve Determination Study for the Upper Orange catchment. A hydrocensus, which focussed on existing groundwater resources in the catchment, was undertaken from 25 April 2022 to 29 April 2022. The hydrocensus involved site visits to selected groundwater monitoring sites.

The Groundwater Survey produced the following key results:

1) The status of existing borehole infrastructure and groundwater monitoring was verified. This allows for improved planning for future data collection.
2) Institutional arrangements relating to data collection and data management are better understood. Although the regional offices conduct their own monitoring, the data management is sometimes poor due to shortage in dedicated geohydrology personnel. This results in data not always getting to the databases.
3) The regional offices have limited communication with Water Services Providers. As such the regions have limited knowledge of the status of groundwater monitoring at municipal level. However this also presents an opportunity for future engagement with Water Services Providers to acquire data.
4) Data collected at groundwater monitoring resources indicate very good groundwater quality in the catchment. Using EC as a groundwater quality indicator, EC levels reported to be below the SANS241 upper aesthetic limit of 170mS/m at all boreholes. The observed EC levels is classified as a Class I water (i.e., good) when compared to domestic water supply guidelines. It was also noted that the south-eastern region (GRU7) reported relatively lower EC compared to southwestern region (GRU10). The northern region (GRU14, GRU5, GRU4, and GRU3) of the catchment has the highest EC.

   ORP is a measure of the tendency of a chemical species to acquire electron from or lose electron to an electrode and thereby be reduced or oxidised respectively. A high ORP reading indicates the presence of an oxidizing agent, whereas a low reading indicates a reducing agent. In general, the higher the ORP value the healthier the groundwater quality and lower ORP readings are likely to indicate poorer quality or contaminated groundwater. ORP measurements in the catchment range from 21 to 154 millivolts. Boreholes in the southwest have lower ORP while boreholes towards the southeast have relatively higher ORP levels. However, stream UO-STREAM-01 has lower ORP; this may be a result of surface water being exposed to livestock grazing and drinking, which poses a risk for contamination. pH at all boreholes is within the SAN241 operational range of 5.0 – 9.7. The measured pH varies from 7.3-7.6.

   The measured water levels vary between 0.33mbgl to 10.61mbgl. No clear spatial trend in water levels is visible at this stage.

Based on the outcome of the Groundwater Survey, the High Confidence Reserve Determination study presents potential opportunities to improve certain key areas. This includes the support and guidance with the implementation of the regional groundwater monitoring programme and enforcement of compliance of water use licenses.

7. RECOMMENDATIONS

Based on the results of the Groundwater Survey, the following are recommended:

- Establish and implement an improved Regional Groundwater Monitoring Plan
- Acquire all monitoring data from the regional offices that is currently not in the DWS databases
- Conduct a follow up on compliance of groundwater use licenses
- Engage with Water Services Providers to provide groundwater monitoring information

Annexure A – Hydstra Data

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
C5N0011	-	C52G	Borehole	-28.86330	25.96667	-	-	-
C5N0012	-	C52G	Borehole	-28.85420	26.03889	-	-	-
C5N0015	-	C51H	Borehole	-29.75810	25.42917	-	-	-
C5N0500	-	C52J	Borehole	-29.14420	25.80806	-	-	-
C5N0502	-	C52J	Borehole	-29.14420	25.80833	-	-	-
C5N0503	-	C52J	Borehole	-29.14440	25.80806	-	-	-
C5N0504	-	C52J	Borehole	-29.14500	25.81167	-	-	-
C5N0505	-	C52J	Borehole	-29.14500	25.81167	-	-	-
C5N0506	-	C52H	Borehole	-29.0064	26.05417	-	-	-
C5N0507	-	C52F	Borehole	-29.10310	26.27667	-	-	-
C5N0508	-	C52H	Borehole	-29.06170	26.05417	-	-	-
C5N0509	-	C52H	Borehole	-29.06170	26.09917	-	-	-
C5N0510	-	C52H	Borehole	-29.11080	26.13306	-	-	-
C5N0511	-	C52H	Borehole	-29.0350	26.07139	-	-	-
C5N0512	-	C52H	Borehole	-29.07440	26.12222	-	-	-
C5N0515	-	C52F	Borehole	-29.16670	26.33306	-	-	-
C5N0516	-	C52F	Borehole	-29.19810	26.27694	-	-	-
C5N0517	-	C52D	Borehole	-29.11940	26.51667	-	-	-
C5N0518	-	C52F	Borehole	-29.10420	26.27083	-	-	-
C5N0519	-	C52F	Borehole	-29.13890	26.28583	-	-	-
C5N0520	-	C52H	Borehole	-29.05780	26.1375	-	-	-
C5N0522	-	C52H	Borehole	-29.05670	26.125	-	-	-
C5N0523	-	C52H	Borehole	-28.67220	25.76806	-	-	-
C5N0524	-	C52A	Borehole	-29.57330	26.67944	-	-	-
C5N0525	-	C52A	Borehole	-29.57720	26.67583	-	-	-
C5N0526	-	C51J	Borehole	-29.75000	25.31667	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
C5N0527	-	C51J	Borehole	-29.74920	25.31667	-	-	-
C5N0528	-	C51J	Borehole	-29.74810	25.32722	-	-	-
C5N0529	-	C51G	Borehole	-30.03310	25.76667	-	-	-
C5N0530	-	C51G	Borehole	-30.03310	25.78306	-	-	-
C5N0531	-	C51G	Borehole	-30.03030	25.79250	-	-	-
C5N0532	-	C51G	Borehole	-30.03030	25.79250	-	-	-
C5N0533	-	C51G	Borehole	-30.03030	25.79250	-	-	-
C5N0534	-	C51A	Borehole	-29.65420	26.18694	-	-	-
C5N0535	-	C51A	Borehole	-29.65420	26.18694	-	-	-
C5N0536	-	C51A	Borehole	-29.65420	26.18722	-	-	-
C5N0537	-	C51A	Borehole	-29.65420	26.18694	-	-	-
C5N0538	-	C51A	Borehole	-29.65420	26.18722	-	-	-
C5N0539	-	C51A	Borehole	-29.65420	26.18694	-	-	-
C5N0540	-	C51A	Borehole	-29.65420	26.18306	-	-	-
C5N0541	-	C51A	Borehole	-29.65420	26.17500	-	-	-
C5N0543	-	C51A	Borehole	-29.65420	26.16667	-	-	-
C5N0544	-	C51A	Borehole	-29.65420	26.18694	-	-	-
C5N0546	-	C51A	Borehole	-29.65420	26.18306	-	-	-
C5N0601	-	C51K	Borehole	-29.16310	24.70778	-	-	-
C5N0602	-	C51K	Borehole	-29.16080	24.72056	-	-	-
C5N0604	-	C51K	Borehole	-29.15670	24.69611	-	-	-
C5N0605	-	C51K	Borehole	-29.16690	24.72167	-	-	-
C5N0606	-	C51K	Borehole	-29.15190	24.71333	-	-	-
C5N0607	-	C51K	Borehole	-29.16330	24.71083	-	-	-
C5N0608	-	C51K	Borehole	-29.15970	24.71278	-	-	-
C5N0609	-	C51K	Borehole	-29.16920	24.72028	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
C5N0612	-	C52K	Borehole	-29.19810	25.55833	-	-	-
C5N0621	-	C52L	Borehole	-28.78420	24.77528	-	-	-
C5N0622	-	C52L	Borehole	-28.78690	24.78028	-	-	-
C5N0623	-	C52K	Borehole	-28.87450	25.667	-	-	-
C5N0624	-	C52K	Borehole	-28.90990	25.6613	-	-	-
C5N0625	-	C52J	Borehole	-29.28130	25.9933	-	-	-
C5N0626	-	C52J	Borehole	-29.17430	26.1231	-	-	-
C5N0627	-	C52J	Borehole	-29.29770	25.7705	-	-	-
C5N0628	-	C52G	Borehole	-29.00680	26.2213	-	-	-
C5N0639	-	C52K	Borehole	-29.18390	25.4105	-	-	-
C5N0640	-	C52K	Borehole	-29.15690	25.6961	-	-	-
C5N0641	-	C52K	Borehole	-29.12720	25.4385	-	-	-
C5N0642	-	C52K	Borehole	-29.11840	25.4298	-	-	-
C5N0643	-	C52K	Borehole	-29.10290	25.3829	-	-	-
C5N0644	-	C52K	Borehole	-29.09000	25.6126	-	-	-
D1N0003	-	D13H	Borehole	-31.37420	27.04194	-	-	-
D1N0004	-	D13H	Borehole	-31.37310	27.04167	-	-	-
D1N0005	-	D13H	Borehole	-31.34920	27.04111	-	-	-
D3N0001	-	D35G	Borehole	-31.08580	25.73083	-	-	-
D3N0002	-	D35G	Borehole	-31.08390	25.73167	-	-	-
D3N0004	-	D35J	Borehole	-30.94030	25.47472	-	-	-
D3N0005	-	D35D	Borehole	-31.1225	25.73778	-	-	-
D3N0006	-	D35G	Borehole	-31.0628	25.73306	-	-	-
D3N0007	-	D35G	Borehole	-31.0542	25.73583	-	-	-
D3N0008	-	D35G	Borehole	-31.045	25.7325	-	-	-
D3N0009	-	D35G	Borehole	-31.0344	25.72556	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
D3N0010	-	D35G	Borehole	-31.0825	25.72917	-	-	-
D3N0011	-	D35G	Borehole	-31.0456	25.725	-	-	-
D3N0012	-	D35G	Borehole	-31.0417	25.70694	-	-	-
D3N0013	-	D35G	Borehole	-31.0417	25.70694	-	-	-
D3N0015	-	D35G	Borehole	-31.0778	25.71389	-	-	-
D3N0016	-	D35G	Borehole	-31.0731	25.71028	-	-	-
D3N0017	-	D35G	Borehole	-31.0839	25.72	-	-	-
D3N0018	-	D35J	Borehole	-30.9403	25.47472	-	-	-
D3N0019	-	D35J	Borehole	-31.0858	25.72167	-	-	-
D3N0020	-	D35G	Borehole	-31.0778	25.71667	-	-	-
D3N0021	-	D35D	Borehole	-31.1831	25.72	-	-	-
D3N0022	-	D35D	Borehole	-31.1667	25.71306	-	-	-
D3N0023	-	D35D	Borehole	-31.1317	25.70694	-	-	-
D3N0024	-	D35D	Borehole	-31.1831	25.69639	-	-	-
D3N0025	-	D35D	Borehole	-31.1833	25.70889	-	-	-
D3N0026	-	D35D	Borehole	-31.1831	25.70417	-	-	-
D3N0027	-	D35D	Borehole	-31.1917	25.76944	-	-	-
D3N0028	-	D35D	Borehole	-31.1917	25.76944	-	-	-
D3N0030	-	D35D	Borehole	-31.1833	25.74528	-	-	-
D3N0031	-	D35D	Borehole	-31.18	25.74639	-	-	-
D3N0032	-	D35D	Borehole	-31.195	25.74167	-	-	-
D3N0034	-	D35G	Borehole	-30.7892	25.77194	-	-	-
D3N0035	-	D35G	Borehole	-30.7867	25.76917	-	-	-
D3N0036	-	D35G	Borehole	-30.7881	25.76694	-	-	-
D3N0037	-	D35G	Borehole	-30.7889	25.76167	-	-	-
D3N0038	-	D35G	Borehole	-30.7756	25.75139	-	-	-

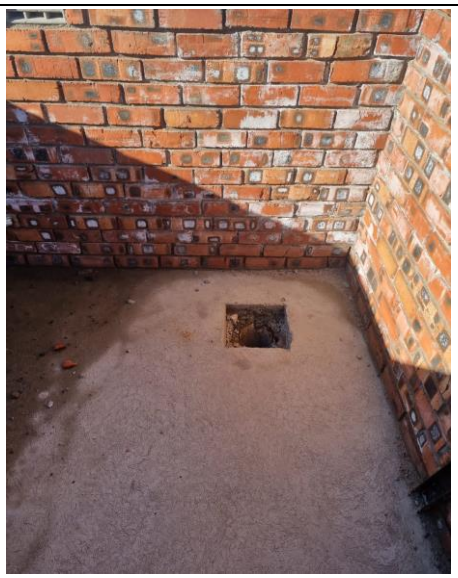
BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
D3N0039	-	D35G	Borehole	-30.8278	25.77667	-	-	-
D3N0040	-	D35G	Borehole	-30.8167	25.76528	-	-	-
D3N0041	-	D35G	Borehole	-30.8164	25.77278	-	-	-
D3N0042	-	D35G	Borehole	-30.8217	25.75778	-	-	-
D3N0043	-	D35G	Borehole	-30.8056	25.75139	-	-	-
D3N0044	-	D35G	Borehole	-30.8228	25.74278	-	-	-
D3N0045	-	D35G	Borehole	-30.85	25.76667	-	-	-
D3N0046	-	D35G	Borehole	-30.8625	25.75806	-	-	-
D3N0047	-	D35G	Borehole	-30.8792	25.775	-	-	-
D3N0048	-	D35G	Borehole	-30.8831	25.77917	-	-	-
D3N0049	-	D35G	Borehole	-30.8831	25.775	-	-	-
D3N0050	-	D35G	Borehole	-30.8831	25.70806	-	-	-
D3N0051	-	D35G	Borehole	-30.9081	25.77056	-	-	-
D3N0052	-	D35G	Borehole	-30.97500	25.75416	-	-	-
D3N0053	-	D35G	Borehole	-30.9792	25.7417	-	-	-
D3N0054	-	D35G	Borehole	-30.975	25.7417	-	-	-
D3N0055	-	D35G	Borehole	-30.9831	25.7542	-	-	-
D3N0056	-	D35G	Borehole	-30.9831	25.7417	-	-	-
D3N0057	-	D35G	Borehole	-30.9875	25.75	-	-	-
D3N0061	-	D35K	Borehole	-30.6917	25.7581	-	-	-
D3N0063	-	D35K	Borehole	-30.6956	25.7417	-	-	-
D3N0067	-	D35H	Borehole	-30.6956	25.7733	-	-	-
D3N0069	-	D35G	Borehole	-30.8783	25.7869	-	-	-
D3N0078	-	D35K	Borehole	-30.6889	25.7578	-	-	-
D3N0080	-	D35K	Borehole	-30.6889	25.7578	-	-	-
D3N0081	-	D34F	Borehole	-30.7578	25.1461	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
D3N0082	-	D34F	Borehole	-30.7594	25.1425	-	-	-
D3N0083	-	D34F	Borehole	-30.7508	25.1356	-	-	-
D3N0084	-	D34F	Borehole	-30.7153	25.1389	-	-	-
D3N0116	-	D32G	Borehole	-31.2067	24.9744	-	-	-
D3N0118	-	D32G	Borehole	-31.2228	24.9794	-	-	-
D3N0119	-	D32G	Borehole	-31.2278	24.9806	-	-	-
D3N0120	-	D32G	Borehole	-31.2169	24.9778	-	-	-
D3N0121	-	D32G	Borehole	-31.2014	24.9756	-	-	-
D3N0122	-	D32G	Borehole	-31.2017	24.975	-	-	-
D3N0123	-	D32G	Borehole	-31.2028	24.975	-	-	-
D3N0124	-	D32G	Borehole	-31.2031	24.975	-	-	-
D3N0125	-	D32G	Borehole	-31.2064	24.9758	-	-	-
D3N0126	-	D32G	Borehole	-31.2039	24.9781	-	-	-
D3N0127	-	D32G	Borehole	-31.2075	24.9775	-	-	-
D3N0128	-	D32G	Borehole	-31.2056	24.9769	-	-	-
D3N0131	-	D32G	Borehole	-31.2028	24.9764	-	-	-
D3N0132	-	D32G	Borehole	-31.2003	24.9767	-	-	-
D3N0133	-	D32G	Borehole	-31.2028	24.9758	-	-	-
D3N0500	-	D32G	Borehole	-31.185	24.9772	-	-	-
D3N0501	-	D32G	Borehole	-31.22	24.9797	-	-	-
D3N0502	-	D32G	Borehole	-31.1878	24.9417	-	-	-
D3N0503	-	D32G	Borehole	-31.1881	24.9417	-	-	-
D3N0507	-	D35G	Borehole	-30.8783	25.7869	-	-	-
D3N0511	-	D35H	Borehole	-30.6903	25.7633	-	-	-
D3N0512	-	D35H	Borehole	-30.6903	25.7633	-	-	-
D3N0513	-	D35H	Borehole	-30.6906	25.7631	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
D3N0514	-	D35H	Borehole	-30.6903	25.7633	-	-	-
D3N0517	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0518	-	D34F	Borehole	-30.7214	25.0786	-	-	-
D3N0519	-	D34F	Borehole	-30.7586	25.1333	-	-	-
D3N0520	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0521	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0522	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0523	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0524	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0525	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0526	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0527	-	D34F	Borehole	-30.725	25.0942	-	-	-
D3N0528	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0529	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0530	-	D34F	Borehole	-30.7278	25.0914	-	-	-
D3N0531	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0534	-	D34F	Borehole	-30.7269	25.1014	-	-	-
D3N0536	-	D35G	Borehole	-30.8831	25.7836	-	-	-
D3N0538	-	D35H	Borehole	-30.6906	25.7631	-	-	-
D3N0539	-	D35G	Borehole	-30.8831	25.7836	-	-	-
D3N0540	-	D35H	Borehole	-30.6903	25.7633	-	-	-
D3N0543	-	D35G	Borehole	-30.8783	25.7869	-	-	-
D3N0544	-	D34G	Borehole	-30.2581	25.2806	-	-	-
D3N0545	-	D35G	Borehole	-30.8836	25.7831	-	-	-
D3N0546	-	D33A	Borehole	-30.0606	24.6747	-	-	-
D3N0547	-	D33A	Borehole	-30.0681	24.6803	-	-	-

BH Identifier	Alternative Identifier	Quaternary Catchment	Type	Latitude	Longitude	Depth (mbgl)	Discharge (l/s)	Water Level (mbgl)
D3N0548	-	D33A	Borehole	-30.0811	24.6933	-	-	-
D3N0549	-	D33A	Borehole	-30.0925	24.6972	-	-	-
D3N0550	-	D33A	Borehole	-30.0897	24.6539	-	-	-
D3N0551	-	D33A	Borehole	-30.0889	24.6561	-	-	-
D3N0557	-	D32G	Borehole	-30.7333	24.1831	-	-	-
D3N0558	-	D32F	Borehole	-30.7167	24.1167	-	-	-
D3N0571	-	D32F	Borehole	-31.1452	24.2891	-	-	-
D3N0572	-	D32F	Borehole	-31.0498	24.4311	-	-	-
D3N0573	-	D32F	Borehole	-31.0791	24.399	-	-	-
D3N0574	-	D32F	Borehole	-31.0776	24.3614	-	-	-
D3N0575	-	D32F	Borehole	-31.1077	24.3991	-	-	-
Q1N0041	-	D32B	Borehole	-31.5531	24.5233	-	-	-

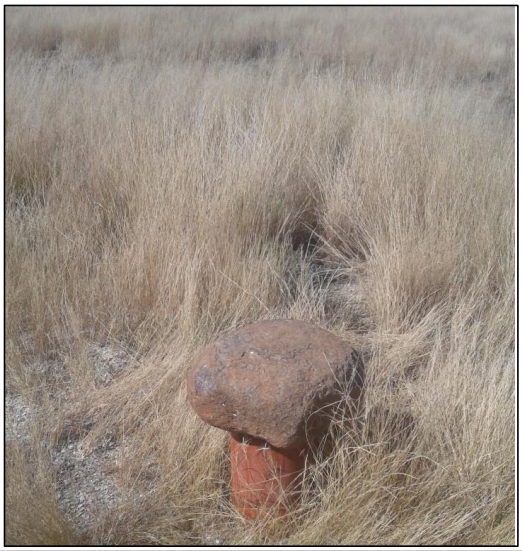
Annexure B – Hydrocensus Data

GROUNDWATER RESOURCES		
Resource ID	**UO-BH-01**	
Latitude	-29.00668	
Longitude	26.22134	
Resource Type	Borehole	
Alternative ID No	C5N0628	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	7.4	
Final Depth	63.64	
Discharge Rate	Unkown	
Equipment	None	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-02**	
Latitude	-29.11841	
Longitude	25.43976	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	6.1	
Final Depth	17.25	
Discharge Rate	Unkown	
Equipment	None	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-03**	
Latitude	-29.11819	
Longitude	2543551	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Not in use	
Depth to GW	6.4	
Final Depth	-	
Discharge Rate	-	
Equipment	None	
Comments	Borehole owned by municipality and is blocked, Borehole destroyed.	

GROUNDWATER RESOURCES		
Resource ID	**UO-BH-04**	
Latitude	-28.59433	
Longitude	25.59156	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	0.82	
Final Depth	58.4	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring. Borehoele is located in private property.	
Resource ID	**UO-BH-05**	
Latitude	-28.68591	
Longitude	25.75362	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	2.92	
Final Depth	60	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-06**	
Latitude	-29.10295	
Longitude	25.38289	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	4.93	
Final Depth	34.76	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring. Borehoele is located in private property.	

GROUNDWATER RESOURCES		
Resource ID	**UO-BH-07**	
Latitude	-29.12718	
Longitude	2543851	
Resource Type	Borehole	
Alternative ID No	C5N0641	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	6.13	
Final Depth	38.8	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-08**	
Latitude	-29.40719	
Longitude	25.1071	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	-	
Final Depth	-	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole owned by the Municipality and used for groundwater level monitoring & blocked	
Resource ID	**UO-BH-09**	
Latitude	-29.16019	
Longitude	24.71239	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	4.2	
Final Depth	60	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	

GROUNDWATER RESOURCES		
Resource ID	**UO-PVT-BH-10**	
Latitude	-29.15995	
Longitude	24.71268	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Standby for Irrigation	
Depth to GW	4.00	
Final Depth	18.64	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for irrigation during very dry season.	
Resource ID	**UO-BH-11**	
Latitude	-31.0498	
Longitude	24.43106	
Resource Type	Borehole	
Alternative ID No	D3N0572	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	60.00	
Final Depth	3.51	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-12**	
Latitude	-31.07757	
Longitude	24.36136	
Resource Type	Borehole	
Alternative ID No	D3N0574	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	0.00	
Final Depth	50.63	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	

GROUNDWATER RESOURCES		
Resource ID	**UO-BH-13**	
Latitude	-31.07901	
Longitude	24.39899	
Resource Type	Borehole	
Alternative ID No	D3N573	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	10.61	
Final Depth	50.63	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring, no sampling was conducted because boreholes is capped.	
Resource ID	**UO-BH-14**	
Latitude	-31.10766	
Longitude	24.3995	
Resource Type	Borehole	
Alternative ID No	D3N0575	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	6.55	
Final Depth	61.56	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-15**	
Latitude	-31.14517	
Longitude	24.2891	
Resource Type	Borehole	
Alternative ID No	D3N0571	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	5.33	
Final Depth	60.01	
Discharge Rate	Unkown	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	

GROUNDWATER RESOURCES		
Resource ID	**UO-BH-16**	
Latitude	-31.16179	
Longitude	24.92868	
Resource Type	Borehole	
Alternative ID No	-	
Sample No.	-	
Current Use	Monitoring	
Depth to GW	3.8	
Final Depth	29.34	
Discharge Rate	-	
Equipment	none	
Comments	Borehole used for groundwater level monitoring	
Resource ID	**UO-BH-17**	
Latitude	-30.97672	
Longitude	27.59097	
Resource Type	Borehole	
Alternative ID No	EC-D13-094	
Sample No.	-	
Current Use	Not in use	
Depth to GW	Unknown	
Final Depth	Unknown	
Discharge Rate	Unknown	
Equipment	Submersible Pump	
Comments	Borehole owned by municipality is used to agument water supply for local community, Borehole control box has been destroyed. However submersible pump still installed	
Resource ID	**UO-BH-18**	
Latitude	-3.97812	
Longitude	27.59124	
Resource Type	Borehole	
Alternative ID No	EC-D13-095	
Sample No.	-	
Current Use	Not in use	
Depth to GW	Unknown	
Final Depth	Unknown	
Discharge Rate	Unknown	
Equipment	Submersible Pump	
Comments	Borehole owned by municipality is used to agument water supply for local community, Borehole control box has been destroyed. However submersible pump still installed	

GROUNDWATER RESOURCES	
Resource ID	**UO-BH-19**
Latitude	-30.97303
Longitude	24.58939
Resource Type	Borehole
Alternative ID No	-
Sample No.	-
Current Use	Not in use
Depth to GW	Unknown
Final Depth	Unknown
Discharge Rate	Unknown
Equipment	Submersible Pump
Comments	Borehole owned by municipality is used to agument water supply for local community, Borehole control box has been destroyed. However submersible pump still installed

SURFACE WATER RESOURCES	
Resource ID	**UO-WETLAND-01**
Latitude	-31.08393
Longitude	24.36317
Resource Type	Wetland
Alternative ID No	-
Sample No.	-
Current Use	None
Depth to GW	-
Final Depth	-
Discharge Rate	-
Equipment	-
Comments	Wetland dries up in the dry season. Water source potentially give an indication of baselfow contributingbto ground water

Resource ID	**OU- STREAM-01**
Latitude	-30.97303
Longitude	27.58864
Resource Type	None Parenial Stream
Alternative ID No	-
Sample No.	-
Current Use	Live stock
Depth to GW	-
Final Depth	-
Discharge Rate	-
Equipment	-
Comments	Stream Is a non parenial stream.aproximatley 50m away from UO-BH-19

Annexure C – Hydrocensus Survey Sheets

HYDROCENSUS SURVEY

Project Name	Upper Orange Reserve Determination
Project Description	High Confidence Reserve Determination
Project Number	5634
Village/Community Name	Grondwater Reserve Unit 3, 4, 5, 14

Site Description

Topography		Soil Cover		Geology		Aquifer Impact		Current Water Supply		Existing Pollution		Groundwater Potential	
Flat	x	Sandy	x	Dolerite	X	Primary		Groundwater	x	None	x	Low	
Steep		Silty	x	Mudstone	x	Secondary	X	Springs		Sanitation		Moderate	x
Ridge		Clayey	x	Shale		Shallow Fractured	X	River	x	Petrol Station		Good	
Slope		Rock Outcrop %		Tillite		Deep Fractured		Bulk	x	Industry			
Elevated		Est. Thickness		Sandstone	x	Other		Tanker		Cemetery			
Valley				Granite / Gneiss				Reticulation	x	Other			
Other				Other	X			Other					

Community Survey Notes

Hydrocensus

Survey Number	Resource Nr.	South (d,d)	East (d,d)	Type	Status	Equip	Depth (m)	Water Level (m)	Sample Number	Comments
		0.00000°	0.00000°							
1	UO-BU-01	-29.00668	26.22134	BH	IN USE	NONE	63.34	7.4	-	Monitoring Borehole
2	UO-BU-02	-29.11841	25.43976	BH	IN USE	NONE	17.25	6.1	-	Monitoring Borehole
3	UO-BU-03	-29.11819	25.43551	BH	NOT IN USE	NONE	-	6.4	-	Blocked and Destroyed
4	UO-BU-04	-28.59433	25.59156	BH	IN USE	NONE	58.4	0.8	-	Monitoring Borehole
5	UO-BU-05	-28.68591	25.75362	BH	IN USE	NONE	60	2.92	-	Monitoring Borehole
6	UO-BU-06	-29.10295	-29.10295	BH	IN USE	NONE	34.76	493	-	Monitoring Borehole
7	UO-BU-07	29.12718	29.12718	BH	IN USE	NONE	38.8	6.13	-	Monitoring Borehole
8	UO-BU-08	-29.40719	27.01071	BH	NOT IN USE	NONE	-	-	-	Monitoring Borehole
9	UO-BU-09	-29.16019	24.71239	BH	IN USE	NONE	60	4.2	-	Monitoring Borehole
10	UO-PVT-BH-01	-29.15995	24.71268	BH	IN USE		18.64	4	-	Irrigation

Hydrocensus Notes

Boreholes are all HYDSTRA groundwater resources and are used for groundwater monitoring purposes, with an exception of borehole UO-PVT-BH-01.

KEY		
Type	Status	Equip
spring	in use	none
bh	not used	hand pump
	destroyed	submersible
		other

Community Representative Name		Survey Representative Name	
Community Representative Signature		Survey Representative Signature	
		Survey Date	25/04/2022 to 27/04/2022

HYDROCENSUS SURVEY

Project Name	Upper Orange Reserve Determination
Project Description	High Confidence Reserve Determination
Project Number	5634
Village/Community Name	Grondwater Reserve Unit 7

Site Description

Topography		Soil Cover		Geology		Aquifer Impact		Current Water Supply		Existing Pollution		Groundwater Potential	
Flat		Sandy	x	Dolerite		Primary		Groundwater	x	None	x	Low	
Steep		Silty	x	Mudstone	x	Secondary	X	Springs		Sanitation		Moderate	
Ridge		Clayey		Shale		Shallow Fractured	X	River	x	Petrol Station		Good	x
Slope	x	Rock Outcrop %		Tillite		Deep Fractured		Bulk	x	Industry			
Elevated	x	Est. Thickness		Sandstone	x	Other		Tanker		Cemetery			
Valley	x			Granite / Gneiss				Reticulation	x	Other			
Other				Other	X			Other					

Community Survey Notes

Hydrocensus

Survey Number	Resource Nr.	South (d,d) 0.00000°	East (d,d) 0.00000°	Type	Status	Equip	Depth (m)	Water Level (m)	Sample Number	Comments
1	UO-BH-17	-30.97672	27.59097	BH	NOT IN USE	Sub Pump			-	Borehole Control box destroyed Municipal Borehole
2	UO-BH-18	-30.97812	27.59124	BH	NOT IN USE	Sub Pump	-	-	-	Borehole Control box destroyed Municipal Borehole
3	UO-BH-19	-30.97332	27.58939	BH	NOT IN USE	Sub Pump	-	-	-	Borehole Control box destroyed Municipal Borehole
4	UO-STREAM-21	-30.97303	27.58864	STRM	-	-	-	-	-	Stream is Semi-Parenial

Hydrocensus Notes

None of the boreholes are in use . Electrical supply control boxes have been destroyed, however borehole submersible pumps are still intact. Boreholes are used to agument water supply for the community residents.

KEY		
Type	Status	Equip
spring	in use	none
bh	not used	hand pump
WL	destroyed	submersible
STRM		
		other

Community Representative Name		Survey Representative Name	
Community Representative Signature		Survey Representative Signature	
		Survey Date	29/04/2022

HYDROCENSUS SURVEY

Project Name	Upper Orange Reserve Determination
Project Description	High Confidence Reserve Determination
Project Number	5634
Village/Community Name	Grondwater Reserve Unit 10

Site Description

Topography		Soil Cover		Geology		Aquifer Impact		Current Water Supply		Existing Pollution		Groundwater Potential	
Flat	X	Sandy	X	Dolerite		Primary		Groundwater	X	None	X	Low	
Steep		Silty	X	Mudstone	X	Secondary	X	Springs		Sanitation		Moderate	X
Ridge		Clayey	X	Shale		Shallow Fractured	X	River	X	Petrol Station		Good	
Slope		Rock Outcrop %		Tillite		Deep Fractured		Bulk	X	Industry			
Elevated		Est. Thickness		Sandstone	X	Other		Tanker		Cemetery			
Valley				Granite / Gneiss				Reticulation	X	Other			
Other				Other	X			Other					

Community Survey Notes

Hydrocensus

Survey Number	Resource Nr.	South (d,d) 0.00000°	East (d,d) 0.00000°	Type	Status	Equip	Depth (m)	Water Level (m)	Sample Number	Comments
1	UO-BH-11	-31.0498	24.43106	BH	IN USE	NONE	60	3.51	-	Monitoring Borehole
2	UO-BH-12	-31.07757	24.36136	BH	IN USE	NONE	50.63	0.33	-	Monitoring Borehole
3	UO-BH-13	-31.07901	24.39899	BH	IN USE	NONE	61.56	10.61	-	Capped
4	UO-BH-14	-31.10766	24.3995	BH	IN USE	NONE	60	6.55	-	Monitoring Borehole
5	UO-BH-15	-31.14517	24.2891	BH	IN USE	NONE	29.34	5.33	-	Monitoring Borehole
6	UO-BH-16	-31.16179	24.92868	BH	IN USE	NONE	29.34	3.8	-	Monitoring Borehole
6	UO-WETLAND-01	-31.08393	24.36317	WL	-	-	-	-	-	Wetland dries up in Dry season

Hydrocensus Notes

Boreholes are used for groundwater monitoring purposes. Wetland dries up during dry season.

KEY		
Type	Status	Equip
spring	in use	none
bh	not used	hand pump
WL	destroyed	submersible
STRM		
		other

Community Representative Name		Survey Representative Name	
Community Representative Signature		Survey Representative Signature	
		Survey Date	28/04/2022

Annexure D – Meeting Attendance List

BLOEMFONTEIN DWS REGIONAL OFFICE

ATTENDANCE REGISTER

UPPER ORANGE HYDROCENSUS MEETING

NAME & SURNAME	DEPTMENT	CONTACT	SIGN	DATE
MFUNDO NTUZA	J.G AFRIKA	0661043025		25/04/25
S. Ndlovu	DWS	0734671463		25/04/2022
Ndivhuwo Hetshendelelu	DWS	0797315743		25/04/2022
Kukazi Majola	DWS	0837913575		25/04/2022
Regan Rose	JG AFRIKA	0836533637		25/04/2022
M'Fundi Biyela	DWS - FS	0825563262		25/04/2022