GEOHYDROLOGICAL REPORT

June 2026

GEOHYDROLOGICAL INVESTIGATION FOR PROPOSED WASTEWATER TREATMENT WORKS, WARRENTON NORTHERN CAPE PROVINCE.

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Declaration:

I act as an independent, professionally registered Geohydrologist for this proposed project requiring geohydrological services. Work relating to the project will be conducted in an objective manner, even if this results in views and findings that are not favourable to the applicant.

I have no, and will not engage in, conflicting interests in the undertaking of the activity. I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed.

Project Name:	GEOHYDROLOGICAL INVESTIGATION FOR PROPOSED WASTEWATER TREATMENT WORKS, WARRENTON NORTHERN CAPE PROVINCE .
Date Finished:	4 June 2026
Specialist:	Dirk Moolman M.Sc Geohydrology B.Sc (Hons.) Geohydrology B.Sc Environmental Sciences SACNASP Reg. no. 115614 ………………………………………………………………….. Signature

Summary of Uncertainties, Knowledge Gaps and Limitations

1. Data Availability and Quality

- Limited Borehole Data: Many areas lack sufficient historic borehole logs, yield test data, or hydrochemical results, which restricts accurate aquifer characterization.
- Unverified Community Boreholes: Existing boreholes (especially in rural or agricultural areas) may have undocumented construction details or yield data, leading to uncertainty in resource estimation.
- Data from Government Sources: Public databases (e.g., NGA, WARMS) may contain outdated or incomplete information.
- Inconsistent Monitoring Data: Long-term groundwater level and quality monitoring records are often unavailable.

2. Geological and Hydrogeological Complexity

- Heterogeneous Aquifer Systems: Fractured rock aquifers, such as dolerite intrusions or weathered granite, display high spatial variability that is difficult to interpolate between boreholes.
- Structural Controls: Faults, dykes and other geological structures that influence groundwater flow may be inferred from mapping but not confirmed through geophysical or drilling data.
- Unmapped Features: Some areas may contain unmapped geological units or paleochannels that affect groundwater storage and flow patterns.

3. Limitations of Field Investigations

- Site Access: Restricted access to private land may prevent a full hydrocensus assessment of boreholes within the area of interest.
- Geophysical surveys provide indirect evidence of subsurface structures and potential preferential pathways; however, without confirmatory drilling and lithological logging, interpretations remain indicative rather than definitive.
- Although care was taken during the field survey to identify potential pollution sources, it is possible that some smaller or less visible sources (e.g., informal waste disposal sites, septic tanks, or agricultural chemical storage areas) were overlooked. These unrecorded sources may influence groundwater quality and represent a limitation of the current investigation.

4. Groundwater Use and Impact Prediction

- Future Abstractions: Uncertainty exists around cumulative groundwater impacts from future users not currently accounted for in the study area.
- Climate Variability: Changes in rainfall patterns, evapotranspiration, and land use may affect long-term groundwater availability and recharge, but are difficult to predict with certainty.

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Glossary of Geohydrological Terms

Geohydrological Term	Definition
Aquifer	Aquifer means a geological formation which has structures or textures that hold water or permit appreciable water movement through them,
Aquifer Testing	Aquifer testing involves the withdrawal of measured quantities of water from or the addition of water to, a borehole(s); and the measurement of resulting changes in head in the aquifer both during and after the period of abstraction or addition.
Aquitard	A saturated but poorly permeable bed, formation or group of formations that does not yield water freely to a borehole or spring,
Confined Aquifer	A formation in which the groundwater is isolated from the atmosphere at the point of discharge by impermeable geologic formations; confined groundwater is generally subject to pressure greater than atmospheric.
Contamination	The degradation of natural water quality as a result of man's activities, regardless of whether or not contaminant concentrations reach levels that cause significant degradation of water quality and restrict its use,
Dolerite Dyke	A tabular or sheet-like body of igneous rock that cuts through and across the layering of adjacent rocks.
Drawdown	Drawdown is the lowering of the water table or piezometric surface caused by the extraction of groundwater by pumping a borehole,
Effluent	Liquid waste or sewage discharge, usually discharged in rivers or the sea,
Fractured Water	Is defined as a formation that contains sufficient fractures, cracks and faults that yields economic quantities of water to boreholes and springs.
Groundwater Recharge	The addition of water to the saturated zone, infiltration of surface water and/or the lateral migration of groundwater from adjacent aquifers.
Groundwater Resource	All groundwater available for beneficial use, including man, aquatic ecosystems and greater environment.
Hydraulic Conductivity	Measure of the ease with which water will pass through the earth's material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (m/d).
Perched Aquifer	Aquifers that contain perched groundwater i.e. bodies of groundwater separated from an underlying body of groundwater by an unsaturated zone.
Porosity	Porosity is the ratio of the volume of void space to the total volume of the rock or earth material.
Preferential Flow	The preferential movement of water through more permeable zones in the subsurface.
Recharge	The addition of water to the saturated zone, either by the downward percolation of precipitation or surface water and/or the lateral migration of groundwater from adjacent aquifers.
Rest/Static Water Level	The groundwater level in a borehole not influenced by abstraction or artificial recharge.
Runoff	All surface and subsurface flow from a catchment, but in practice refers to the flow in a river i.e. excludes groundwater not discharged into a river.
Safe/Sustainable Yield	Safe yield is defined as the maximum rate of withdrawal that can be sustained by an aquifer without causing an unacceptable decline in the hydraulic head or deterioration in water quality in the aquifer.
Transmissivity	Transmissivity is the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer.
Unconfined Aquifer	An aquifer without an upper confining layer of impermeable or low permeability soil or rock material. The water table is exposed to the atmosphere through a series of interconnected openings in the overlying soil and/or rock layers and is in equilibrium with atmospheric pressure
Unsaturated Zone	That part of the geological stratum above the water table where interstices and voids contain a combination of air and water.
Vulnerability	This relates to the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. Vulnerability gives an indication of how susceptible an aquifer is to contamination.
Wellfield	A group or cluster of boreholes in an area used collectively to supply sufficient groundwater to a user or users.

1 INTRODUCTION

A geohydrological assessment is a critical component in the planning and design of a wastewater treatment works, as it provides crucial information about the geological and hydrological conditions of the site. This assessment aims to evaluate the suitability of the site for the construction and operation of the treatment works, taking into consideration factors such as groundwater flow, aquifer characteristics and groundwater quality.

The geohydrological assessment for a WWTW typically includes a detailed study of the site's geology, hydrogeology, and groundwater conditions. This involves collecting and analysing data from various sources, such as geological maps, borehole logs, groundwater level measurements, and hydraulic conductivity tests.

The assessment also considers the potential impacts of the treatment works on the surrounding environment, including the risk of groundwater contamination. This information is used to design appropriate mitigation measures to minimise these risks and ensure the long-term sustainability of the treatment works.

This geohydrological study will include the following topics:

- Geophysical investigation detecting possible preferential pathways;
- Drilling targets for upstream and downstream monitoring boreholes;
- Proposed monitoring network;
- Hydrocensus investigation;
- Chemical and Bacteriological analysis on collected hydrocensus and monitoring sites,
- Aquifer Vulnerability assessment;
- Risk Assessment;
- Geohydrological Impact assessment and
- Recommendations

2 SITE LOCATION AND GEOGRAPHICAL SETTING

2.1 SITE LOCATION

1:50 000 topographical maps are the largest maps providing full coverage of South Africa. They accurately illustrate the location of natural and man-made features by means of symbols, colour and elevation by means of spot-heights and contours (20m interval). Additional information includes place names, boundaries, etc. These maps contain essential information for planning and decision making but also have many other uses (Department of Rural Development and Land Reform 2013)

The site location is indicated on the **1:50 000 topographical map 2824BB Warrenton** in Figure 1 and Figure 2. The applicant plans to construct a new WWTW which will be situated west of the town Warrenton.

2.2 RSA DRAINAGE REGIONS & WATER MANAGEMENT AREAS (2012)

The National Water Act (Act 36 of 1998) requires the progressive development of a National Water Resource Strategy (NWRS), which provides the framework for the protection, use, development, conservation, management and control of water recourses for the country as a whole. Further, the NWRS provides the framework within which water will be managed at the regional or catchment level, within defined Water Management Areas. The purpose of this map is to give a representation of the primary, secondary, tertiary and quaternary drainage region boundaries of the Republic of South Africa. The Department of Water and Sanitation is the custodian of these boundaries and they are reviewed on an ongoing basis.

This site is located in the Northern Cape Province and falls within **Quaternary Catchment C91D** and is presented in Figure 4.

2.3 CLIMATE CONDITIONS

The climate of the Warrenton area falls within the BSh classification, characterized as arid steppe hot as illustrated in Figure 7. Warrenton is expected to receive rain mainly from December to April, over which 400 – 500mm of precipitation may occur (Figure 6). The evaporation, however, far exceeds the rainfall amount and is measured at 2600 – 2800 mm/a.

2.4 DRAINAGE

Based on the contours, river position, and topographic gradient shown in Figure 5, the regional drainage direction is generally from the south/southeast toward the north/northwest into the Vaal River.

The river valley forms the lowest elevation zone (~1135–1170 mamsl), while the irrigation and WWTW infrastructure occur on relatively elevated terrain (~1180–1200 mamsl).

Irrigation Area Drainage

The circular irrigation area is located immediately south of the Vaal River floodplain on gently sloping terrain. Surface and shallow subsurface drainage from the irrigation area will therefore predominantly drain northward, north westward and north-eastward, toward the adjacent Vaal River valley. Thus, a downstream monitoring borehole was sited north of the irrigation area.

The local gradient indicates runoff and potential seepage migration from the irrigation area would naturally move downslope toward the river corridor.

Proposed WWTW Drainage

The WWTW is positioned slightly eastwaerd of the irrigation area. Based on the contour configuration, drainage from the WWTW will predominantly flow northward to north-westwards toward the Vaal River floodplain. Thus, a monitoring borehole was sited north-westwards of the proposed WWTW.

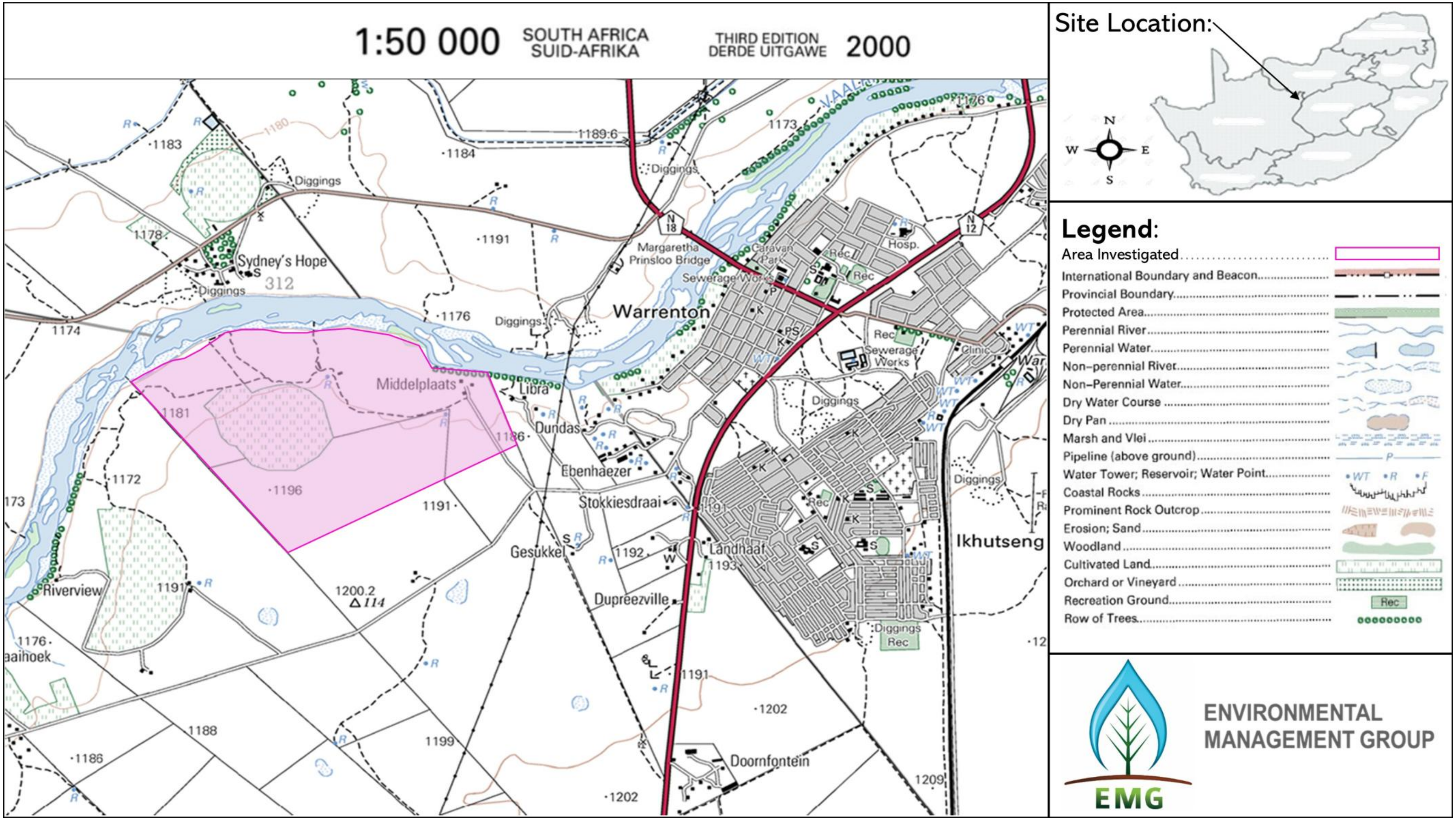

Figure 1. 1:50 000 scale topographical map, 2823DC.

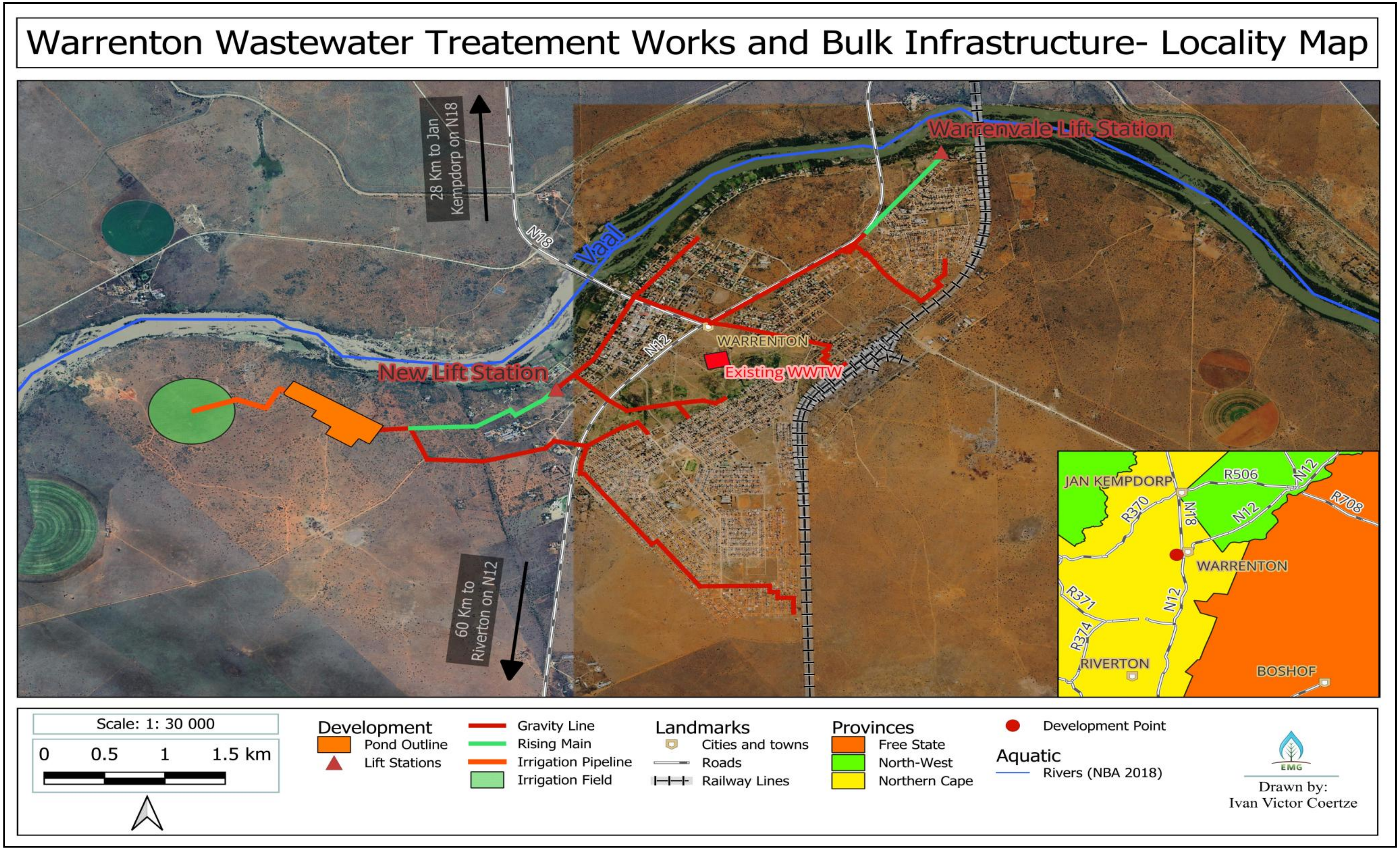

Figure 2. The locality map depicts the local area of the proposed development.

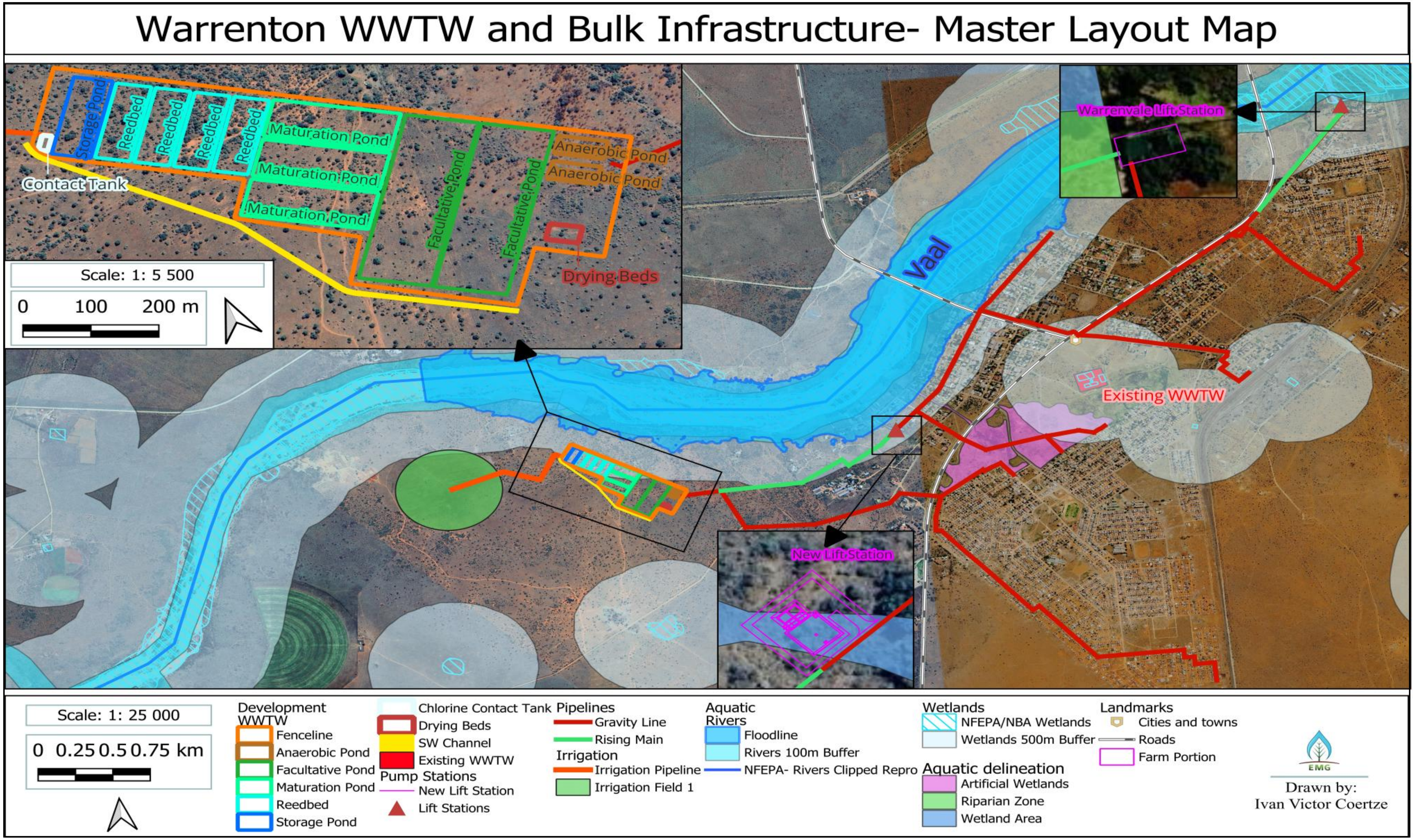

Figure 3. WWTW layout design.

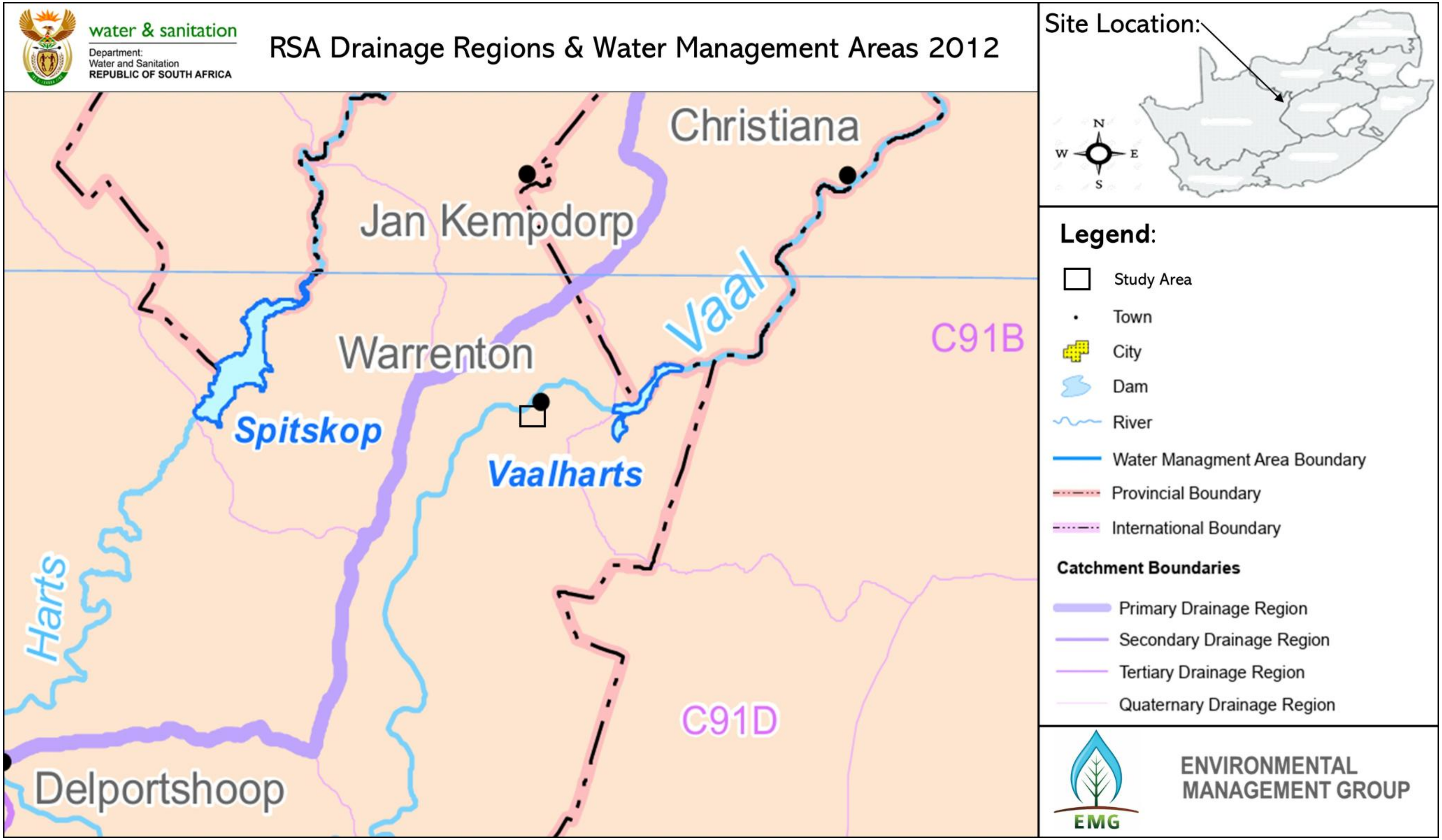

Figure 4. RSA Drainage regions & water management areas (2012).

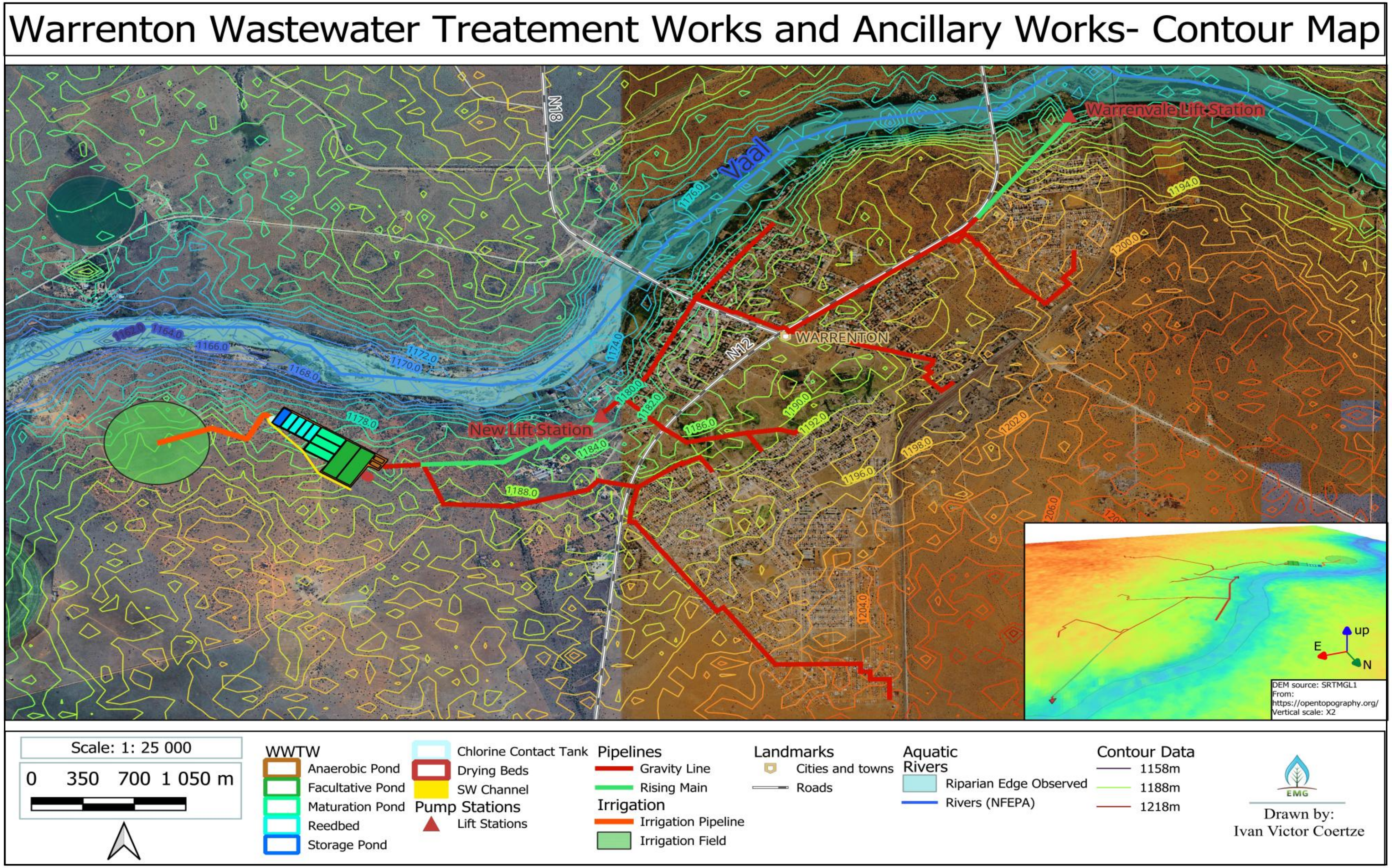

Figure 5. Local Site drainage map.

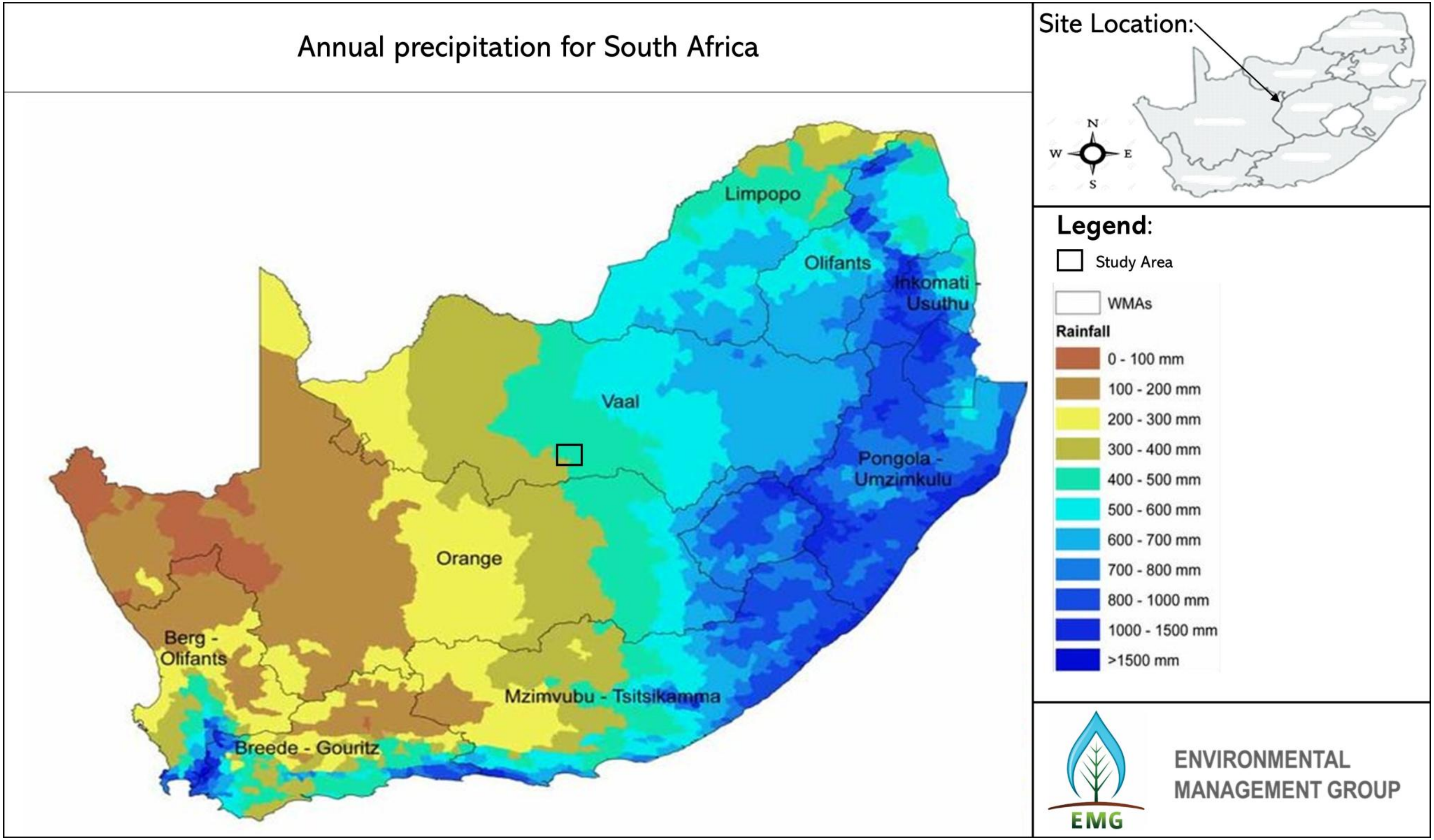

Figure 6. Map displaying South Africa's Annual Precipitation, with the designated development area delineated by a black border.

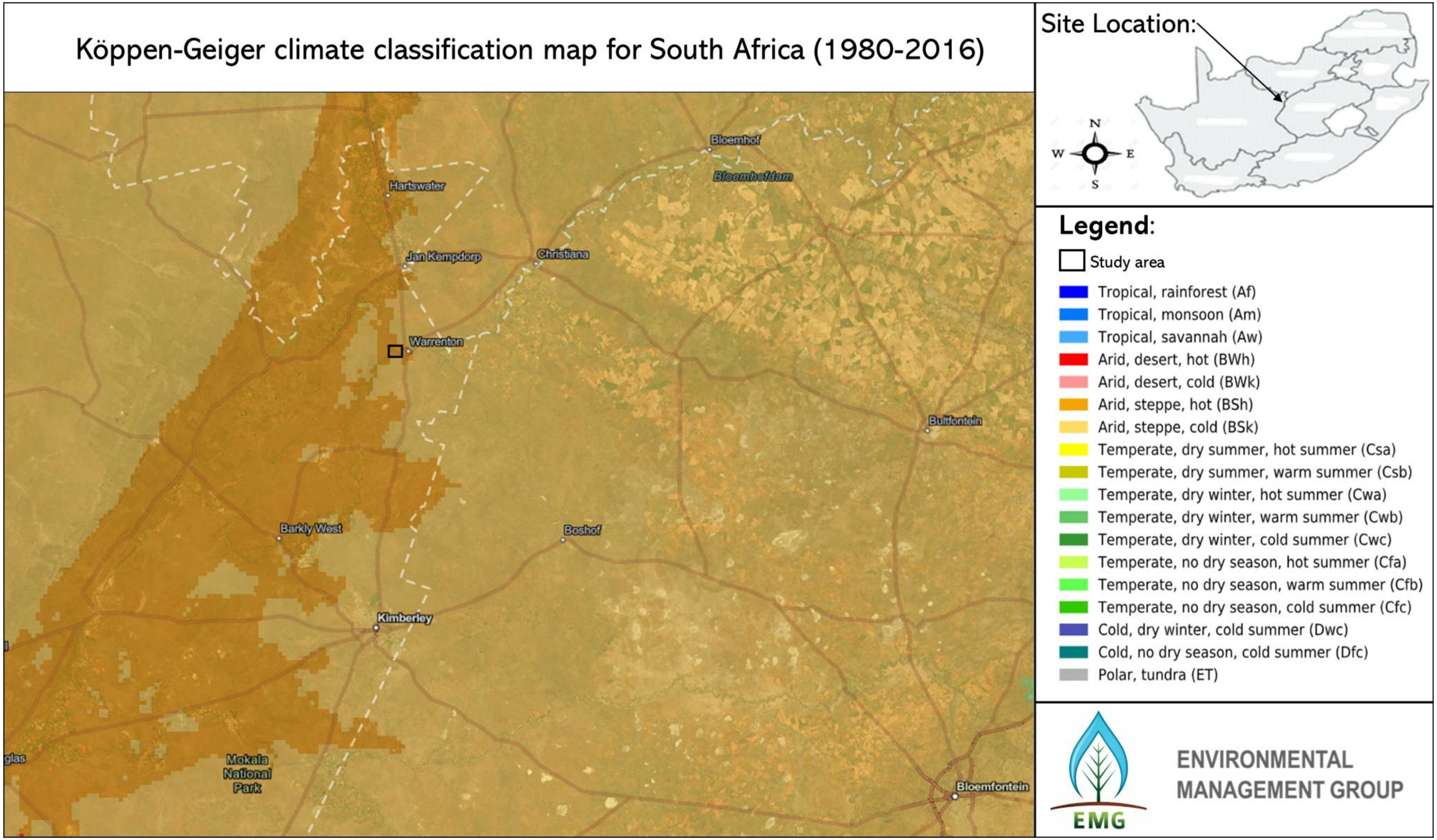

Figure 7. A map that illustrates the climate classification according to the Koppen-Geiger system from 1980 to 2016.

3 SITE GEOLOGY AND GEOHYDROLOGY

3.1 GEOLOGY

This section presents an assessment of the geology of the Warrenton region in South Africa's Northern Cape Province, which is based on the 2824 Kimberley map (Scale of 1:250,000) indicated in Figure 8. The local geology is dominated by units from the Karoo and Ventersdorp Supergroup, spanning from Neoarchean volcanic rocks to Permian sediments of the Karoo Supergroup, with younger Quaternary cover and Dolerite intrusions. These units define the region's geological framework and influence groundwater resources.

3.1.1 Local Geology

The geology of the Warrenton area is characterized by the following main units in Figure 8 (2824 Kimberley):

- Legend **RA**: Ventersdorp Supergroup, Platberg Group, Allanridge Formation

This Neoarchean (~2.7 Ga) unit consists primarily of andesite and amygdaloidal lava. The Allanridge Formation represents the uppermost volcanic sequence of the Ventersdorp Supergroup, that were formed in a rift-related large igneous province setting on the Kaapvaal Craton. These mafic to intermediate lavas are often amygdaloidal (vesicle-filled), providing secondary porosity that can enhance local groundwater storage in fractured zones.

- Legend **Ppr**: Karoo Supergroup, Dwyka Group, Prince Albert Formation

This Early Permian unit consists of shale, representing the post-glacial transgressive phase following the Late Paleozoic Ice Age. The Prince Albert Formation overlies the basal Dwyka tillites and consists of fine-grained mudrocks deposited in a marine shelf environment during the subsidence of the northern Kalahari Basin. These shales are generally impermeable but may host limited groundwater in weathered or fractured intervals.

- Legend **QC**: Quaternary Sediment

Surficial deposits include calcrete and surface limestone.

- Legend **JD**: Intrusive Dolerite (Jurassic)

Early Jurassic (~183 Ma) dolerite intrusions, part of the Karoo Large Igneous Province, occur as sills and dykes cutting through the older Ventersdorp and Karoo strata. These mafic bodies create local barriers or conduits for fluid flow and contribute to fracturing in host rocks.

3.1.2 Geological Structures

The region exhibits relatively gentle deformation, with flat lying to shallowly dipping Karoo strata overlying the older Ventersdorp volcanic rocks. Faulting associated with the Ventersdorp rift, and the Karoo basin tectonics can be present while the dolerite emplacement caused additional fracturing. Karoo Supergroup: Ecca Group (Volksrust Formation)

3.1.3 Geological Conclusion

The local geology of Warrenton, as depicted on the 2824 Kimberley map, features Neoarchean mafic-andesitic volcanics of the Allanridge Formation (Ventersdorp Supergroup). Wich is overlain by Early Permian shales of the Prince Albert Formation (Karoo Supergroup), with dolerite intrusions and Quaternary calcrete or some surface limestone cover. These rocks support moderate groundwater potential in a semi-arid setting.

3.2 SOIL CLASSIFICATION

According to the water research commission, soils of South Africa listed in Figure 9, soils that can be expected is sandy to loam with a moderate to deep depth. This information will be taken into consideration when assessing the aquifer vulnerability of the area.

3.3 HYDROGEOLOGY

In response to the issue of limited groundwater knowledge, the Department of Water Affairs and Forestry (DWAF) has undertaken the task of developing and releasing twenty-three 1:500,000-scale General Hydrogeological Maps. The objective is to amalgamate and disseminate point borehole data, along with groundwater expertise and insights in order to address this issue.

The 1:500 000 Hydrogeological Map Series of South Africa (DWAF, 1998) is utilised to estimate the principal groundwater under investigation is located within **Zone d2** indicating possible groundwater occurrence of 0.1 – 0.5 l/s. Typically, intragranular and fractured aquifers occur in these areas.

3.3.1 Groundwater Depth

According to the DWA map, the groundwater depth in the study area is approximately 10 - 20 mbgl, as illustrated in Figure 11.

3.3.2 Groundwater Recharge

The DWA mean annual recharge of the area is between 15 – 25 mm/a and on average 20 mm/a (refer to Figure 12). The Vegter recharge maps estimate the recharge as 20 mm/a (refer to Figure 13). DWA and Vegter's data estimate the recharge as 20mm per annum for the area under investigation.

3.3.3 Groundwater Potential Contaminants

From an aquifer's perspective, this area is currently undisturbed for the proposed WWTW area, for the irrigation area, it was previously utilised for irrigation by pumping water from the Vaal river. According to the designs for the proposed WWTW, all facilities containing water will be lined to prevent seepage into the groundwater regime, however leaks and spills may occur during the lifespan of the facility.

The treated effluent will be utilised for irrigation purposes, thus it is imperative that the irrigation water quality complies with the prescribed limits and standards set by the relevant regulatory authorities. If the effluent is not treated to the recommended standards, it can affect the groundwater quality in the vicinity of the irrigation area.

During this investigation, drilling of upstream and downstream monitoring boreholes for the WWTW and the irrigation area is recommended to quantify the current state of the groundwater quality and to continue monitoring over time for the establishment of water quality trends.

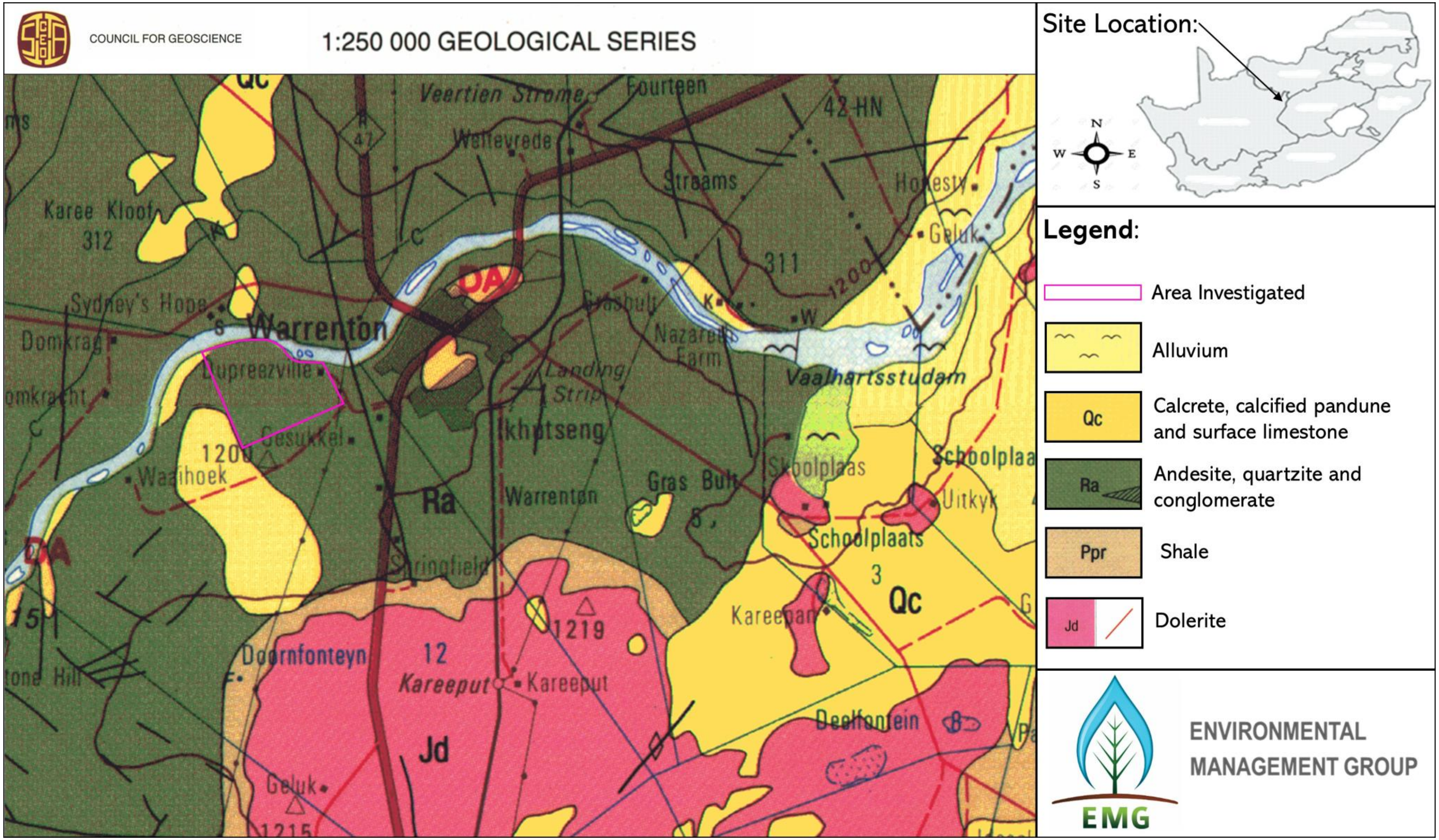

Figure 8. Map indicating the regional geology on a 1:250 000 Geological Series map.

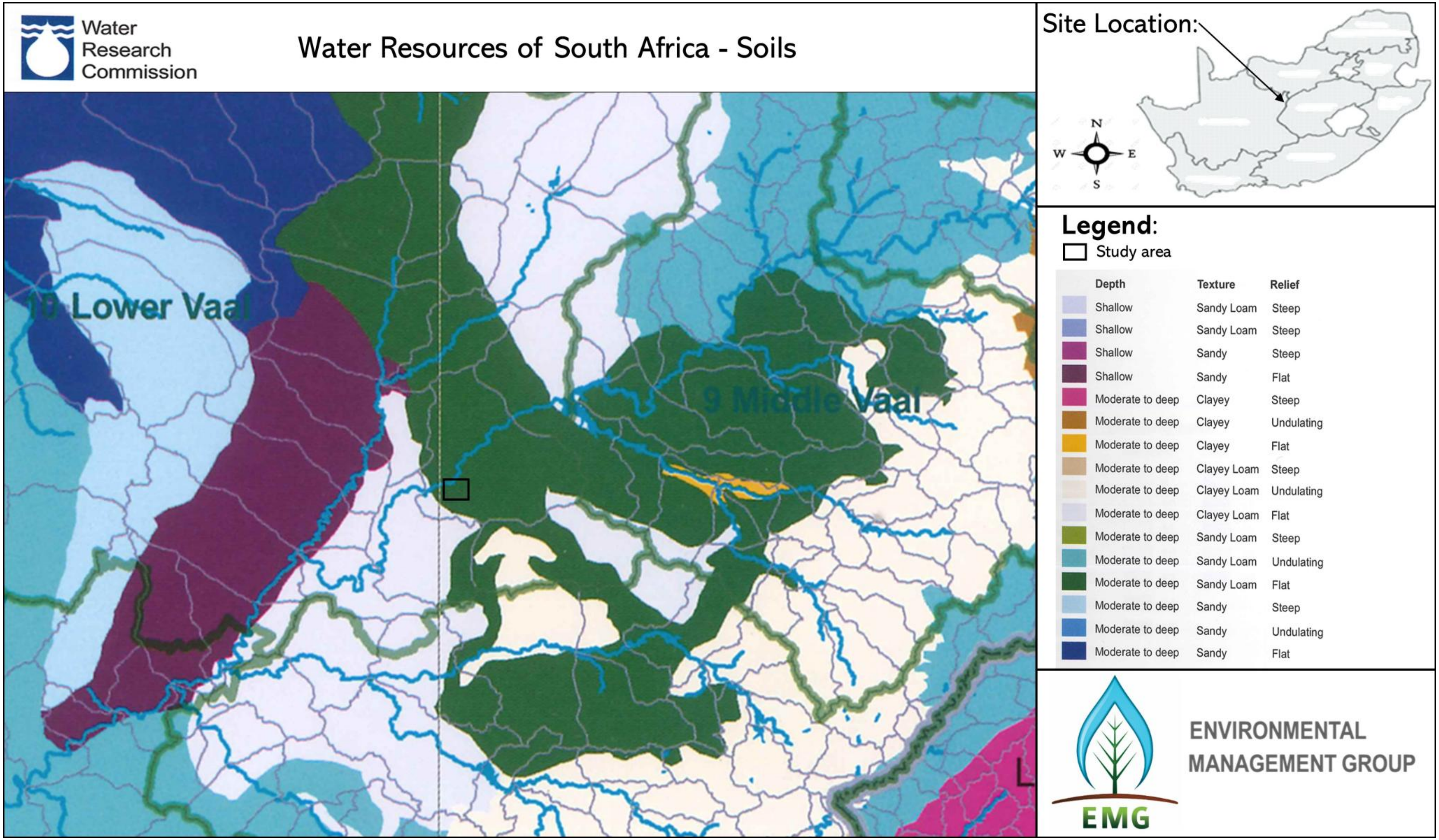

Figure 9. Map illustrating South African Soils.

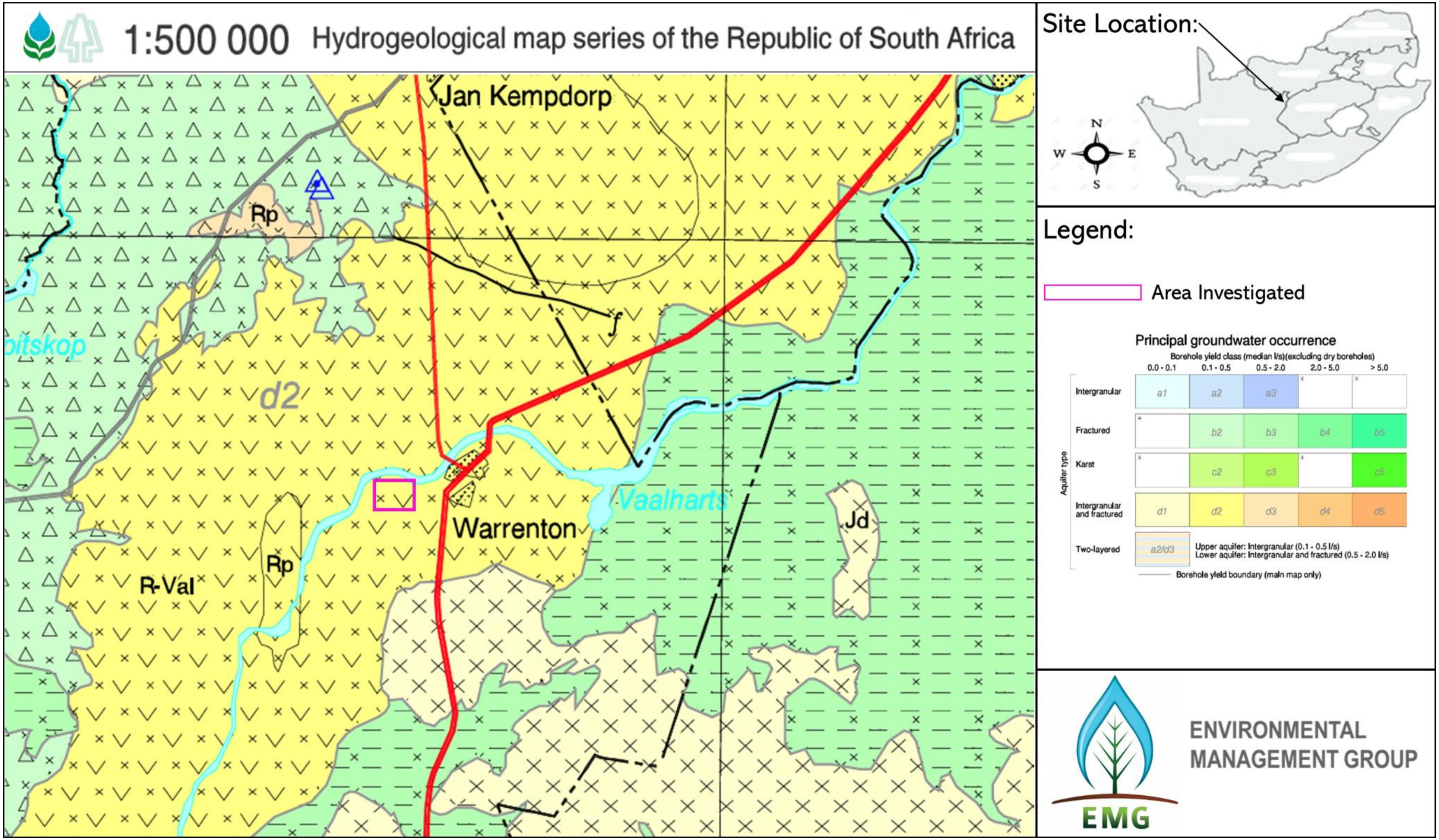

Figure 10. 1:500 000 Hydrogeological Map Series of South Africa (DWAF, 1998).

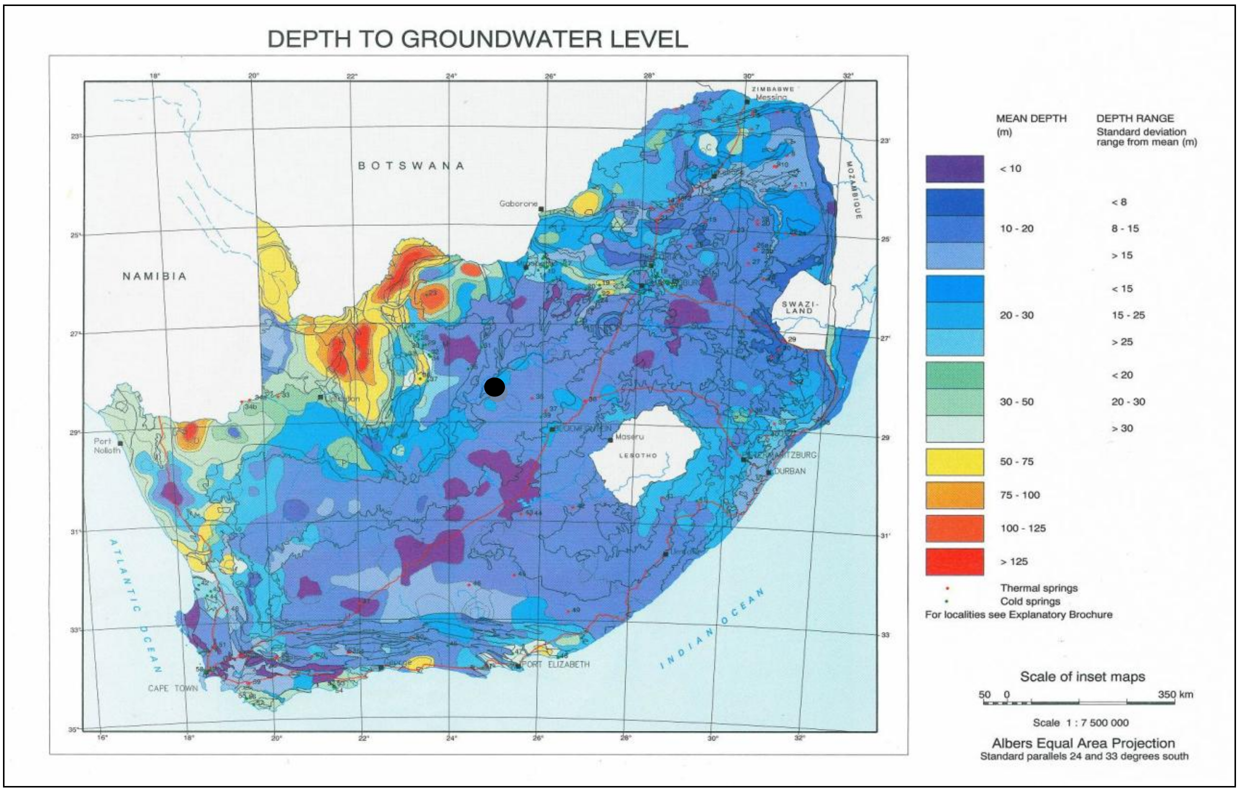

Figure 11. Depth of groundwater level (adapted from the Groundwater Resources of South Africa Map, DWA, 1995). Site location indicated with black circle.

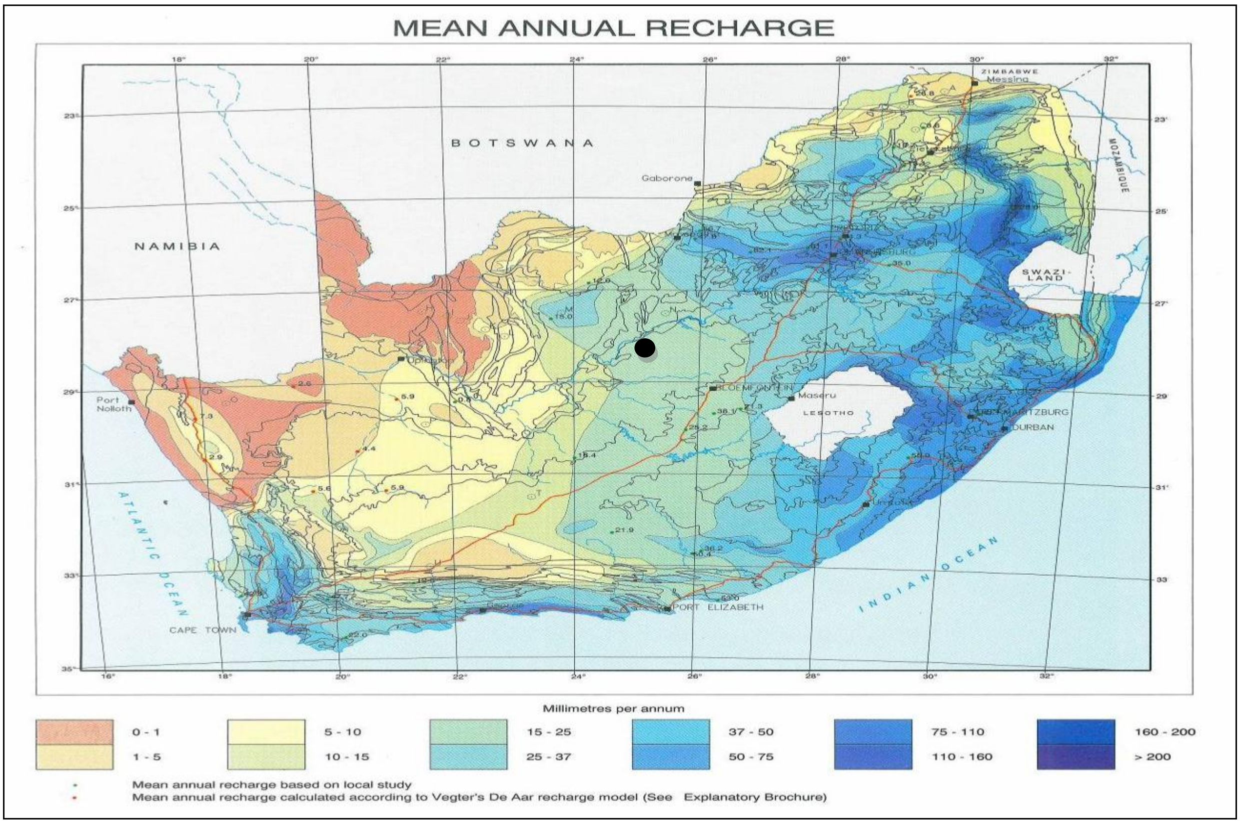

Figure 12. Mean annual recharge (adapted from the Groundwater Resources of South Africa Map, DWA, 1995). Site location indicated with black circle.

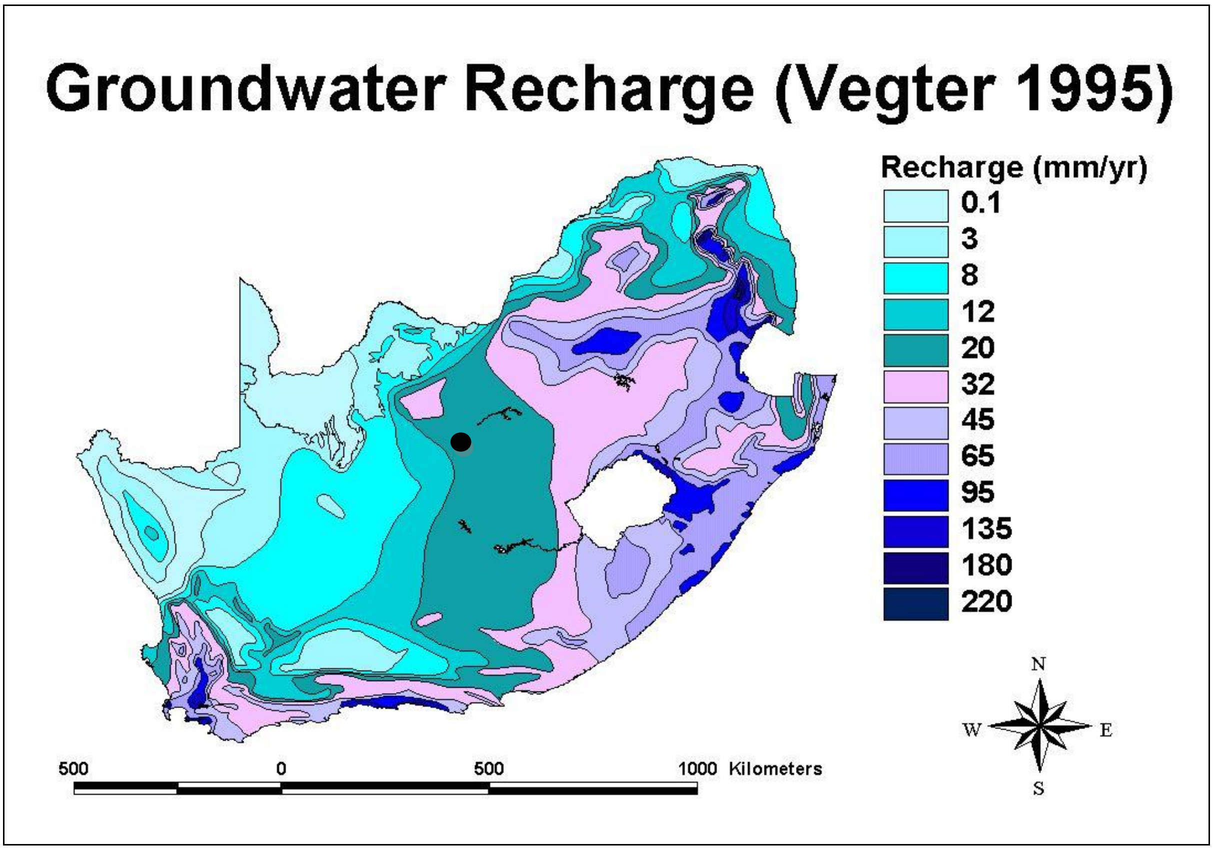

Figure 13. Groundwater recharge estimation map (Vegter, 1995). Site location indicated with black circle

4 GEOPHYSICAL INVESTIGATION

4.1 GEOPHYSICAL SURVEY AND SITING OF MONITORING BOREHOLES

The geophysical survey on site was completed with a G5 Proton Magnetometer to determine possible structures and faults in the local area. Siting of upstream and downstream monitoring boreholes was also completed during the survey. The traverse locations and recommended monitoring boreholes can be viewed in Figure 16. Geophysical data generated from the survey are listed in Appendix C and visually presented in a graph format from Figure 17 to Figure 21.

4.2 GEOPHYSICAL METHOD

The following section was abbreviated from "*Geophysical field manual for technicians* by A.T Roux".

Geophysical techniques rely on the presence of discontinuities or contrasts in the physical properties of materials:

Many geological formations, by virtue of their content of magnetic minerals, will behave like large, buried magnets and will have a magnetic field associated with them. This very local magnetic field will be superimposed on the normal magnetic field of the earth

Measurements of the magnetic field taken in the locality of such geological formations will show departures from the undisturbed earth's magnetic field in the vicinity of these formations. These changes, or anomalies as they are called, could be large or small and could be either an increase or decrease of the earth's magnetic field and will depend on the depth of burial, degree and direction of magnetisation, and the attitude of the formation in relation to the direction of the earth's field at that locality.

Magnetometers are the instruments used for measuring the magnetic field and by virtue of their sensitivity and range, are able to measure not only the changes of field between two rock types with only small differences in magnetic content, but also the prominent anomaly from a dolerite dyke.

Magnetic surveys are used to locate and delineate:

- Magnetic iron ore deposits,
- Metallic ore deposits, which may have either magnetite, pyrrhotite ore ilmenite associated with ore,

- Magnetite-rich zones which may have some indirect or association with a metallic deposit and faults.

It has become apparent in previous section that not only will a magnetic body produce a magnetic effect at the surface, but the amplitude or intensity of the magnetic anomaly and the shape of the anomaly bears some direct relationship to magnetic mineral content, the size, depth and the shape of the buried body. It then becomes possible to distinguish between these different rocks even if they lie hidden under cover (Figure 14).

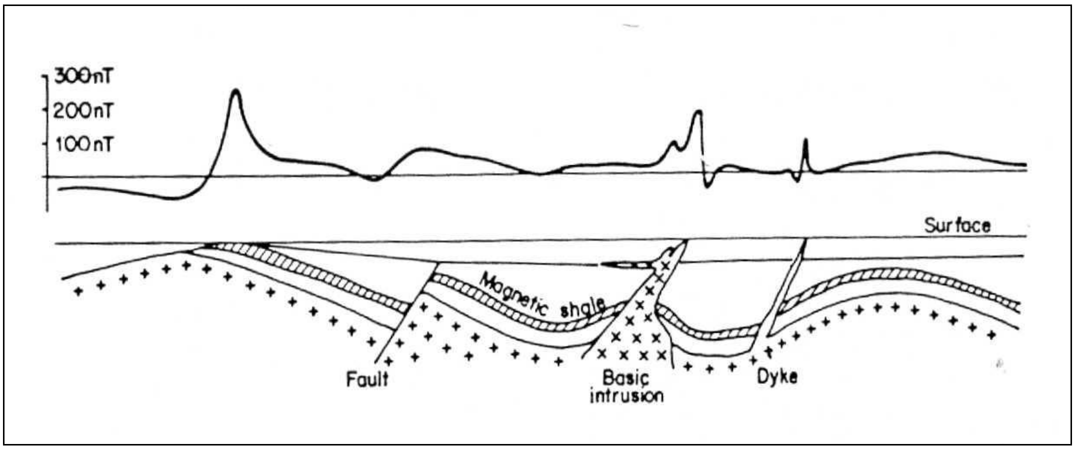

Figure 14. Magnetic profile across a typical geological section. The profile is for the total field inclination of 600 but would look very similar for the vertical component.

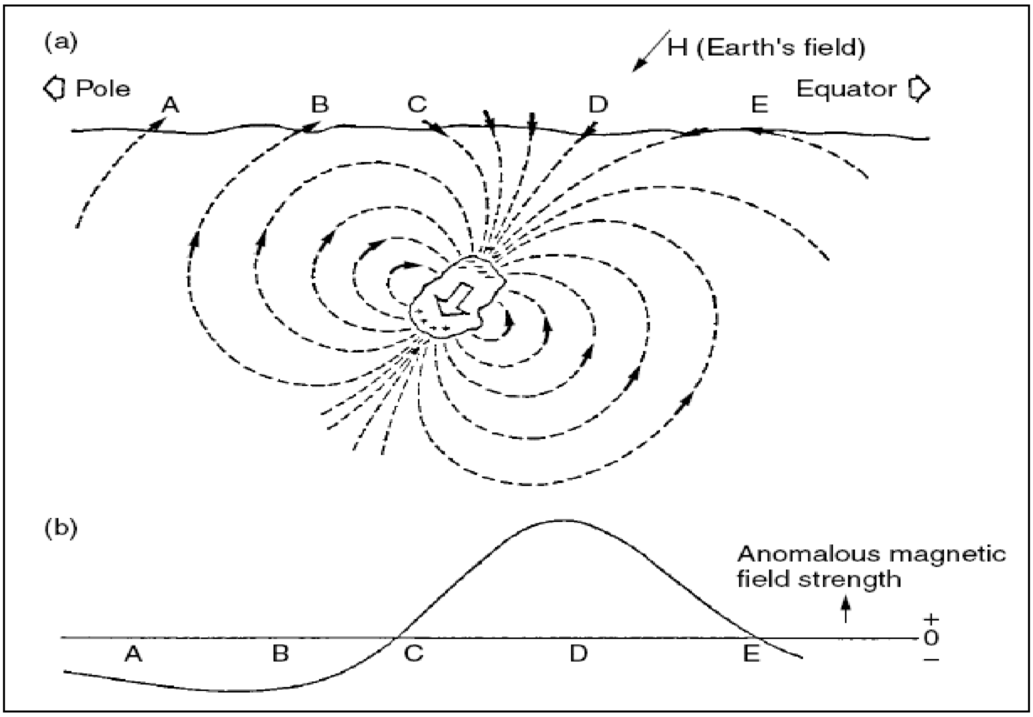

Figure 15. Mid-latitude total field anomaly due to induced magnetisation. (a) The induced field. (b) the anomaly profile.

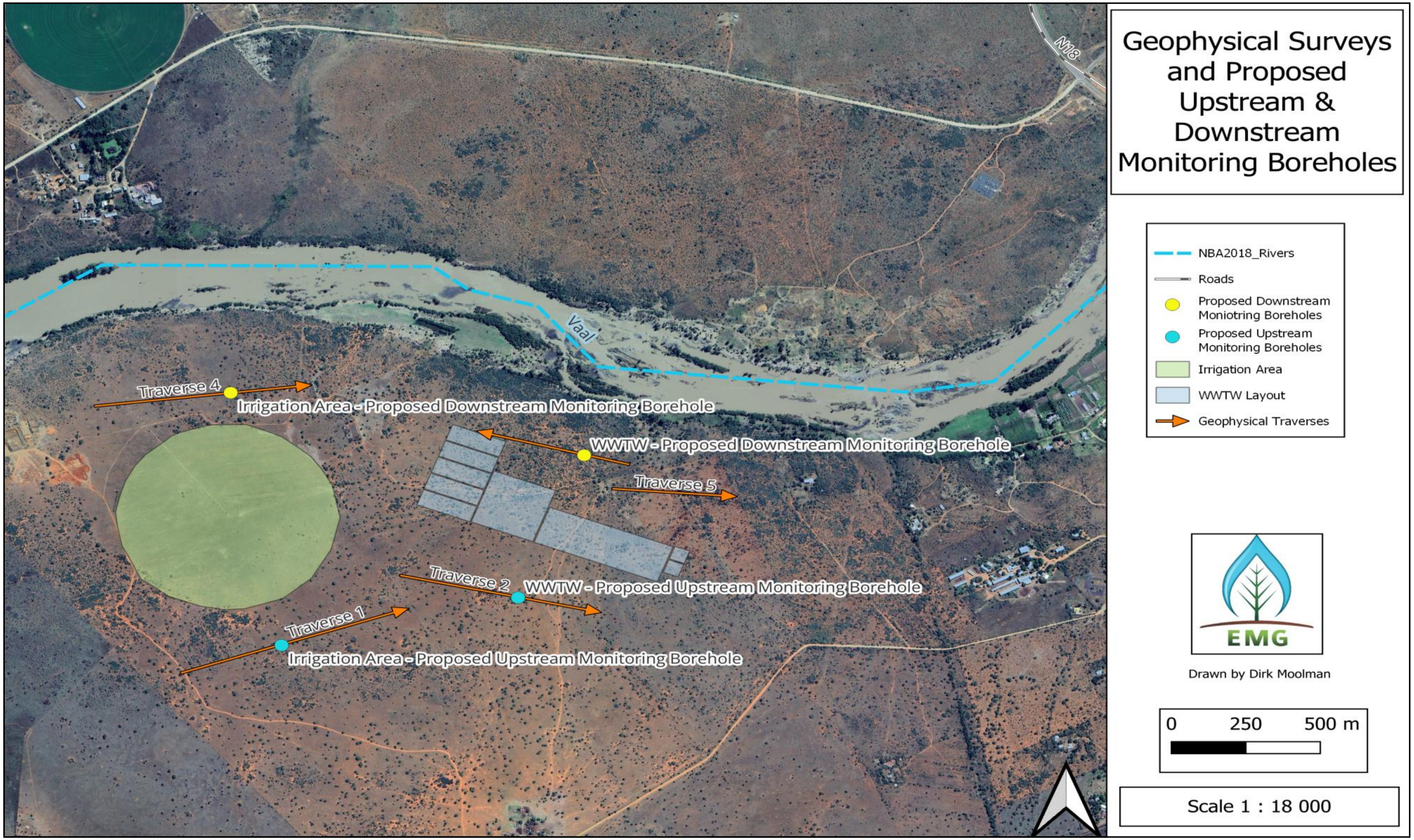

Figure 16. Geophysical traverses and monitoring boreholes locations.

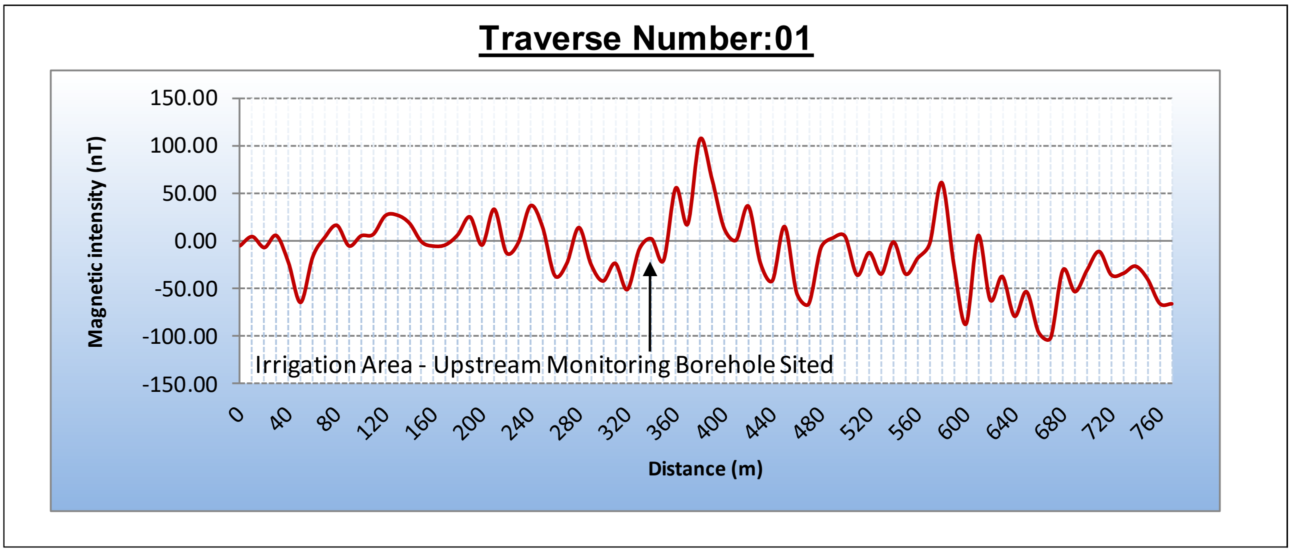

Figure 17. Visual display of geophysical data.

Figure 17 is a presentation of the data in a graph format for interpretation. A predominant magnetic anomaly was detected from 370 to 400 meters, this can be due to a possible fracture or an intrusive dolerite structure. Thus, the irrigation area upstream monitoring borehole was sited at 350 meters to intersect the possible fractures or a dolerite structure. This monitoring borehole will provide an indication of the upstream groundwater quality and will be evaluated in conjunction with the hydrocensus water quality.

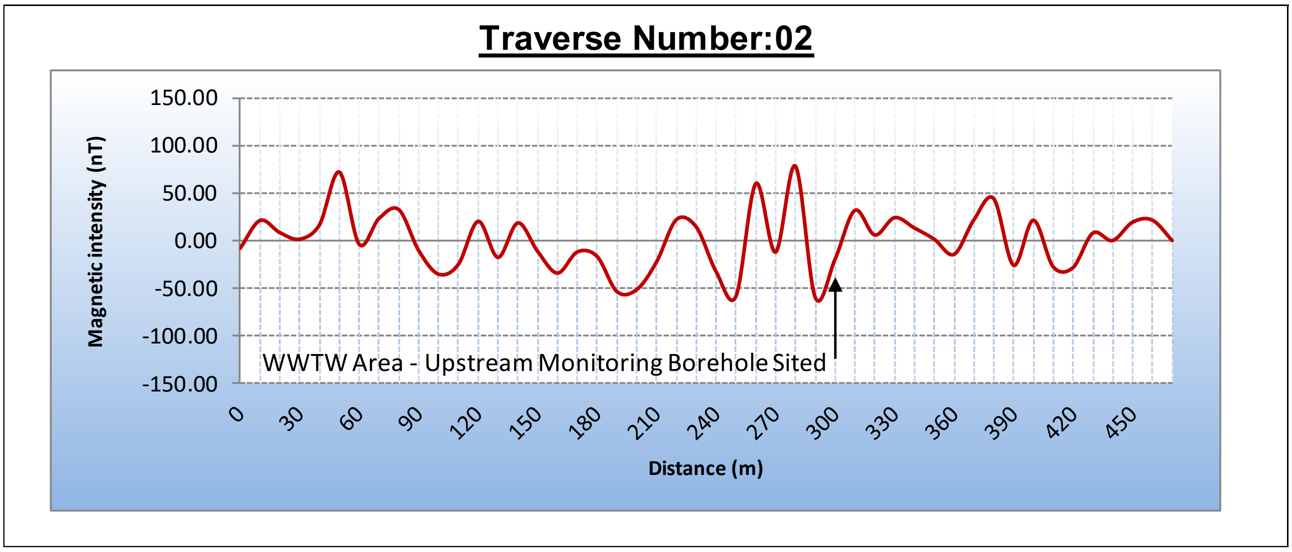

Figure 18. Visual display of geophysical data.

Figure 18 is a presentation of the data in a graph format for interpretation. A predominant magnetic anomaly was detected from 250 to 300 meters, this can be due to a possible fracture or an intrusive dolerite structure. Thus, the WWTW area upstream monitoring borehole was sited at 310 meters to intersect the possible fractures or a dolerite structure. This monitoring borehole will provide an indication of the upstream groundwater quality and will be evaluated in conjunction with the hydrocensus water quality.

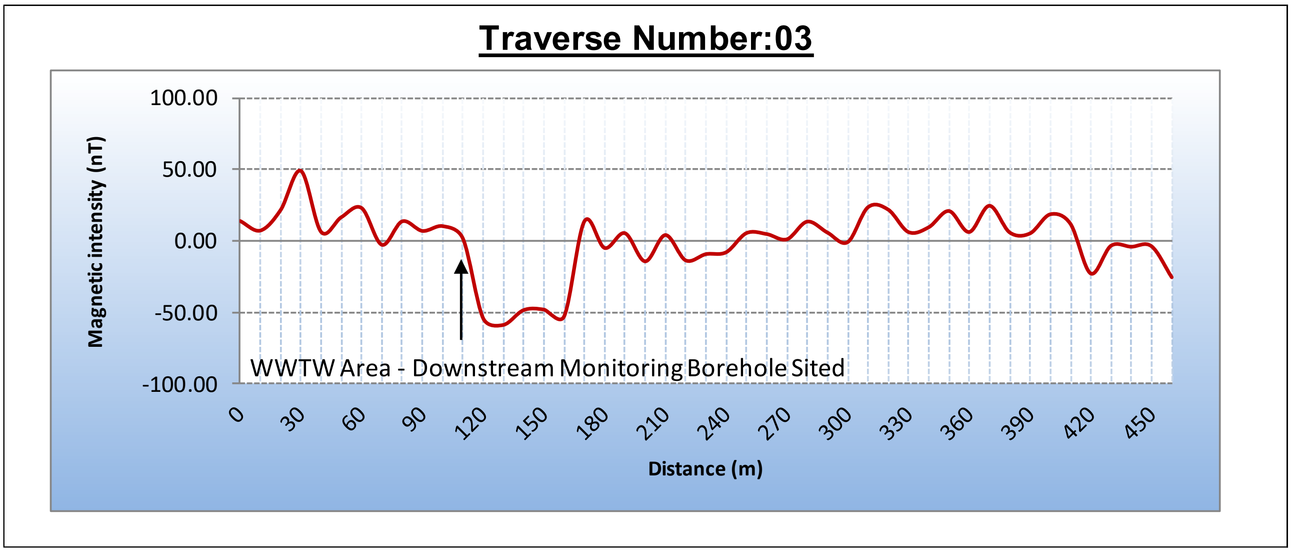

Figure 19. Visual display of geophysical data.

Figure 19 is a presentation of the data in a graph format for interpretation. A predominant negative magnetic anomaly was detected at 110 to 160 meters, this can be due to a possible fracture or an intrusive dolerite structure. Thus, the WWTW downstream monitoring borehole was sited at 100 meters to intersect the possible fractures or a dolerite structure. This monitoring borehole will act as an early warning system and to detect possible pollutants migrating downstream off site.

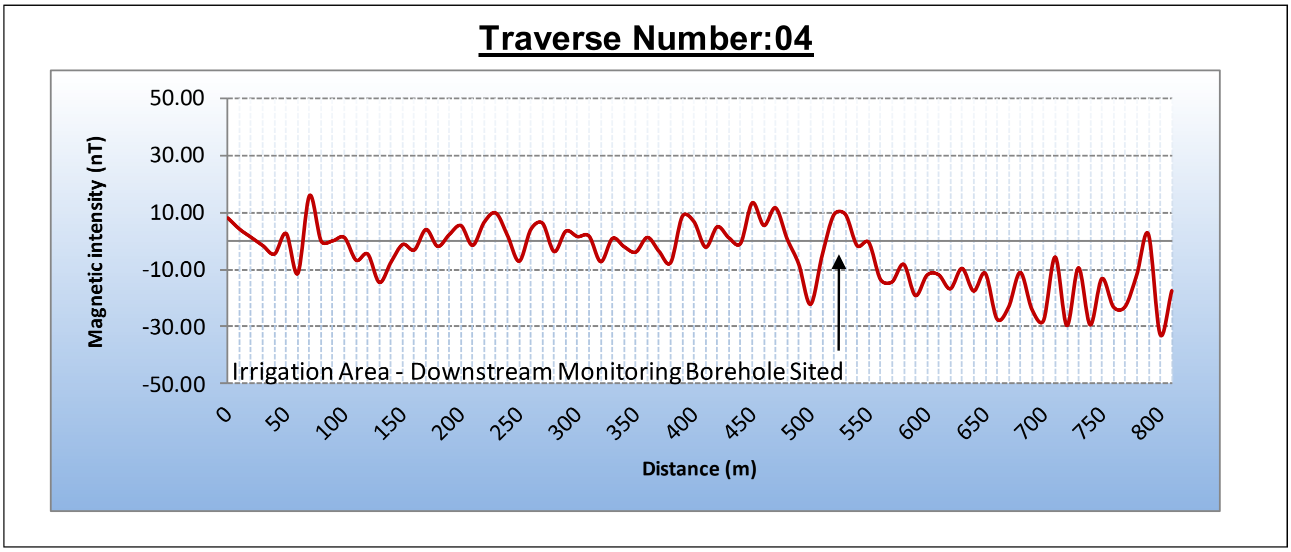

Figure 20. Visual display of geophysical data.

Figure 20 is a presentation of the data in a graph format for interpretation. A predominant magnetic anomaly was detected at 490 to 510 meters, this can be due to a possible fracture or an intrusive dolerite structure. Thus, the irrigation area downstream monitoring borehole was sited at 520 meters to intersect the possible fractures or a dolerite structure. This monitoring borehole will act as an early warning system and to detect possible pollutants migrating downstream off site.

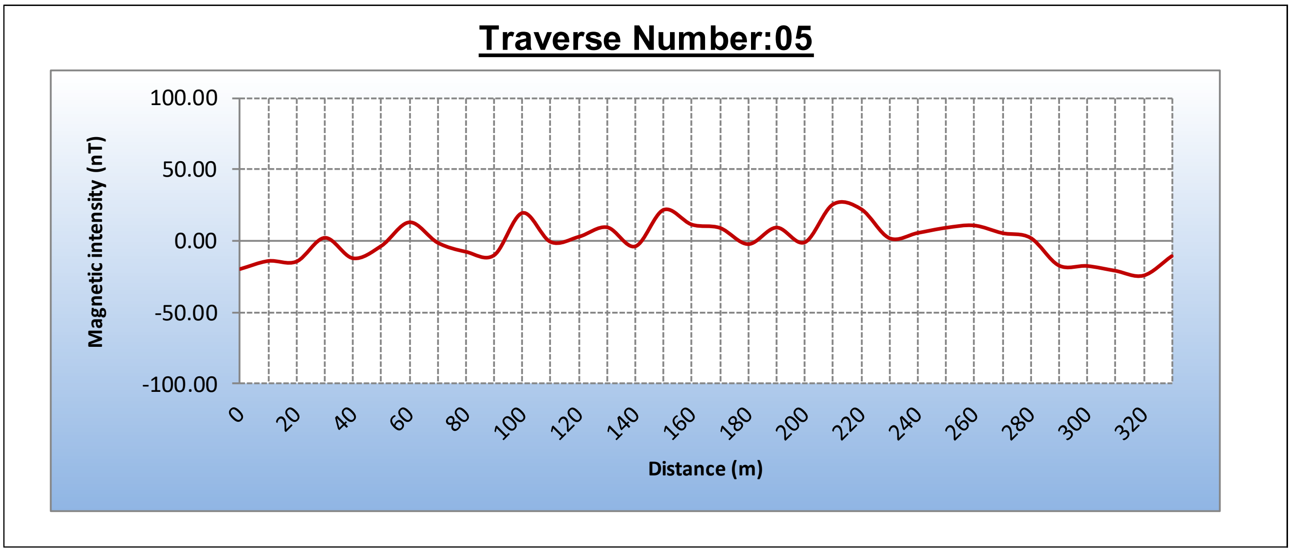

Figure 21. Visual display of geophysical data.

Figure 21 is a presentation of the data in a graph format for interpretation. No predominant anomalies were detected for the siting of a monitoring borehole.

5 HYDROCENSUS

A hydrocensus is designed to systematically collect, analyse, and interpret data related to water resources within a given geographic area. This approach provides a holistic view of the hydrological landscape surrounding surface water bodies, groundwater aquifers and the interplay between them. A hydrocensus offers a framework for evaluating the quantity, quality, and distribution of water resources.

A site investigation was done on the 30th of April 2026. The objective of the site assessment was to establish groundwater level depths and water quality at existing boreholes and surface water sites within a 1km radius of the proposed site. Two (2) boreholes were identified and sampled for water quality analysis during the site assessment. A total number of 2 surface water sites (upstream and downstream) were identified within the Vaal River and sampled.

Table 2. Hydrocensus summary.

Site No	Latitude (S)	Longitude (E)	Site Type	Site Description	Date	Static Water Level (mbgl)	Borehole Depth (mbgl)	Sampled	Photo	Equipment
HCBH01	-28.132278°	24.820806°	Groundwater	Hydrocensus borehole upstream from WWTW	30/03/2026	Closed	Closed	Yes	Yes	Yes (Submersible Pump)
HCBH02	-28.107556°	24.849472°	Groundwater	Hydrocesus borehole located in Warrenton	30/03/2026	Closed	Closed	Yes	Yes	Yes (Submersible Pump)
SW01	-28.117444°	24.825917°	Surface Water	Upstream surface water site in Vaal River	30/03/2026	Surface Water Site	~	Yes	Yes	~
SW02	-28.117139°	24.799056°	Surface Water	Downstream surface water site in Vaal River	30/03/2026	Surface Water Site	~	Yes	Yes	~

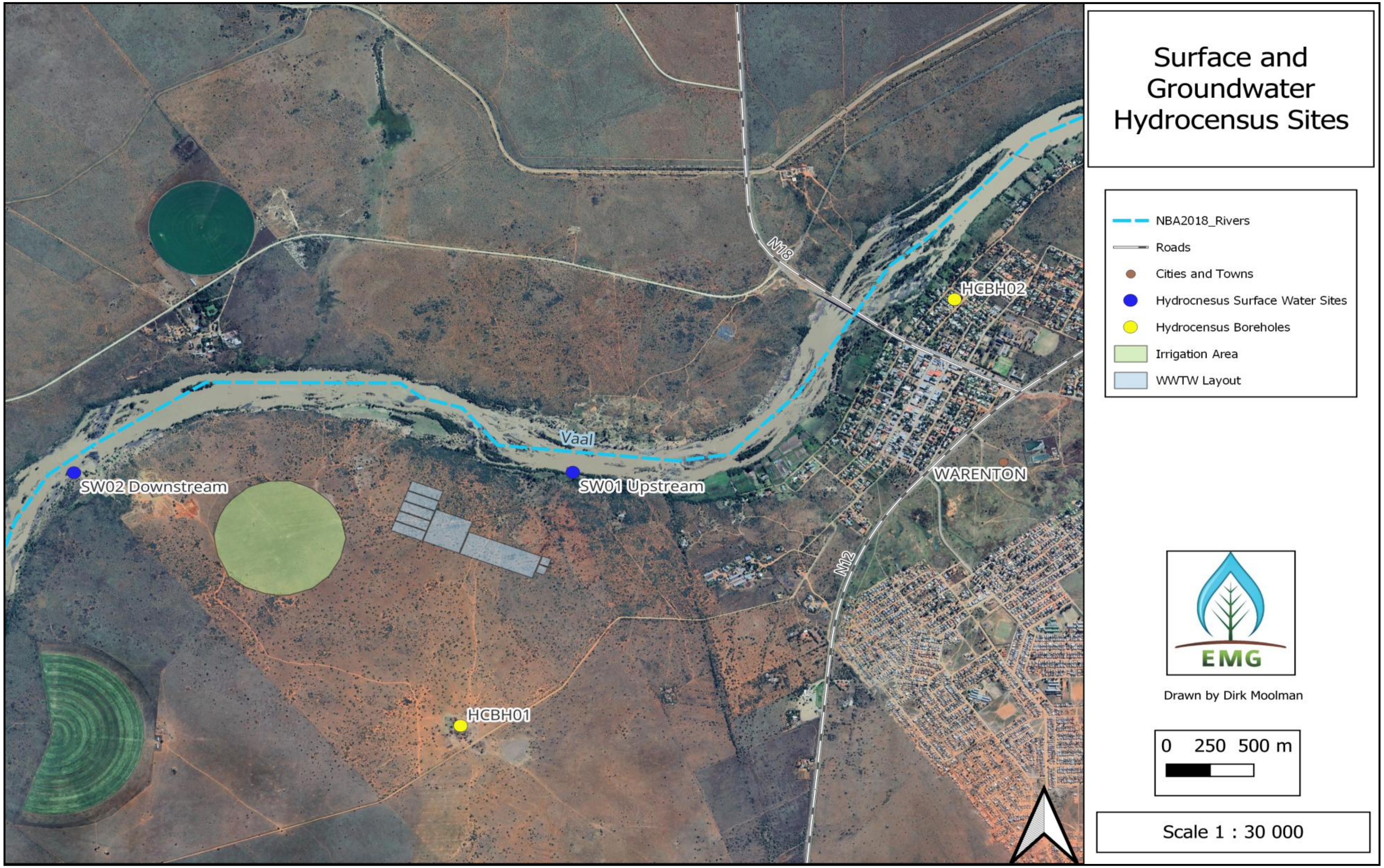

Figure 22. Hydrocensus location map.

5.1 HYDROCENSUS SITES PHOTOS

	
HCBH01.	HCBH02.
	
SW01 (surface water upstream)	SW01 (Saturation Pond).

5.2 HYDROCENSUS WATER QUALITY

Water samples were collected and submitted to an accredited laboratory for chemical and bacteriological analysis, the results are listed in Table 3 and described below.

BH 01

BH 01 water quality is of Class 1 water quality. Major ions and trace elements are within acceptable SANS 241 limits. No bacteriological contamination was detected, making the sample suitable for domestic and general use.

BH 02

BH 02 shows and elevated magnesium concentration at 80mg/l, this can cause insignificant health effects in sensitive groups only (Department of Water Affairs and Forestry et al., 1998). Bacteriological contamination was detected, including E. coli, faecal coliforms and total coliforms, indicating possible bactreiological contamination and the need for disinfection prior to domestic use.

SW Upstream and Downstream

The major elements and trace elements are within the SANS 241 guidelines, however bacteriological contamination was detected due to Faecal Coliforms and Total coliforms detected.

Table 3. Hydrocensus chemical and bacteriological water results.

Water Quality Analysis							
Analysis	**Symbol**	**Unit**	**SANS 241:2015 Standard Limit**	**Value**			
				BH 01	**BH 02**	**SW Upstream**	**SW Upstream**
Major Elements							
pH	pH	pH	5< to >9.7	7.76	7.10	7.68	7.77
Electrical Conductivity	EC	mS/m	<170	76.3	135	40.1	40
Total Dissolved Solids	TDS	mg/l	<1200	453	865	222	220
Total Alkalinity	~	mg CaCO3 / l	~	329	341	106.0	103
Total Hardness	~	mg CaCO3 / l	~	407	682	143.7	143
Chloride	Cl	mg/l	<300	32	123.0	29.2	28
Nitrite	NO_2	mg/L	<0.9	<0.01	<0.01	0.02	<0.01
Nitrate	NO_3	mg/L	<12	8.01	6.37	<0.35	0.36
Sulphate	SO_4	mg/L	<500	37	239	50.8	50.80
Fluoride	F	mg/L	<1.5	<0.09	<0.09	<0.09	<0.09
Calcium	Ca	mg/L	<150	61	141.0	30.0	30
Magnesium	Mg	mg/L	<70	61.9	80.0	16.70	16.7
Sodium	Na	mg/L	<200	25.6	47.20	22.4	22
Potassium	K	mg/L	<50	1.91	1.9	7.92	7.7
Trace Elements							
Aluminium	Al	mg/L	<0.3	<0.01	<0.01	<0.01	<0.01
Antimony	Sb	mg/L	<0.02	<0.01	<0.01	<0.01	<0.01
Arsenic	As	mg/L	<0.01	<0.009	<0.009	<0.009	<0.009
Barium	Ba	mg/L	~	<0.01	<0.01	<0.01	<0.01
Boron	Ba	mg/L	<0.3	0.04	0.09	<0.01	<0.01
Iron	Fe	mg/L	<2	<0.01	<0.01	1.51	1.35
Manganese	Mg	mg/L	<0.4	<0.01	<0.01	<0.01	<0.01
Chromium	Cr	mg/L	<0.05	<0.01	<0.01	<0.01	<0.01
Copper	Cu	mg/L	<2	<0.01	<0.01	<0.01	<0.01
Nickel	Ni	mg/L	<0.07	<0.01	<0.01	<0.01	<0.01
Zinc	Zn	mg/L	<5	<0.01	<0.01	<0.01	<0.01
Cadmium	Cd	mg/L	<0.003	<0.002	<0.002	<0.002	<0.002
Selenium	Se	mg/L	<0.04	<0.01	<0.01	<0.01	<0.01
Lead	Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Bacteriological Constituents							
E.coli		CFU/100ml	**0**	0	2	0	0
Faecal Coliforms		CFU/100ml	**0**	0	12	28	28
Total Coliforms		CFU/100ml	**<10**	0	52	52	60

6 AQUIFER VULNERABILITY

6.1 INTRODUCTION

The objective of defining and mapping aquifer vulnerability is to help planners protect groundwater as an essential economic resource and to act as a foundation for the designation of protection zones. The concept of aquifer vulnerability derives from the assumption that the physical environment may provide some degree of groundwater protection against human impacts, especially regarding pollutants entering the sub-surface. Aquifer vulnerability thus combines the hydraulic inaccessibility of the saturated zone with the penetration of pollutants, with the attenuation capacity of the strata overlying the saturated zone (Foster 1998).

The vulnerability of the underground water source is related to the distance that the contaminant must flow to reach the water table, and the ease with which it can flow through the soil and rock layers above the water table. The water level depth of the area under investigation is approximately 10-20 mblg according to the Groundwater Resources of South Africa Map, DWA, 1995. No water levels were measured at the identified hydrocensus boreholes as they were locked. The soil properties are defined in (Figure 9) to establish the movement of possible pollutants through the unsaturated zone.

6.2 AQUIFER VULNERABILITY

This aquifer vulnerability map (Figure 24) indicates the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. Green represents the least vulnerable region that is only vulnerable to conservative pollutants in the long term when continuously discharged or leached. Yellow represents the moderately vulnerable region, which is vulnerable to some pollutants but only when continuously discharged or leached. Red represents the most vulnerable aquifer region, which is vulnerable to many pollutants except those strongly absorbed or readily transformed in many pollution scenarios (Aquifer vulnerability of South Africa).

According to the aquifer vulnerability map from the Department of Water Affairs (Figure 24), the aquifer of the area under investigation is classified as moderately vulnerable. The DRASTIC method was utilised to combine methods of classifying aquifer vulnerability.

6.3 AQUIFER CLASSIFICATION

This map (Figure 23) indicates the aquifer classification system of South Africa. Blue represents the major aquifer region which is a high-yielding system of good water quality. Green represents the minor aquifer region which is a moderately-yielding aquifer system of variable water quality. Pink represents the poor aquifer region which is a low to negligible yielding aquifer system of moderate to poor water quality (Aquifer vulnerability of South Africa).

The area under investigation is classified as a minor aquifer indicating that the pollution may only affect a minor resource however, this was verified with the Hydrocensus investigation conducted as no large scale groundwater abstraction is taking place within close proximity of the investigated site that can be affected.

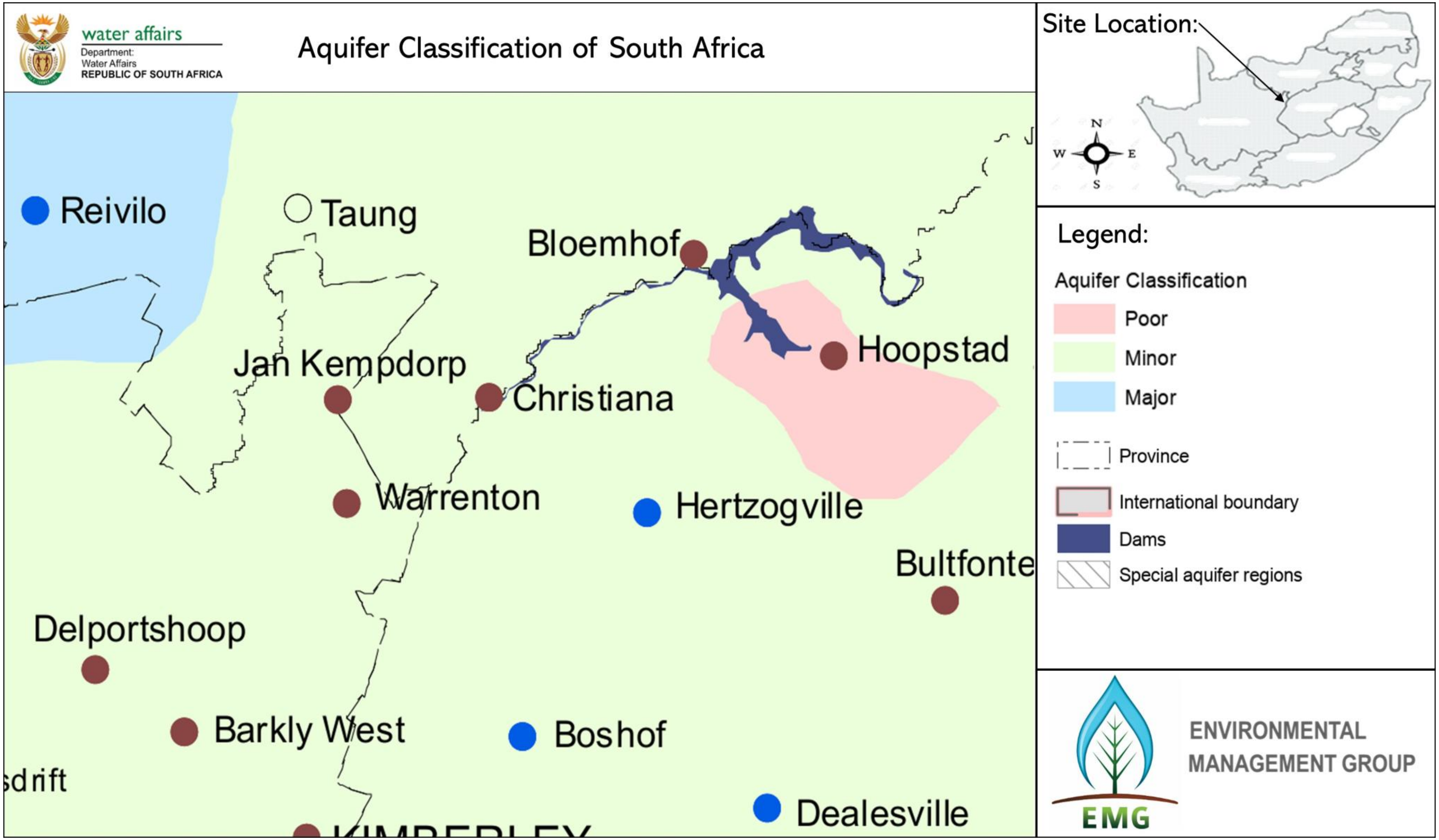

Figure 23. Aquifer classification map.

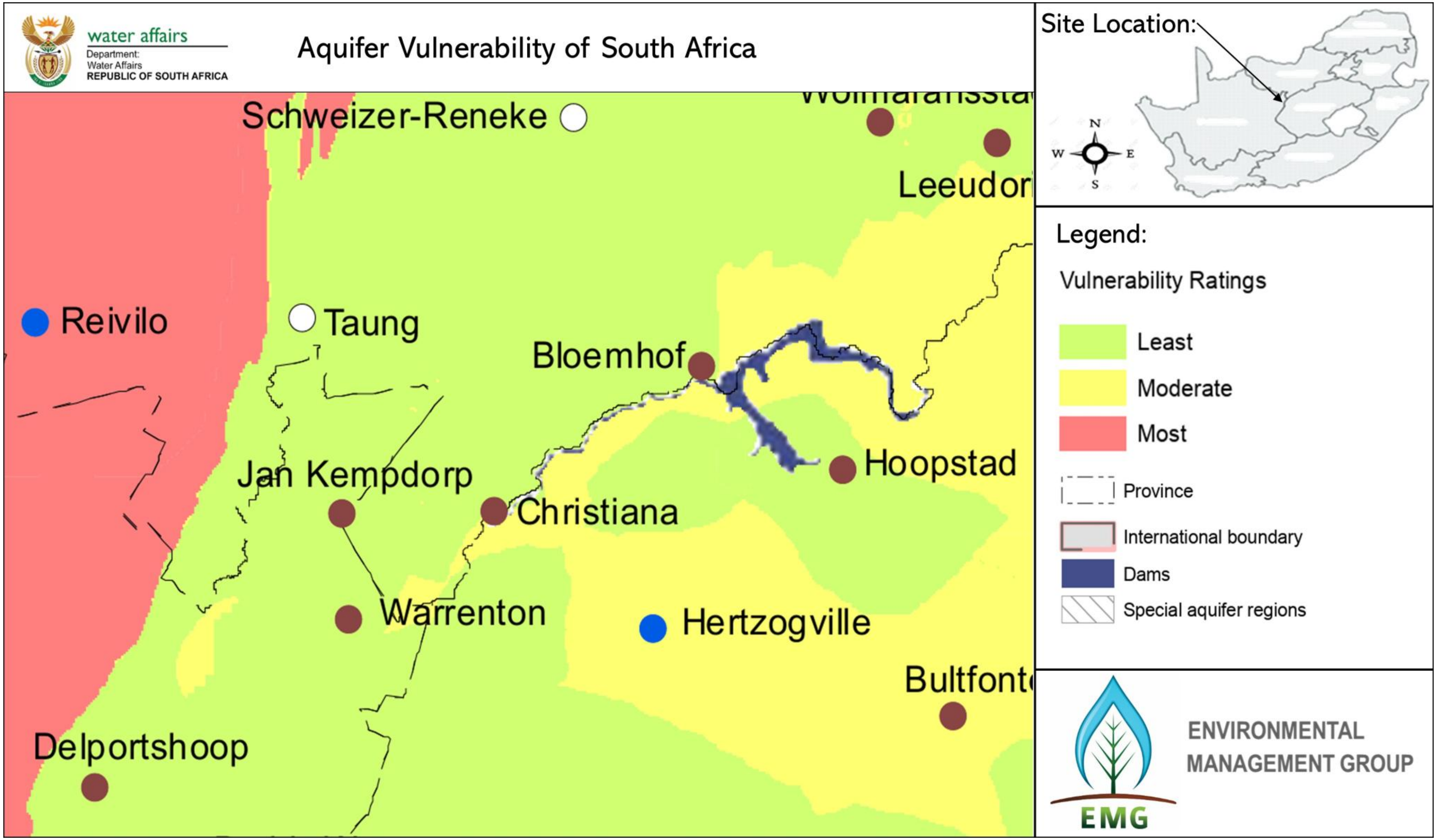

Figure 24. Aquifer vulnerability map.

6.4 AQUIFER VULNERABILITY – DRASIC INDEX

The DRASTIC model is a valuable tool for assessing groundwater vulnerability and, more typically, for research purposes.

The DRASTIC approach is simple to use, and numerous researchers have used it to assess groundwater vulnerability across the world. Basically, in this model seven parameters are used for the assessment of vulnerability. These model parameters are considered for the ratings and weights of the parameters and give the DRASTIC index value (Rosen 1994).

The following Equation calculates the DRASTIC index using a linear combination of all parameters.

$$D_i = D_R D_W + R_R R_W + A_R A_W + S_R S_W + T_R T_W + I_R I_W + C_R C_W$$

Where *Di*= DRASTIC index
D = depth of water table
R = net recharge
A = aquifer
S = soil
T = topography
I = impact of vadose zone
C = conductivity
Subscript w = Weight of the parameters
Subscript R = Rate of the parameters

The DRASTIC index is a dimensionless metric that assesses the vulnerability of groundwater to pollution. If the value of the DRASTIC index is higher, then we can say that the area can be more affected by pollution and if the value of the DRASTIC index is lower, then the area can be less affected by pollution. Basically, the range of the DRASTIC index is between 70 and 200.

Table 4. Standard DRASTIC parameters

Layers	Range	Rating Type	Weight	Total
Depth to water (m)	0–1.5	10	5	
	1.5–4.5	9	5	
	4.5–9	7	5	
	9–15	5	5	
	15–22.5	3	5	15
	22.5–30	2	5	
	>30	1	5	
Recharge (mm/y)	>254	9	4	
	178–254	8	4	
	102–178	6	4	
	51–102	3	4	
	0–51	1	4	4
Aquifer media	Karst limestone	9–10	3	
	Basalt	2–10	3	
	Sand and gravel	4–9	3	
	Massive limestone	4–9	3	
	Massive sandstone	4–9	3	
	Bedded sandstone, limestone and shale sequences	5–9	3	
	Glacial till	4–6	3	
	Weathered metamorphic/igneous	3–5	3	
	Metamorphic/igneous	2–5	3	12
	Massive shale	1–3	3	
Soil media	Thin or absent	10	2	
	Gravel	10	2	
	Sand	9	2	
	Peat	8	2	
	Shrinking and/or aggregated clay	7	2	
	Sandy loam	6	2	12
	Loam	5	2	
	Silty loam	4	2	
	Clay loam	3	2	
	Muck	2	2	
	Non-shrinking and non-aggregated clay	1	2	
Topography (%)	0–2	10	1	
	2–6	9	1	9
	6–12	5	1	
	12–18	3	1	
	>18	1	1	
Impact of vadose zone	Karst limestone	8–10	5	
	Basalt	2–10	5	
	Sand and gravel	6–9	5	
	Metamorphic/igneous	2–8	5	25
	Sand and gravel with significant silt	4–8	5	
	Bedded sandstone, limestone and shale	4–8	5	
	Sandstone	4–8	5	
	Limestone	2–7	5	
	Shale	2–5	5	
	Silt/clay	2–6	5	
	Confining layer	1	5	
Hydraulic conductivity (m/day)	>82	10	3	
	41–82	8	3	
	29–41	6	3	
	12–29	4	3	
	4–12	2	3	6
Total				83

Table 5. Definition of a vulnerability class.

Vulnerability class	Corresponding Definition
Extreme	Most water pollutants are vulnerable to it, and it has a rapid impact in many contamination scenarios.
High	In various pollution settings, it is vulnerable to a wide range of contaminants (excluding those that are easily absorbed or converted).
Moderate	Some contaminants make it vulnerable, but only if they are discharged or leached on a regular basis.
Low	Only when conservative pollutants are continually and widely emitted or leached are they vulnerable to conservative pollutants in the long run.
Negligible	There are no substantial vertical groundwater flow leakages in the confining beds.

Table 6. Vulnerability assessment criteria based on the DRASTIC method.

Vulnerability Class	Low	Average	High	Very High
Calculated Index Value	<101	101-140	141-200	>200

6.4.1 DRASTIC Results

The vulnerability map of the study area (Figure 24) clearly shows the dominance of a “moderate” vulnerability class. Table 6 presents the DRASTIC results indicating a low vulnerability assessment of the aquifer when conservative pollutants are continually and widely emitted or leached.

The DRASTIC result and the map for the Aquifer vulnerability of South Africa both indicate a low to moderate aquifer vulnerability respectively that is applicable to this site. Recommended practices listed in this document and Stormwater Management Plan must be implemented to protect the integrity of the aquifer as spillages and underground leakages can occur that can affect the groundwater quality of the aquifer as the water table is between 10 and 20meters below the surface. All structures that will contain wastewater or treated water will be lined, that will ensure minimal seepage into the groundwater. However, groundwater monitoring must be conducted in order to detect possible leaks or spillages that may occur in the future.

7 RISK ASSESSMENT

The DWAF initiative to develop a strategy for managing groundwater quality required that an aquifer classification system be developed. After a literature study of classification systems used elsewhere in the world and a series of scoping workshops to define the desired features and characteristics, a classification was developed and presented a technical workshop for discussion and finalisation (Parsons 1995).

Aquifer management classification and vulnerability (Parsons 1995) developed a South African aquifer system management classification consisting of two parts: a weighted aquifer class classification and a groundwater quality management index. When combined, these provide a decision-support tool to define the required level of protection of the aquifer.

The aquifer system management classification also recognised the need to consider two important South African management aspects namely:

- The high value of sole-source aquifers in the country, and
- The need for a pragmatic approach which allows for special factors to be considered.

For Calculating the Ground Water Management Classification System ratings (Table 8), the following methods were utilised:

Aquifer Vulnerability - Combining results from the aquifer vulnerability map and the DRASTIC index.

Aquifer Classification - Combining groundwater quality results (Table 3) and the Aquifer classification map (Figure 23).

Table 7. Definitions of aquifer system management classes according to Vegter.

Sole Source Aquifer	An Aquifer which is used to supply 50% or more of urban domestic water for a given area, and for which there are no reasonable available alternative sources of water.
Major Aquifer Region	High Yielding aquifer system of good quality water.
Minor Aquifer Region	A moderately-yielding aquifer system of variable water quality.
Poor Groundwater Region	Low to negligible yielding aquifer system of moderate to poor water quality.
Special Aquifer System	An aquifer system designated as such by the minister of water affairs and forestry, after due process

Table 8. Ground Water Management Classification System ratings.

Aquifer System Management Classification		Aquifer Vulnerability Classification		Groundwater Quality Management Index	Level of Protection
Class	Points	Class	Points		
Sole Source Aquifer System	6			<1	Limited Protection
Major Aquifer System	4	High	3	1 - 3	Low Level Protection
Minor Aquifer System	2	Medium	2	3 - 6	Medium Level Protection
Non-aquifer System	0	Low	1	6 - 10	High Level Protection
Special Aquifer System	0-6			>10	Strictly non-degradation

7.1 RISK ASSESSMENT RESULTS

According to this classification system the aquifer underlying the proposed site can be described as a 'Minor-Aquifer System' (score = 2) with a 'Medium Aquifer Vulnerability' (score = 2) and requiring a medium Level of Protection (score = 4).

The Groundwater Management Classification System ratings indicate a Medium level of protection that is applicable to this site. Recommended practices listed in this document and Stormwater Management Plan must be implemented to protect the integrity of the aquifer as spillages and underground leakages can occur that can affect the groundwater quality of the aquifer as the water table is approximately 10 to 20meters below the surface. All structures that will contain wastewater or treated water will be lined with concrete that will ensure no seepage into the groundwater. However, groundwater monitoring must be conducted in order to detect possible leaks or spillages that may occur in the future.

8 GEOHYDROLOGICAL IMPACT ASSESSMENT

8.1 METHODOLOGY

For each potential impact, the EXTENT, MAGNITUDE, DURATION, PROBABILITY of occurrence, IRREPLACEABLE loss of resources and the REVERSIBILITY of potential impacts must be assessed by the specialist by using the results of their specialist studies. The assessment of the above criteria will be used to determine the significance of each impact, with and without the implementation of the proposed mitigation measures. The scales to be used to assess these variables and to define the rating categories are tabulated in Table 9 & Table 10 below.

Table 9. Evaluation components and ranking scale.

Evaluation Component	Ranking scale
Magnitude	10 - Very high: Bio-physical and/or social functions and/or processes might be severely altered. 8 - High: Bio-physical and/or social functions and/or processes might be considerably altered. 6 - Medium: Bio-physical and/or social functions and/or processes might be notably altered. 4 - Low : Bio-physical and/or social functions and/or processes might be slightly altered. 2 - Very Low: Bio-physical and/or social functions and/or processes might be negligibly altered. 0 - Zero: Bio-physical and/or social functions and/or processes will remain unaltered.
Duration	5 - Permanent 4 - Long term: Impact ceases after operational phase/life of the activity > 60 years. 3 - Medium term: Impact might occur during the operational phase/life of the activity – 60 years. 2 - Short term: Impact might occur during the construction phase - < 3 years. 1 - Immediate
Extent	5 - International: Beyond National boundaries. 4 - National: Beyond Provincial boundaries and within National boundaries. 3 - Regional: Beyond 5 km of the proposed development and within Provincial boundaries. 2 - Local: Within 5 km of the proposed development. 1 - Site-specific: On site or within 100 m of the site boundary. 0 – None
Irreplaceable loss	5 – Definite loss of irreplaceable resources. 4 – High potential for loss of irreplaceable resources. 3 – Moderate potential for loss of irreplaceable resources. 2 – Low potential for loss of irreplaceable resources. 1 – Very low potential for loss of irreplaceable resources. 0 – None
Revisability	5 – Impact cannot be reversed. 4 – Low potential that impact might be reversed. 3 – Moderate potential that impact might be reversed. 2 – High potential that impact might be reversed. 1 – Impact will be reversible. 0 – No impact.
Probability (of occurrence)	5 - Definite: >95% chance of the potential impact occurring. 4 - High probability: 75% - 95% chance of the potential impact occurring. 3 - Medium probability: 25% - 75% chance of the potential impact occurring 2 - Low probability: 5% - 25% chance of the potential impact occurring. 1 - Improbable: <5% chance of the potential impact occurring.

Table 10. Significant points descriptions.

Calculations- Once the evaluation components have been ranked for each potential impact, the significance of each potential impact will be calculated using the following formula: • **SP (Significance Points) = (Magnitude + Duration + Extent + Irreplaceable + Reversibility) x Probability.** The maximum value is 150 SP (significance points).		
Significance Points	**Environmental Significance**	**Description**
125 – 150	Very high (VH)	An impact of very high significance will mean that the project cannot proceed, and that impacts are irreversible, regardless of available mitigation options.
100 – 124	High (H)	An impact of high significance which could influence a decision about whether or not to proceed with the proposed project, regardless of available mitigation options.
75 – 99	Medium-high (MH)	If left unmanaged, an impact of medium-high significance could influence a decision about whether or not to proceed with a proposed project. Mitigation options should be relooked.
40 – 74	Medium (M)	If left unmanaged, an impact of moderate significance could influence a decision about whether or not to proceed with a proposed project.
<40	Low (L)	An impact of low is likely to contribute to positive decisions about whether or not to proceed with the project. It will have little real effect and is unlikely to have an influence on project design or alternative motivation.
+	Positive impact (+)	A positive impact is likely to result in a positive consequence/effect and is likely to contribute to positive decisions about whether or not to proceed with the project.

Table 11. Geohydrological impact assessment

Geohydrological Impact Assessment		
Activity		
The infrastructure containing raw wastewater and treated wastewater may pose a potential risk of leachate generation, which could infiltrate the subsurface and impact the underlying groundwater quality. Leachate containing elevated concentrations of nutrients, organic matter, and E.coli may migrate through the unsaturated zone, particularly if infrastructure is not maintained and if leaks and spills occur.		
Evaluation component	**Before Mitigation**	**After Mitigation**
Magnitude	8	6
Duration	4	4
Extent	2	2
Irreplaceable	3	2
Reversibility	3	3
Probability	4	2
Total Significant Points	**80**	**34**
Significance rating:	**Medium-high (MH)**	**Low (L)**
Proposed Mitigations	*The proposed monitoring boreholes should be sampled quarterly and analysed by an accredited laboratory. *Establish a, secure database to archive all groundwater data submitted by approved consultants. This preserved data is essential for generating temporal trend plots to proactively evaluate any potential degradation of groundwater quality during the Water Treatment Works (WWTW) operational phase. Following WWTW closure, monitoring must be sustained until groundwater quality parameters demonstrably return to baseline conditions, if the groundwater quality was affected. *In the event that any leaks are detected, prompt repair and maintenance actions must be undertaken to prevent continued seepage and further deterioration of groundwater quality *Groundwater and surface water quality monitoring to prevent groundwater and surface water contamination, through means of prevention when detected early enough. *The facility should be kept clean and tidy at all times. *Any waste generated should be disposed of accordingly in registered waste sites and not dumped on site or the surrounding area. *No sludge and waste should be disposed of on site, as the groundwater table is expected to be between 10 and 20mbgl (can be confirmed when drilling monitoring boreholes) which could cause seepage of the waste into the groundwater resource. *All areas and surfaces associated with waste handling, storage, or processing should be constructed with impermeable materials to prevent infiltration and potential groundwater contamination. *Stormwater and surface runoff must be properly diverted and managed to ensure that it does not come into contact with waste materials or contaminated zones on site. *The structural integrity of all pipes, conveyance systems, and related infrastructure should be routinely inspected, maintained, and upgraded as necessary to prevent leaks or failures. *Any accidental spills or leakages must be promptly contained, cleaned, and the contaminated material disposed of at a registered and approved landfill facility in accordance with waste management regulations.	

8.2 IMPACT ASSESSMENT CONCLUSION

The Geohydrological Impact Assessment identified that the uncontrolled operation of the Water Treatment Works (WWTW) infrastructure, particularly the potential for leakage from raw and treated sewage containment areas, mismanagement and spillages poses a **Medium-High (MH) significance risk** to the underlying groundwater system. This initial risk is primarily driven by the high magnitude, extent, and lack of immediate reversibility of potential contamination.

However, the implementation of the comprehensive Proposed Mitigation Measures and an Environmental Management Plan, it will successfully reduce the overall significance of the potential impact to a **Low (L)** rating. This reduction is achieved by effectively controlling the potential contaminant sources and pathways.

9 SURFACE AND GROUNDWATER MONITORING NETWORK

9.1.1 Introduction

Surface and groundwater monitoring networks play a pivotal role in detecting and mitigating pollution, providing the data needed to understand the extent, sources, and trends of contaminants in groundwater. These networks consist of strategically placed monitoring boreholes that regularly collect water samples for analysis, offering real-time insights into the chemical, physical, and biological characteristics of groundwater.

By systematically monitoring surface and groundwater quality, these networks enable early detection of pollution allowing for timely intervention and remediation efforts. They also help in assessing the effectiveness of pollution control measures and ensuring compliance with environmental regulations. Furthermore, monitoring networks contribute to the development of predictive models that can forecast future contamination scenarios, aiding in proactive resource management.

9.2 DEVELOPMENT OF GROUNDWATER MONITORING NETWORK

During the geophysical investigation (chapter 4), upstream and downstream monitoring boreholes were strategically sited based on the interpretation of geophysical data, with specific emphasis on identifying potential preferential flow paths that may facilitate the migration of groundwater contaminants and to be located above and down gradient for the facility. The locations of these boreholes are presented in Figure 25, while their coordinates and associated monitoring recommendations are provided in Table 12.

9.3 SURFACE AND GROUNDWATER MONITORING PLAN

During the site visit, no monitoring boreholes were identified on site. The locations of the proposed upstream and downstream monitoring boreholes for the proposed WWTW and Irrigation area is indicated in Figure 25.

Surface and Groundwater quality monitoring should be conducted quarterly and the samples must be submitted to an accredited laboratory for analysis. Establish a secure database by approved consultants to archive all groundwater data submitted. This preserved data is essential for generating temporal trend plots to proactively evaluate any potential degradation of groundwater quality during the Water Treatment Works (WWTW) operational phase. Following WWTW closure, monitoring must be sustained until groundwater quality parameters demonstrably return to baseline conditions (if the aquifer was affected during the operational phase), underscoring the critical need for complete and enduring data safeguarding.

Figure 25. Proposed surface and groundwater monitoring network.

9.3.1 Monitoring Objectives

- Establish baseline groundwater levels, quality, and flow dynamics within the study area to serve as a reference for detecting potential impacts
- Monitor the groundwater quality of the local aquifer,
- Detect possible pollution within the aquifer through interpretation of water quality on time graphs,
- Provide an early warning mechanism through strategically placed monitoring boreholes (upstream and downstream).
- Identify any potential risks or impacts associated with the development.

9.3.2 Water Quality Monitoring and Schedule

Quarterly water quality monitoring is recommended for upstream and downstream boreholes and surface water sites; samples must be submitted to a SANS-accredited laboratory for chemical and bacteriological analysis. Compare the results against established water quality objectives and standards to identify potential issues. Table 12 is a summary of the monitoring recommendations. The selection of monitoring parameters is based on parameters recommended by Woolf, K., McGibbon, D., Misrole, M., Mkali, A. and Flügel, T., 2023. *Guidance document on groundwater data collection.* WRC Report No. TT 905/22. Pretoria: Water Research Commission. These parameters have therefore been included in the proposed groundwater monitoring programme to ensure that any potential migration or impact of these contaminants on the underlying aquifer can be effectively assessed and managed over time.

Table 12. Monitoring network recommendations.

Site ID	Coordinates		Static Water Level (mbgl)	Borehole Depth (mbgl)	Water Strike Depth (mbgl)	Sample Depth (mbgl)	Site Type SW/GW	Frequency	Monitoring parameters		
	Latitude	Longitude							Cations and Anions (Woolf et al., 2023)	Non-Ionic Parameters	Bacteriological Analysis
Irrigation Area Upstream Monitoring Borehole	-28.125944°	24.812111°	To be determined by drilling information				GW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	e.Coli, Faecal Coliforms
Irrigation Area Downstream Monitoring Borehole	-28.116917°	24.810389°	To be determined by drilling information				GW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen
WWTW Area Upstream Monitoring Borehole	-28.124278°	24.820194°	To be determined by drilling information				GW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen
WWTW Area Downstream Monitoring Borehole	-28.119167°	24.822472°	To be determined by drilling information				GW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	e.Coli, Faecal Coliforms
Vaal River Upstream	-28.117444°	24.825917°	NA				SW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen
Vaal River Downstream	-28.117139°	24.799056°	NA				SW	Quarterly	Calcium, Magnesium, Sodium, Potassium, Ammonium, Iron, Manganese, Chloride, Sulphate, Bicarbonate, Carbonate, Nitrite, Nitrate, Orthophosphate, Fluoride	pH, EC, TDS, COD, TSS, Alkalinity, Dissolved Oxygen	e.Coli, Faecal Coliforms

10 CONCLUSION AND RECOMMENDATIONS

10.1 CONCLUSIONS

An average to moderate aquifer vulnerability was assigned to the area and a medium level of protection is needed (Parsons 1995). However, it is recommended that the management recommendations be implemented as mismanagement can lead to an impact on the groundwater system.

A hydrocensus site investigation was done on the 30th of April 2026. The objective of the site assessment was to establish groundwater level depths and water quality at existing boreholes and surface water sites within a 1km radius of the proposed site. Two (2) boreholes were identified and sampled for water quality analysis during the site assessment. A total number of 2 surface water sites (upstream and downstream) were identified within the Vaal River and sampled. This hydrocensus also confirmed limited dependence of groundwater resources within the 1km radius from the proposed WWTW.

During the geophysical investigation (chapter 4), upstream and downstream monitoring boreholes were strategically sited based on the interpretation of geophysical data, with specific emphasis on identifying potential preferential flow paths that may facilitate the migration of groundwater contaminants and to be located above and down gradient for the facility. The locations of these boreholes are presented in Figure 25, while their coordinates and associated monitoring recommendations are provided in Table 12.

The locations of the proposed upstream and downstream monitoring boreholes for the proposed WWTW and Irrigation area is indicated in Figure 25. Surface and Groundwater quality monitoring should be conducted quarterly and the samples must be submitted to an accredited laboratory for analysis. Establish a secure database by approved consultants to archive all groundwater data submitted. This preserved data is essential for generating temporal trend plots to proactively evaluate any potential degradation of groundwater quality during the Water Treatment Works (WWTW) operational phase. Following WWTW closure, monitoring must be sustained until groundwater quality parameters demonstrably return to baseline conditions (if the aquifer was affected during the operational phase), underscoring the critical need for complete and enduring data safeguarding.

The implementation of the comprehensive recommended Mitigation Measures (Table 11) and an Environmental Management Plan will successfully reduce the overall significance of the potential impact to a Low (L) rating. This reduction is achieved by effectively controlling the potential contaminant sources and pathways.

10.2 RECOMMENDATIONS

- Implement best practices from the Stormwater Management Plan to safeguard the aquifer.
- Ensure all structures that handle wastewater or treated water are lined with proper liners to prevent seepage into groundwater.
- Surface and groundwater quality must be sampled quarterly and analysed by an SANAS accredited laboratory according to the proposed monitoring network listed in Table 12
- Continue surface and groundwater monitoring to detect potential future leaks and establish trends in water quality, following the guidelines in Table 12 of the study.
- It is imperative that the irrigation water quality complies with the prescribed limits and standards set by the relevant regulatory authorities. Compliance with these water quality requirements will ensure that irrigation practices do not negatively affect or degrade the groundwater quality within the aquifer

The following measurements for effective management of the facility to prevent possible pollution seeping into the groundwater system

- Establish and maintain a secure database for all groundwater data to enable long-term trend analysis and ensure monitoring continues until post-closure recovery to baseline levels.
- Always maintain the facility in a clean and orderly condition.
- Dispose of all waste at registered facilities; no on-site dumping is permitted.
- Prohibit on-site disposal of sludge or waste due to shallow groundwater levels that may allow seepage.
- Construct all waste handling and storage areas with impermeable surfaces to prevent infiltration.
- Divert and manage stormwater to avoid contact with waste or contaminated areas.
- Regularly inspect and maintain all pipes and infrastructure to prevent leaks and system failures.

- Immediately contain and clean up any spills, and dispose of contaminated materials at registered landfill sites

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12 APPENDIX A – LABORATORY WATER QUALITY RESULTS

YANKA LABORATORIES

CHEMISTRY TEST RESULTS

LABORATORY NUMBER			SpNova 1	SpNova 2	SpNova 3	SpNova 4	Domestic Water. Class II is for information only. SANS 241:2025 back to 2006: SANS 241:2025 STANDARD LIMIT [Operational] [Aesthetic] [2015/2011/other]	Class II (Max Allowance for Limited Duration) *2006	Class II Water Consumption Period, a max *2006	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT	Target WQ Guidelines
SAMPLE DESCRIPTION			BH 1	BH 2	Up Stream	Down Stream						
SAMPLE NUMBER			E95896-001	E95896-002	E95896-003	E95896-004						
SAMPLED		Test Method **	2026/04/01 00:00	2026/04/01 00:00	2026/04/01 00:00	2026/04/01 00:00						
Remarks			Clear	Clear	Murky	Murky						
Total Alkalinity (pH>4.5)	mg $CaCO_3$/L	YE010Alk	329	341	106	103						
Bicarbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	329	341	106	103						
Carbonate Alkalinity	mg $CaCO_3$/L	YE010Alk	0.00	0.00	0.00	0.00						
M Alkalinity (8.3>pH>4.5)	mg $CaCO_3$/L	YE010Alk	329	341	106	103						
P Alkalinity (pH>8.3)	mg $CaCO_3$/L	YE010Alk	0.00	0.00	0.00	0.00						
Conductivity (Laboratory)	mS/m	YE020CON	76.3	135	40.1	39.5	< 170	150 - 370	7 years	* < 70	* < 50	< 40
pH (Laboratory)		YE030pH	7.76	7.10	7.68	7.77	5.0 - 9.7	4.0 - 10.0	No limit	5.5-9.5	5.5-7.5	6.5 - 8.5
Total Hardness	mg $CaCO_3$/L	YE061H	407	682	144	143						< 50
Calcium Hardness	mg $CaCO_3$/L	YE061H	152	352	74.9	74.4						
Magnesium Hardness	mg $CaCO_3$/L	YE061H	255	329	68.8	68.8						
Total Dissolved Solids (TDS)	mg/L	Calculation	453	865	222	220	< 1200	1000-2400	7 years			<450
Temperature	°C	Thermometer	21.0	21.0	21.0	21.0						
Calcium	mg Ca/L	YE060ICP	60.8	141	30.0	29.8	< 150	150 - 300	7 years			< 32
Chloride	mg Cl/L	YE070AK	32.2	123	29.2	28.2	< 250	200 - 600	7 years			<100
Magnesium	mg Mg/L	YE060ICP	61.9	80.0	16.7	16.7	< 70	70 - 100	7 years			< 30
Nitrate	mg N/L	YE070AK	8.01	6.37	<0.35	0.36	< 12	10 - 20	7 years	< 15	<1.5	< 6
Nitrite	mg N/L	YE070AK	<0.01	<0.01	0.02	<0.01	< 0.9					
Potassium	mg K/L	YE060ICP	1.91	1.92	7.92	7.71	< 50	50 - 100	7 years			< 50
Sodium	mg Na/L	YE060ICP	25.6	47.2	22.4	21.8	< 200	200 - 400	7 years			< 70
Sulphate	mg SO_4/L	YE070AK	37.1	239	50.8	50.8	< 250	400 - 600	7 years			< 200
Aluminium	mg Al/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.2	0.3 - 0.5	1 year			< 0.15
Antimony	mg Sb/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.02					
Arsenic	mg As/L	YE060ICP	<0.009	<0.009	<0.009	<0.009	< 0.01			<0.02	<0.01	<0.01
Barium	mg Ba/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 1.3					
Boron	mg B/L	YE060ICP	0.04	0.09	<0.01	<0.01	<2.4			<1.0	<0.5	<0.5
Cadmium	mg Cd/L	YE060ICP	<0.002	<0.002	<0.002	<0.002	< 0.003			<0.005	<0.001	<0.005
Chromium	mg Cr/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.05			<0.05	<0.02	
Copper	mg Cu/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 2			<0.01	<0.002	< 0.2
Fluoride	mg F/L	YE070AK	<0.09	<0.09	<0.09	<0.09	< 1.5	1.0 - 1.5	1 year	<1.0	<1.0	<1.0
Iron	mg Fe/L	YE060ICP	<0.01	<0.01	1.51	1.35	< 0.3	0.2 - 2.0	7 years	<0.3	<0.3	< 0.1
Lead	mg Pb/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.01			< 0.01	<0.006	< 0.01
Manganese	mg Mn/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.1	0.1 - 1.0	7 years	< 0.1	< 0.1	< 0.02
Nickel	mg Ni/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.07					< 0.2
Selenium	mg Se/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 0.04			< 0.02	< 0.02	< 0.02
Zinc	mg Zn/L	YE060ICP	<0.01	<0.01	<0.01	<0.01	< 3			<0.1	<0.04	< 1
Langelier Index (indicative, not SANS)		Calculation	0.52	0.21	-0.32	-0.25	-0.5 - 0.5	negative: water may corrode surfaces; positive: water may form scale on surfaces				
pHs (indicative, not SANS)		Calculation	7.24	6.89	8.00	8.02		Saturation pH (used in calculations)				
Sodium Absorption Ratio (indicative)		Calculation	0.55	0.78	0.81	0.79	< 1.5	Relevant in irrigation and				< 1.5
TDS to EC Ratio (indicative, not SANS)		Calculation	5.93	6.41	5.54	5.56		Analytical indicator				
Corrosion Ratio (indicative, not SANS)		Calculation	0.33	1.38	1.03	1.03	0 - 0.3	A.k.a. Larson-Skold Index; >0.3: water may (>1.2 would) corrode surfaces due to				
Ryznar Index (indicative, not SANS)		Calculation	6.73	6.68	8.33	8.27	6 - 7	< 6: water may form scale on surfaces; > 7: water may corrode surfaces				
Anion Sum			8.85	15.78	4.01	3.95						
Cation Sum			9.36	15.83	4.15	4.10						
Difference			0.52	0.05	0.14	0.15						
% Difference			2.83%	0.17%	1.71%	1.89%						

Methods adapted to accommodate local laboratory conditions.
SM refers to the Standard Methods for the Examination of Water and Wastewater.
Unless analysis is indicated as "Total", tests are performed on filtered samples as per ISO 11885.
Ion balance is not used as QC check where pH<3.5.
**** Methods Starting with YE are accredited, and based on ISO, SANS, and/or other national or international standards, please see http://www.yanka.co.za/TestsAndStandards.htm . For ranges, uncertainties, etc., please contact us.**

YANKA LABORATORIES

MICROBIOLOGY TEST RESULTS

LABORATORY NUMBER			SpNova 1	SpNova 2	SpNova 3	SpNova 4	STANDARD LIMIT SANS 241:2015	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max	ALLOWABLE COMPLIANCE CONTRIBUTION DOMESTIC USE 241:2006 Max Allowance of 1% of	SEWAGE LIMIT GENERAL LIMIT	SEWAGE LIMIT SPECIAL LIMIT
SAMPLE DESCRIPTION			**BH 1**	**BH 2**	**Up Stream**	**Down Stream**					
SAMPLE NUMBER			E95896-001	E95896-002	E95896-003	E95896-004					
SAMPLED		**Test Method**	**2026/04/01 00:00**	**2026/04/01 00:00**	**2026/04/01 00:00**	**2026/04/01 00:00**					
Remarks			**Clear**	**Clear**	**Murky**	**Murky**					
Total Coliforms	CFU/100mL	YE101TC / ISO 9308 based	0	52	52	60	< 10	No Limit	Alert 10		
Faecal Coliforms	CFU/100mL	YE102FC / ISO 9308 based	0	12	28	28	0	0	1	<1000	0
e.Coli	CFU/100mL	YE104EC / ISO 9308 based	0	2	0	0	0	0	1	<1000	

Methods adapted to accommodate local laboratory conditions.

SM refers to the Standard Methods for the Examination of Water and Wastewater.

*** Samples tested beyond 24 hours after being taken would likely not produce valid results**

*** Methods Starting with YE are accredited. For ranges, uncertainties, etc., please contact us.*

Results are reported as 0 where no growth was detected.

13 APPENDIX B – LABORATORY ACCREDITATION CERTIFICATE

sanas
South African National
Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

YANKA LABORATORIES (PTY) LTD
Co. Reg. No.: 2012/113891/07

Facility Accreditation Number: **T0647**

is a South African National Accreditation System accredited facility
provided that all conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation, Annexure "A", bearing the above accreditation number for

CHEMICAL AND MICROBIOLOGICAL ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2017

The accreditation demonstrates technical competency for a defined scope and the operation of a quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant accreditation symbol to issue facility reports and/or certificates

Mr F Osman
Acting Chief Executive Officer

Effective Date: 29 January 2029
Certificate Expires: 28 January 2030

14 APPENDIX C -GEOPHYSICAL DATA

Traverse Number: 01				
Profile Direction:W-E		Station Spacing:	10m	
STN	FIELD	REMOVAL REGIONAL	ANOMALY	3 POINT MAVG.
0	26823	26827.88	-4.88	-4.88
10	26834	26829.34	4.66	4.66
20	26824	26830.81	-6.81	-6.81
30	26838	26832.27	5.73	5.73
40	26811	26833.74	-22.74	-22.74
50	26771	26835.20	-64.20	-64.20
60	26820	26836.67	-16.67	-16.67
70	26842	26838.14	3.86	3.86
80	26856	26839.60	16.40	16.40
90	26836	26841.07	-5.07	-5.07
100	26848	26842.53	5.47	5.47
110	26851	26844.00	7.00	7.00
120	26872	26845.46	26.54	26.54
130	26874	26846.93	27.07	27.07
140	26867	26848.39	18.61	18.61
150	26849	26849.86	-0.86	-0.86
160	26846	26851.32	-5.32	-5.32
170	26849	26852.79	-3.79	-3.79
180	26861	26854.25	6.75	6.75
190	26881	26855.72	25.28	25.28
200	26853	26857.18	-4.18	-4.18
210	26892	26858.65	33.35	33.35
220	26848	26860.11	-12.11	-12.11
230	26860	26861.58	-1.58	-1.58
240	26900	26863.04	36.96	36.96
250	26879	26864.51	14.49	14.49
260	26830	26865.98	-35.98	-35.98
270	26844	26867.44	-23.44	-23.44
280	26883	26868.91	14.09	14.09
290	26846	26870.37	-24.37	-24.37
300	26830	26871.84	-41.84	-41.84
310	26850	26873.30	-23.30	-23.30
320	26824	26874.77	-50.77	-50.77
330	26868	26876.23	-8.23	-8.23
340	26880	26877.70	2.30	2.30
350	26859	26879.16	-20.16	-20.16
360	26936	26880.63	55.37	55.37
370	26900	26882.09	17.91	17.91
380	26990	26883.56	106.44	106.44
390	26950	26885.02	64.98	64.98
400	26900	26886.49	13.51	13.51
410	26889	26887.95	1.05	1.05
420	26926	26889.42	36.58	36.58
430	26868	26890.88	-22.88	-22.88
440	26851	26892.35	-41.35	-41.35
450	26909	26893.81	15.19	15.19
460	26841	26895.28	-54.28	-54.28
470	26831	26896.75	-65.75	-65.75
480	26891	26898.21	-7.21	-7.21
490	26903	26899.68	3.32	3.32
500	26906	26901.14	4.86	4.86
510	26867	26902.61	-35.61	-35.61
520	26892	26904.07	-12.07	-12.07
530	26871	26905.54	-34.54	-34.54
540	26906	26907.00	-1.00	-1.00
550	26874	26908.47	-34.47	-34.47
560	26892	26909.93	-17.93	-17.93
570	26909	26911.40	-2.40	-2.40
580	26974	26912.86	61.14	61.14
590	26889	26914.33	-25.33	-25.33
600	26829	26915.79	-86.79	-86.79
610	26923	26917.26	5.74	5.74
620	26857	26918.72	-61.72	-61.72
630	26883	26920.19	-37.19	-37.19
640	26843	26921.65	-78.65	-78.65
650	26870	26923.12	-53.12	-53.12
660	26829	26924.59	-95.59	-95.59
670	26825	26926.05	-101.05	-101.05
680	26897	26927.52	-30.52	-30.52
690	26876	26928.98	-52.98	-52.98
700	26900	26930.45	-30.45	-30.45
710	26921	26931.91	-10.91	-10.91
720	26898	26933.38	-35.38	-35.38
730	26901	26934.84	-33.84	-33.84
740	26910	26936.31	-26.31	-26.31
750	26898	26937.77	-39.77	-39.77
760	26874	26939.24	-65.24	-65.24
770	26875	26940.70	-65.70	-65.70

Traverse Number: 02				
Profile Direction:NW-SE		Station Spacing:	10m	
STN	FIELD	REMOVAL REGIONAL	ANOMALY	3 POINT MAVG.
0	26899	26907.11	-8.11	-8.11
10	26928	26906.93	21.07	21.07
20	26915	26906.74	8.26	8.26
30	26908	26906.56	1.44	1.44
40	26923	26906.37	16.63	16.63
50	26978	26906.19	71.81	71.81
60	26902	26906.01	-4.01	-4.01
70	26929	26905.82	23.18	23.18
80	26938	26905.64	32.36	32.36
90	26895	26905.45	-10.45	-10.45
100	26870	26905.27	-35.27	-35.27
110	26880	26905.08	-25.08	-25.08
120	26925	26904.90	20.10	20.10
130	26887	26904.71	-17.71	-17.71
140	26923	26904.53	18.47	18.47
150	26893	26904.34	-11.34	-11.34
160	26870	26904.16	-34.16	-34.16
170	26892	26903.97	-11.97	-11.97
180	26887	26903.79	-16.79	-16.79
190	26850	26903.60	-53.60	-53.60
200	26852	26903.42	-51.42	-51.42
210	26881	26903.23	-22.23	-22.23
220	26925	26903.05	21.95	21.95
230	26917	26902.86	14.14	14.14
240	26870	26902.68	-32.68	-32.68
250	26844	26902.49	-58.49	-58.49
260	26962	26902.31	59.69	59.69
270	26890	26902.12	-12.12	-12.12
280	26980	26901.94	78.06	78.06
290	26881	26901.75	-59.75	-59.75
300	26842	26901.57	-19.57	-19.57
310	26882	26901.38	31.62	31.62
320	26933	26901.20	5.80	5.80
330	26907	26901.02	23.98	23.98
340	26925	26900.83	13.17	13.17
350	26914	26900.65	1.35	1.35
360	26902	26900.46	-14.46	-14.46
370	26886	26900.28	21.72	21.72
380	26922	26900.09	43.91	43.91
390	26944	26899.91	-25.91	-25.91
400	26874	26899.72	21.28	21.28
410	26921	26899.54	-27.54	-27.54
420	26872	26899.35	-28.35	-28.35
430	26871	26899.17	7.83	7.83
440	26907	26898.98	0.02	0.02
450	26899	26898.80	19.20	19.20
460	26918	26898.61	21.39	21.39
470	26920	26898.43	#REF!	#REF!

Traverse Number: 03				
Profile Direction:SE-NW		Station Spacing:	10m	
STN	FIELD	REMOVAL REGIONAL	ANOMALY	3 POINT MAVG.
0	27221	27207.18	13.82	13.82
10	27214	27206.84	7.16	7.16
20	27228	27206.50	21.50	21.50
30	27255	27206.16	48.84	48.84
40	27212	27205.81	6.19	6.19
50	27222	27205.47	16.53	16.53
60	27228	27205.13	22.87	22.87
70	27202	27204.79	-2.79	-2.79
80	27218	27204.45	13.55	13.55
90	27211	27204.10	6.90	6.90
100	27214	27203.76	10.24	10.24
110	27205	27203.42	1.58	1.58
120	27149	27203.08	-54.08	-54.08
130	27144	27202.74	-58.74	-58.74
140	27154	27202.40	-48.40	-48.40
150	27154	27202.05	-48.05	-48.05
160	27149	27201.71	-52.71	-52.71
170	27215	27201.37	13.63	13.63
180	27196	27201.03	-5.03	-5.03
190	27206	27200.69	5.31	5.31
200	27186	27200.34	-14.34	-14.34
210	27204	27200.00	4.00	4.00
220	27186	27199.66	-13.66	-13.66
230	27190	27199.32	-9.32	-9.32
240	27191	27198.98	-7.98	-7.98
250	27204	27198.64	5.36	5.36
260	27203	27198.29	4.71	4.71
270	27199	27197.95	1.05	1.05
280	27211	27197.61	13.39	13.39
290	27203	27197.27	5.73	5.73
300	27196	27196.93	-0.93	-0.93
310	27220	27196.58	23.42	23.42
320	27218	27196.24	21.76	21.76
330	27202	27195.90	6.10	6.10
340	27205	27195.56	9.44	9.44
350	27216	27195.22	20.78	20.78
360	27201	27194.88	6.12	6.12
370	27219	27194.53	24.47	24.47
380	27200	27194.19	5.81	5.81
390	27199	27193.85	5.15	5.15
400	27212	27193.51	18.49	18.49
410	27205	27193.17	11.83	11.83
420	27170	27192.82	-22.82	-22.82
430	27189	27192.48	-3.48	-3.48
440	27188	27192.14	-4.14	-4.14
450	27188	27191.80	-3.80	-3.80
460	27166	27191.46	-25.46	-25.46

Traverse Number: 04				
Profile Direction:W-E		Station Spacing:	10m	
STN	FIELD	REMOVAL REGIONAL	ANOMALY	3 POINT MAVG.
0	27179	27171.14	7.86	7.86
10	27175	27171.02	3.98	3.98
20	27172	27170.91	1.09	1.09
30	27169	27170.79	-1.79	-1.79
40	27166	27170.67	-4.67	-4.67
50	27173	27170.55	2.45	2.45
60	27159	27170.43	-11.43	-11.43
70	27186	27170.32	15.68	15.68
80	27170	27170.20	-0.20	-0.20
90	27170	27170.08	-0.08	-0.08
100	27171	27169.96	1.04	1.04
110	27163	27169.85	-6.85	-6.85
120	27165	27169.73	-4.73	-4.73
130	27155	27169.61	-14.61	-14.61
140	27162	27169.49	-7.49	-7.49
150	27168	27169.37	-1.37	-1.37
160	27166	27169.26	-3.26	-3.26
170	27173	27169.14	3.86	3.86
180	27167	27169.02	-2.02	-2.02
190	27171	27168.90	2.10	2.10
200	27174	27168.79	5.21	5.21
210	27167	27168.67	-1.67	-1.67
220	27175	27168.55	6.45	6.45
230	27178	27168.43	9.57	9.57
240	27170	27168.31	1.69	1.69
250	27161	27168.20	-7.20	-7.20
260	27172	27168.08	3.92	3.92
270	27174	27167.96	6.04	6.04
280	27164	27167.84	-3.84	-3.84
290	27171	27167.72	3.28	3.28
300	27169	27167.61	1.39	1.39
310	27169	27167.49	1.51	1.51
320	27160	27167.37	-7.37	-7.37
330	27168	27167.25	0.75	0.75
340	27165	27167.14	-2.14	-2.14
350	27163	27167.02	-4.02	-4.02
360	27168	27166.90	1.10	1.10
370	27163	27166.78	-3.78	-3.78
380	27159	27166.66	-7.66	-7.66
390	27175	27166.55	8.45	8.45
400	27173	27166.43	6.57	6.57
410	27164	27166.31	-2.31	-2.31
420	27171	27166.19	4.81	4.81
430	27167	27166.08	0.92	0.92
440	27165	27165.96	-0.96	-0.96
450	27179	27165.84	13.16	13.16
460	27171	27165.72	5.28	5.28
470	27177	27165.60	11.40	11.40
480	27166	27165.49	0.51	0.51
490	27157	27165.37	-8.37	-8.37
500	27143	27165.25	-22.25	-22.25
510	27160	27165.13	-5.13	-5.13
520	27174	27165.01	8.99	8.99
530	27174	27164.90	9.10	9.10
540	27163	27164.78	-1.78	-1.78
550	27164	27164.66	-0.66	-0.66
560	27151	27164.54	-13.54	-13.54
570	27150	27164.43	-14.43	-14.43
580	27156	27164.31	-8.31	-8.31
590	27145	27164.19	-19.19	-19.19
600	27152	27164.07	-12.07	-12.07
610	27152	27163.95	-11.95	-11.95
620	27147	27163.84	-16.84	-16.84
630	27154	27163.72	-9.72	-9.72
640	27146	27163.60	-17.60	-17.60
650	27152	27163.48	-11.48	-11.48
660	27136	27163.37	-27.37	-27.37
670	27140	27163.25	-23.25	-23.25
680	27152	27163.13	-11.13	-11.13
690	27139	27163.01	-24.01	-24.01
700	27135	27162.89	-27.89	-27.89
710	27157	27162.78	-5.78	-5.78
720	27133	27162.66	-29.66	-29.66
730	27153	27162.54	-9.54	-9.54
740	27133	27162.42	-29.42	-29.42
750	27149	27162.30	-13.30	-13.30
760	27139	27162.19	-23.19	-23.19
770	27139	27162.07	-23.07	-23.07
780	27150	27161.95	-11.95	-11.95
790	27164	27161.83	2.17	2.17
800	27129	27161.72	-32.72	-32.72
810	27144	27161.60	-17.60	-17.60

Traverse Number: 05				
Profile Direction:W-E		Station Spacing:	10m	
STN	**FIELD**	**REMOVAL REGIONAL**	**ANOMALY**	**3 POINT MAVG.**
0	27141	27160.76	-19.76	-19.76
10	27147	27161.12	-14.12	-14.12
20	27147	27161.49	-14.49	-14.49
30	27164	27161.85	2.15	2.15
40	27150	27162.21	-12.21	-12.21
50	27159	27162.57	-3.57	-3.57
60	27176	27162.93	13.07	13.07
70	27162	27163.30	-1.30	-1.30
80	27156	27163.66	-7.66	-7.66
90	27154	27164.02	-10.02	-10.02
100	27184	27164.38	19.62	19.62
110	27164	27164.74	-0.74	-0.74
120	27168	27165.11	2.89	2.89
130	27175	27165.47	9.53	9.53
140	27162	27165.83	-3.83	-3.83
150	27188	27166.19	21.81	21.81
160	27178	27166.55	11.45	11.45
170	27176	27166.92	9.08	9.08
180	27165	27167.28	-2.28	-2.28
190	27177	27167.64	9.36	9.36
200	27167	27168.00	-1.00	-1.00
210	27194	27168.36	25.64	25.64
220	27191	27168.73	22.27	22.27
230	27171	27169.09	1.91	1.91
240	27175	27169.45	5.55	5.55
250	27179	27169.81	9.19	9.19
260	27181	27170.17	10.83	10.83
270	27176	27170.54	5.46	5.46
280	27173	27170.90	2.10	2.10
290	27154	27171.26	-17.26	-17.26
300	27154	27171.62	-17.62	-17.62
310	27151	27171.98	-20.98	-20.98
320	27148	27172.35	-24.35	-24.35
330	27162	27172.71	-10.71	-10.71

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Proposed Relocation of the Warrenton WWTW and Associated Bulk Infrastructure.

2. Details of the specialist:

Project Specialist:	Geohydrologist		
Trading name (if any):	EMG		
Business reg. no./ID. no.:	2017/077689/07		
Contact person:	Dirk Moolman		
Physical address:	New Market Road Groenvlei, Langenhoven Park, 9330		
Postal address:	PO Box 37473, Langenhoven Park		
Postal code:	9330	**Cell:**	084 2086 456
Telephone:	-	**Fax:**	-
E-mail:	dirk@envmgp.com		
Qualifications:	MSc (Geohydrology)		
Professional affiliation (s) (if any)	Pr Sci Nat NGA		

3. Details of the consultant

Project consultant/firm:	Environmental Management Group		
Business reg. no./ID. no.:	2017/077689/07		
Contact person:	Ivan Victor Coertze		
Postal address:	PO Box 37473, Langenhovenpark		
Postal code:	9330	**Cell:**	071 371 8825
Telephone:	051 412 6350	**Fax:**	-
E-mail:	ivan@envmgp.com		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, **Dirk Moolman**________________, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

____

Signature of the specialist:

Environmental Management Group

Name of company (if applicable):

11/06/2026

Date:

____

Signature of the Commissioner of Oaths:

11/06/2026

Date:

Professional Accountant

Designation:

Official stamp (below):

COMMISSIONER OF OATHS (RSA)
DALTON MAURITZ BAKKES
Professional Accountant (S.A.) ex officio
SAIPA NO: 35354
P.O. BOX 1703, MONTANA PARK, 0159

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