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Inorganic Business Unit

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Hydrogeological Study for the Infanta Development

Client:

Doug Jeffery Environmental Consultants

GPT Ref No:

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Offices in: Gauteng, Western Cape, KwaZulu-Natal & Mozambique

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Site Name:	Infanta
Site Location:	Infanta, Western Cape
Compiled For:	Doug Jefferies Consulting (Pty) Ltd
Compiled By:	Marius Terblanche
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Distribution List (Current Version):	Mr Lian Roos
Reviewed by:	Marius Terblanche

Disclaimer:

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I hereby declare:

- I have no vested interest (present or prospective) in the project that is the subject of this report as well as its attachments. I have no personal interest with respect to the parties involved in this project.
- I have no bias with regard to this project or towards the various stakeholders involved in this project.
- I have not received, nor have I been offered, any significant form of inappropriate reward for compiling this report.

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Customer Satisfaction:

Feedback regarding the technical quality of this report (i.e. methodology used, results discussed and recommendations made), as well as other aspects, such as timeous completion of project and value of services rendered, can be posted onto GPT's website at www.gptglobal.com.

EXECUTIVE SUMMARY

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by Doug Jeffery Environmental Consultants (Pty) Ltd to conduct a hydrogeological study in support of the water use license to be applied for the by the client on behalf of the proposed Infanta Development.

The site is located in Infanta near Witsand, in the Western Cape.

The area is characterised by a gently undulating topography and in the area of the site the slope is more or less in the order of 3% (0.03).

Locally drainage is towards the Indian Ocean as well as the Brëe River that flows from northwest to southeast to the north of the site.

Climatic data was obtained from the GRDM V4.0 database as developed by the DWA and FetWater. The average annual rainfall is approximately 458mm/a.

The site is underlain by light grey to red sandy soil and calcrete with alluvium deposits to the coastline. Furthermore, the underlying geology in the region consist of the Skurweberg Formation as well as the Rietvlei Formation of the Nardouw Subgroup, Table Mountain Group, as well as the Robberg Formation of the Uitenhage Group. The Skurweberg Formation mainly comprises of light grey quarzitic sandstone. The Reitvlei Formation consists of light grey feldspathic sandstone with occasional thin siltstone and shale beds. The Robberg Formation consists of silicified sandstone and conglomerate. These formations all strike in an east west direction with a northward dip of between 30 and 40 degrees.

According to Meyer (2001), the Table Mountain Group (TMG), notably the often-fractured arenaceous components, is largely anisotropic and thus does not display uniform aquifer characteristics. An intricate network of fissures, joints, fractures and even cavities govern the infiltration, storage and transmission of groundwater in the largely competent and brittle natured arenaceous units of the TMG. The TMG generally constitutes the mountainous areas which, in turn influence precipitation to a significant extent. An abundance of springs is a further characteristic of the TMG

A hydrocensus was conducted on the 28 & 29th of July 2025 within a 1km radius form the property boundary. Seven (7) operational boreholes were located as well as two (2) springs. The hydrocensus recorded an average groundwater level of 4.35 m below ground level (mbgl), with measured depths ranging from 3.60 mbgl to 5.04 mbgl. The general groundwater flow direction is towards the northeast in the direction of the ocean. Boreholes BH05, BH07 and BH09 were selected to be tested for groundwater quality. The water quality results are compared with the SANS 241-1: 2015 target water quality limits.

A Stepped Discharge Test, Constant Discharge Test & Recovery Monitoring was performed on borehole 134C. Based on the available data, it can be concluded that a total volume of 32.4 m^3/day can be abstracted from the tested borehole.

The GDT calculated a vulnerability value of 58% for the aquifer which is classified as medium. Based on information collected during the hydrocensus it can be concluded that the aquifer system in the study area can be classified as a “Minor Aquifer System”, based on the fact that the local population is not dependent on groundwater. A Groundwater Quality Management Index of 4 was estimated for the study area from the ratings for the Aquifer System Management Classification. According to this estimate a medium level of groundwater protection is required for the aquifer.

The general authorisation volume for the area is calculated at 12 975 m^3/year, while the planned water demand is 6 132 m^3/year. Therefore, it can be concluded that the proposed demand falls within the scope of a general authorisation. If the maximum volume that can be abstracted, according to the sustainable yield calculations (Section 7.2) of 32.4 m^3/day or 11 826 m^3/year, is applied for, this volume still remains within the general authorisation allowance.

Recommendations:

The following actions are recommended to be implemented during the construction and the implementation phases:

- Groundwater quality exceedances in the boreholes above the SANS 241 drinking water standards indicated that the groundwater at the site is not suitable for use as potable water without prior treatment. The exceedances in total coliforms can be addressed by improving sanitation systems and ensuring human or animal wastes are properly disposed of.
- The monitoring as recommended in the report should be established prior to operation. The water level monitoring should be conducted weekly for the first three months of operation and if no significant water level decline is observed, the monitoring can be conducted on a monthly basis. Alternatively, automatic water level measurement in the form of pressure transducers can be installed to aid in this process. Logs of flow meter readings should also be kept and the flowmeter should also be read once per month.
- Seawater intrusion may become a concern during extended abstraction periods and should be monitored.
- A rainfall gauge should be installed on the site and rainfall readings should be taken after every rainfall event and the time and date of the reading recorded.
- The monitoring data (water levels, rainfall and chemistry) should be kept in an electronic database for further analysis should this be required.
- The recommended pump cycle for the borehole is 12 hours per day. If the pump cycle is to be extended, the maximum daily volume for each borehole must not be exceeded and the pumping rate must be reduced to sustainable rates. Refer to management recommendations in Table 22.
- It is recommended that the hydrocensus be repeated once every 2 years to ensure that no new groundwater users are affected. The hydrocensus should extend to a 1km radius around the site boundary.
- The regional groundwater table must be maintained to:
    - Ensure that schedule 1 water users adjacent to the site have adequate water supply to basic human need.
    - Ensure that adequate water is available to maintain base flow in the tributaries of the Breede River.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
EC	Electrical Conductivity
km^2	Square kilometre
L/s	Litres per second
GRDM	Groundwater Resource Directed Measures
mamsl	Metres above mean sea level
Mm^3/a	Milicubes per year
m	metre
mm	Millimetre
mm/a	Millimetres per annum
mS/m	Millisiemens per metre
m^3	Cubic metre
MAP	Mean Annual Precipitation
NWA	National Water Act (Act No. 36 of 1998)
RDM	Resource Directed Measures
RQO	Resource Quality Objective
TDS	Total Dissolved Solids
WMA	Water Management Area
WMP	Water Management Plan

DEFINITIONS

Definition	**Explanation**
Aquifer	A geological formation which has structures or textures that hold water or permit appreciable water movement through them. Source: National Water Act (Act No. 36 of 1998).
Borehole	Includes a well, excavation, or any other artificially constructed or improved underground cavity which can be used for the purpose of intercepting, collecting or storing water in or removing water from an aquifer; observing and collecting data and information on water in an aquifer; or recharging an aquifer. Source: National Water Act (Act No. 36 of 1998).
Drawdown	The distance between the static water level and the surface of the cone of depression.
Fractured Aquifer	An aquifer that owes its water-bearing properties to fracturing.
Groundwater	Water found in the subsurface in the saturated zone below the water table.
Groundwater Flow	The movement of water through openings in sediment and rock; occurs in the zone of saturation in the direction of the hydraulic gradient.
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).
Intergranular Aquifer	A term used in the South African map series referring to aquifers in which groundwater flows in openings and void spaces between grains and weathered rock.
Monitoring	The regular or routine collection of groundwater data (e.g. water levels, water quality and water use) to provide a record of the aquifer response over time.
Observation Borehole	A borehole used to measure the response of the groundwater system to an aquifer test.
Production Borehole	A borehole specifically designed to be pumped as a source of water supply.
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.
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.
Unsaturated Zone (Also Termed Vadose Zone)	That part of the geological stratum above the water table where interstices and voids contain a combination of air and water.
Watershed (Also Termed Catchment)	Catchment in relation to watercourse or watercourses or part of a watercourse means the area from which any rainfall will drain into the watercourses or part of a watercourse through surface flow to a common point or points. Source: National Water Act (Act No. 36 of 1998).
Water Table	The upper surface of the saturated zone of an unconfined aquifer at which pore pressure is equal to that of the atmosphere.

HYDROGEOLOGICAL STUDY

INFANTA

1 INTRODUCTION

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by Doug Jefferies Consulting (Pty) Ltd to update a hydrogeological study that will form part of the Environmental Impact Assessment for the use of groundwater for water supply purposes for the proposed development of 21 houses.

The report is structured according to the requirements of the National Water Act, 1998 Regulations regarding the procedural requirements for water use licence applications and appeals 24 March 2017, Act No. R. 267.

2 SCOPE OF WORK

Within the scope of work the groundwater study aimed to address the requirements of the planned water use license application for the abstraction of groundwater for irrigation purposes.

3 METHODOLOGY

3.1 Desk Study

This entailed the gathering of information through the collation, scrutiny and evaluation of available and relevant meteorological, geographical, geological, hydrogeological and water quality data.

3.2 Hydrocensus

A hydrocensus was conducted within a 500 m radius of the site boundary to gather data of legitimate groundwater users in the area.

4 GEOGRAPHICAL SETTING

4.1 Site Location, Topography and Drainage

The site is located near Witsand, in the Western Cape. (Figure 1).

The area (shown in Figure 2) is characterised by a gently undulating topography and in the area of the site the slope is more or less in the order of 3% (0.03).

Locally drainage is towards the Indian Ocean as well as the Breede River that flows from northwest to southeast to the north of the site.

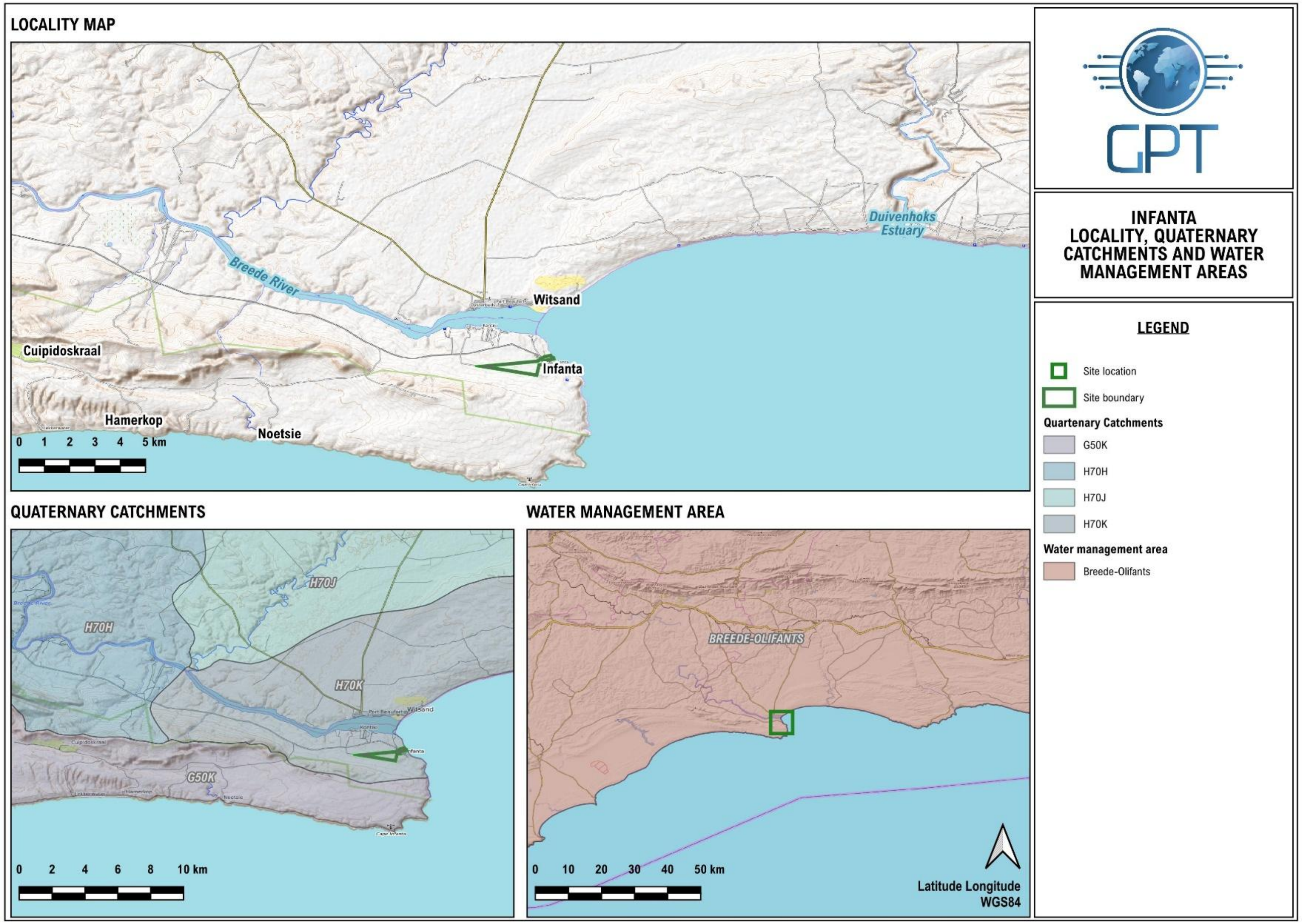


Figure 1: Site Location and Quaternary Catchment Boundaries.

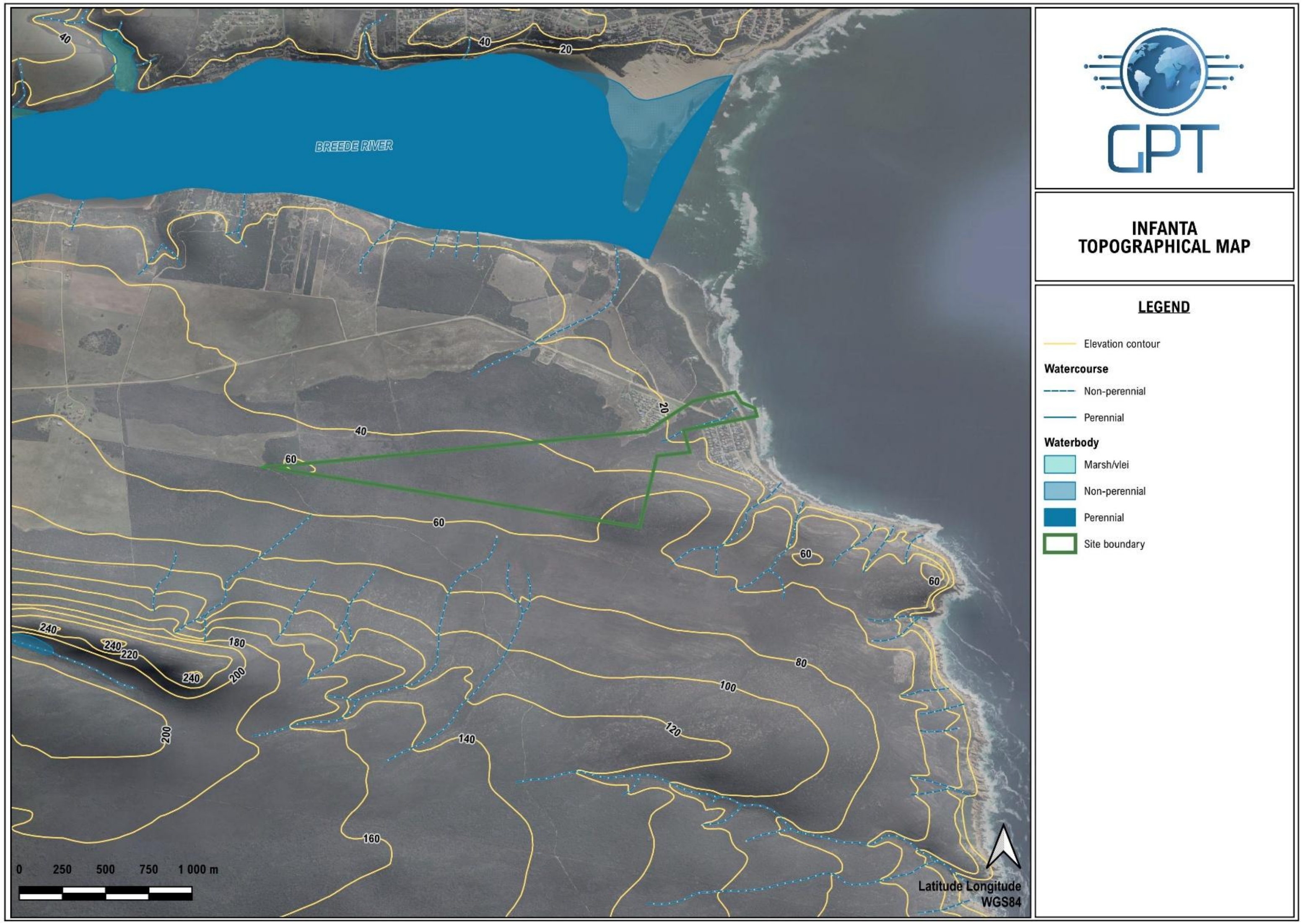


Figure 2: Site Topography.

4.2 Climate

Climatic data was obtained from the GRDM V4.0 database as developed by the DWA and FetWater[1]. The average annual rainfall is approximately 458mm/a.

5 PREVAILING GROUNDWATER CONDITIONS

5.1 Geology

5.1.1 Regional Geology

The investigated area falls within the 1:250 000 series geology map (3420 Riverdale). An extract of this map is shown in Figure 3. According to the map the site is underlain by light grey to red sandy soil and calcrete with alluvium deposits to the coastline. Furthermore the underlying geology in the region consist of the Skurweberg Formation as well as the Rietvlei Formation of the Nardouw Subgroup, Table Mountain Group, as well as the Robberg Formation of the Uitenhage Group. The Skurweberg Formation mainly comprises of light grey quarzitic sandstone. The Reitvlei Formation consists of light grey feldspathic sandstone with occasional thin siltstone and shale beds. The Robberg Formation consists of silicified sandstone and conglomerate. These formations all strike in an east west direction with a northward dip of between 30 and 40 degrees.

5.1.2 Local Geology

Based on the published data and the Parsons (2006) report[2], the site is underlain by Quaternary soil with unknown thicknesses. Underneath these recent sediments the Rietvlei and Skurweberg Formations of the Table Mountain Group can be found. The latter formation is regarded as an extensive aquifer that could support large scale abstraction. However, the 1:250 000 series maps are not detailed enough to accurately represent the geology of the site as it is evident that the site is underlain by the shales of the Bokkeveld Group. Outcrops of the Bokkeveld geology can be seen along the shoreline of the property, where it underlies the younger conglomerate and calcrete lithologies found at the site.

5.2 Hydrogeology

5.2.1 Regional Hydrogeology

According the 1:500 000 hydrogeological map (3317 Cape Town), the site is underlain by a fractured aquifer. The mean yield for a successful borehole in this aquifer is between 0.5 and 2 l/s and this was confirmed by previous reports that included drilling of a new borehole. The previous work by Parsons and Associates (2006) estimates the sustainable yield from 134A at 0.7 l/s when pumped for 12 hours a day, with 134C yielding 1 l/s when pumped for 18 hours a day.

[1] Groundwater Reserve Directed Measured. Department of Water Affairs (2010), developed by FetWater.

[2] Parsons, 2006. Geohydrological Assessment of the Planned Development at Erf 124, Infanta. Parsons and Associates.

As the Bokkeveld Group overlies the Table Mountain Group , the hydrogeology of the THM could be relevant at deeper depths. According to Meyer[3], the Table Mountain Group (TMG), notably the often fractured arenaceous components, is largely anisotropic and thus does not display uniform aquifer characteristics. An intricate network of fissures, joints, fractures and even cavities govern the infiltration, storage and transmission of groundwater in the largely competent and brittle natured arenaceous units of the TMG. The TMG generally constitutes the mountainous areas which, in turn influence precipitation to a significant extent. An abundance of springs is a further characteristic of the TMG. Three kinds of springs can be distinguished:

1. Fault and major structure controlled, generally deep circulating springs, often with large constant supplies

2. Lithologically controlled, relatively shallow circulating springs. These springs issue due to the presence of impeding shale layers such as the Cederberg Shale Formation. Yields from these springs are less constant and seasonal yield fluctuations are a distinctive feature. The bulk of the perennial springs issuing from the TMG are likely to be lithologically controlled.

3. Springs are seeping from numerous small fractures and joints. They are very evident during and shortly after rainy periods and are responsible for the myriad of springs in the TMG. They are however highly seasonal and cease to exist with the onset of dry weather conditions.

The quality of groundwater from the TMG is excellent with electrical conductivities generally ranging between 5 and 70mS/m. However, groundwater with EC's of up to 180mS/m can occasionally be procured from boreholes drilled into interbedded shaly layers. Groundwater is generally of a sodium chloride nature.

In the case of the Bokkeveld Group which is found predominantly at the site, the groundwater found within this lithology is generally poor in terms of hight TDS[4] and typically has EC values between 70-300 mS/m. The groundwater found in this unit at Cape Infanta has been found to be moderately saline with EC values between 133-222 mS/m, which has been attributed to possible marine influence[5].

5.2.2 Local Hydrogeology

The previous work by Parsons and Associates (2006) estimates the sustainable yield from 134A at 0.7 l/s when pumped for 12 hours a day, with 134C yielding 1 l/s when pumped for 18 hours a day. These yields are aligned with the published information and support the statement in the Parsons and Associates report that the initial pumping tests that indicated 5 l/s yields were an overestimation.

Following a request from the then Breede Overberg Catchment Management Agency (BOCMA) in 2014, a 72 hour pumping test was conducted on borehole 134C to determine the sustainable yield. At first a step test was performed to find the required pumping rate for a constant discharge test. The first step was pumped at 0.32 l/s for one hour yielding a drawdown of 4.9 m. The second step was pumped at 0.78 l/s and resulted in a final drawdown of 20.81 m, while the third step was conducted at 1.48 l/s with a final drawdown of 56.03 m after another hour. The 72-hour constant discharge test was then conducted at a pumping rate of 0.92 l/s.

[3] Meyer P.S (2001), An explanation of the 1:500 000 general hydrogeological map Cape Town 3317

[4] Hartnady, C.J.H. and Jones, M.Q.W., 2007. Geothermal studies of the Table Mountain Group aquifer systems. Water Research Commission, Report, (1403/1), p.07.

[5] Papini G, 2002. Groundwater Assessment for the Breede River Basin Study. Department of Water Affairs and Forestry.

The data was analysed using the FC method as detailed in the update of 18 August 2014. The average sustainable yield was determined to be 0.29 l/s for pumping 24 hours per day every day for 100 years. This is regarded as being a very conservative approach, since the use of the borehole is likely to be seasonal. The sustainable conservative yield of the borehole is calculated to be 25000 l/day. For the best case scenario the yield goes up to 48000 l/day. This relates to between 750 and 1440 m^3/month. The development is designed to use 690 m^3/month. This test once again shows that sufficient water is available in borehole 134C for the whole development, without using borehole 134A.

Using the proposed pumping rates the sustainable yield exceeds the required 23 m^3/day requirement as stated by Fraser (2014). The current proposal is to use 134C, since this borehole will have sufficient yield for the planned 23 units and it is situated further away from any other groundwater users.

The Parsons (2006) report estimated the use of groundwater in the vicinity of the proposed development to be 15 300 m3/a. The harvest potential for Erf 134 was calculated as 48 700 m^3/a. Using the reported harvest potential and a 2 km radius around the site an approximate 4 km^2 is available and this would equate to 226 400 m^3/a being available through the groundwater resource in the area.

Parsons (2006) cites a 1999 study by Toens and Partners recorded 37 boreholes in Infanta Village, but found no threat due to saline intrusion at the time of the study. Bacteriological contamination was only observed where TMG rock outcrops were found. Water quality was found to be acceptable for human consumption with EC levels ranging from 170 to 220 mS/m.

5.3 Groundwater Recharge Calculations

Recharge to the shallow, unconfined aquifer was calculated using the RECHARGE program developed by the Institute for Groundwater Studies at the University of the Free State, South Africa. The calculated recharge excluded the recharge indicated by the soil information and the geology and Vegter maps due to the low uncertainty; the recharge percentage equates to approximately 3.1%.

Table 1: Recharge calculation for the aquifer.

Recharge Estimation			
Method	**mm/a**	**% of rainfall**	**Certainty (Very High = 5; Low = 1)**
Soil	126.0	29.4	1
Geology	33.9	7.9	2
Vegter	32.0	7.5	2
Acru	15.0	3.5	4
Harvest Potential	12.0	2.8	4

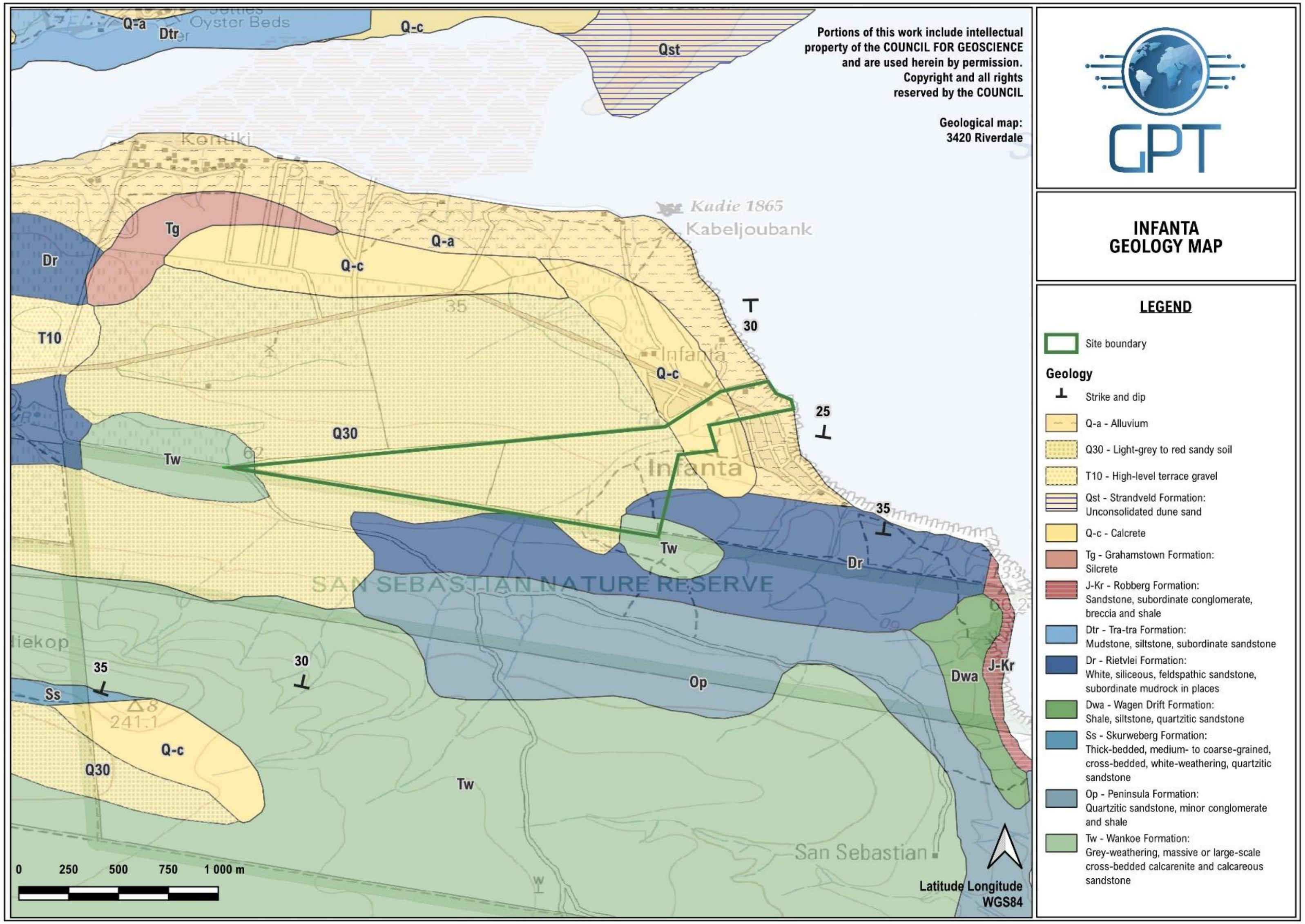


Figure 3: Regional Geology Map (1:250 000 geology series map).

6 Hydrocensus

6.1 Hydrocensus findings and groundwater flow direction

A hydrocensus was conducted on the 28 & 29th of July 2025 within a 1km radius form the property boundary. Seven (7) operational boreholes were located as well as two (2) springs. The majority of the homeowners in Infanta village was not home during the hydrocensus and a number of residents use rainwater as a water supply for domestic use. A summary of the field data is presented in Table 2 below. The hydrocensus data is also plotted on a map presented in Figure 4.

The hydrocensus recorded an average groundwater level of 4.35 m below ground level (mbgl), with measured depths ranging from 3.60 mbgl to 5.04 mbgl. In addition, two free-flowing springs were identified at ground surface. One spring was heavily overgrown and inaccessible for direct measurement, while another could only be visually confirmed. It is possible that these springs represent artesian discharges resulting from historical drilling into a confined aquifer with a high-pressure head; however, this could not be confirmed. Regional hydrogeological data indicate the natural occurrence of springs in the area, and the observed features may also be attributed to these natural conditions.

A groundwater flow direction map was created from the boreholes and can be seen in Figure 5. The general flow direction at Infanta is towards the northeast in the direction of the ocean and flow more towards the inland is in a norther direction.

Table 2: Details of the hydrocensus boreholes.

New Label	LONGITUDE	LATITUDE	Owner	WL (mbcl)	Collar	WL (mbgl)	Pump Installed	Water use	Notes
BH05	20° 50' 55.8096" E	34° 25' 12.3060" S	Infant Park	4.51	0.15	4.36	Submersible	Domestic & Garden	Supplies Infanta Park with water, up to 18 families.
BH06	20° 50' 55.4644" E	34° 25' 12.1548" S	Infant Park	3.71	0.11	3.6	Submersible	Domestic, Garden, Livestock & Agriculture	Water also sold to municipality for ablutions
BH07	20° 51' 17.9658" E	34° 25' 15.6952" S	Sea Cottage Trust	-	-	-	Submersible	Garden	No Access through pump capping.
BH08	20° 51' 17.6683" E	34° 25' 16.3768" S	Ika van Niekerk	4.81	-0.23	5.04	No pump	No Use	No pump installed
BH09	20° 51' 16.4459" E	34° 25' 12.2236" S	Unknown	4.2	-0.23	4.43	Submersible	Unknown	Permission granted for data gathering from neighbour
BH10	20° 51' 10.4005" E	34° 25' 13.4005" S	Elsa	-	-	-	Submersible	-	Could not collect data, nobody home, BH seen from the fence
BH134C	20° 50' 40.03" E	34° 25' 14.84" S	Mark De Agrella	11.07	0.3	10.77	No pump	Proposed Domestic Use Supply	Test pumped in June 2020.
BH11	20° 50' 57.0156" E	34° 25' 15.8592" S	Abandoned borehole, blocked @ 1.5mbgl						
BH134A	20° 50' 57.0624" E	34° 25' 14.3040" S	No Access (pump house locked) & Owner not present						
SP01	20° 51' 10.3680" E	34° 25' 20.1468" S	Artesian Well						
SP02	20° 51' 26.0136" E	34° 25' 25.9140" S	Artesian Well						

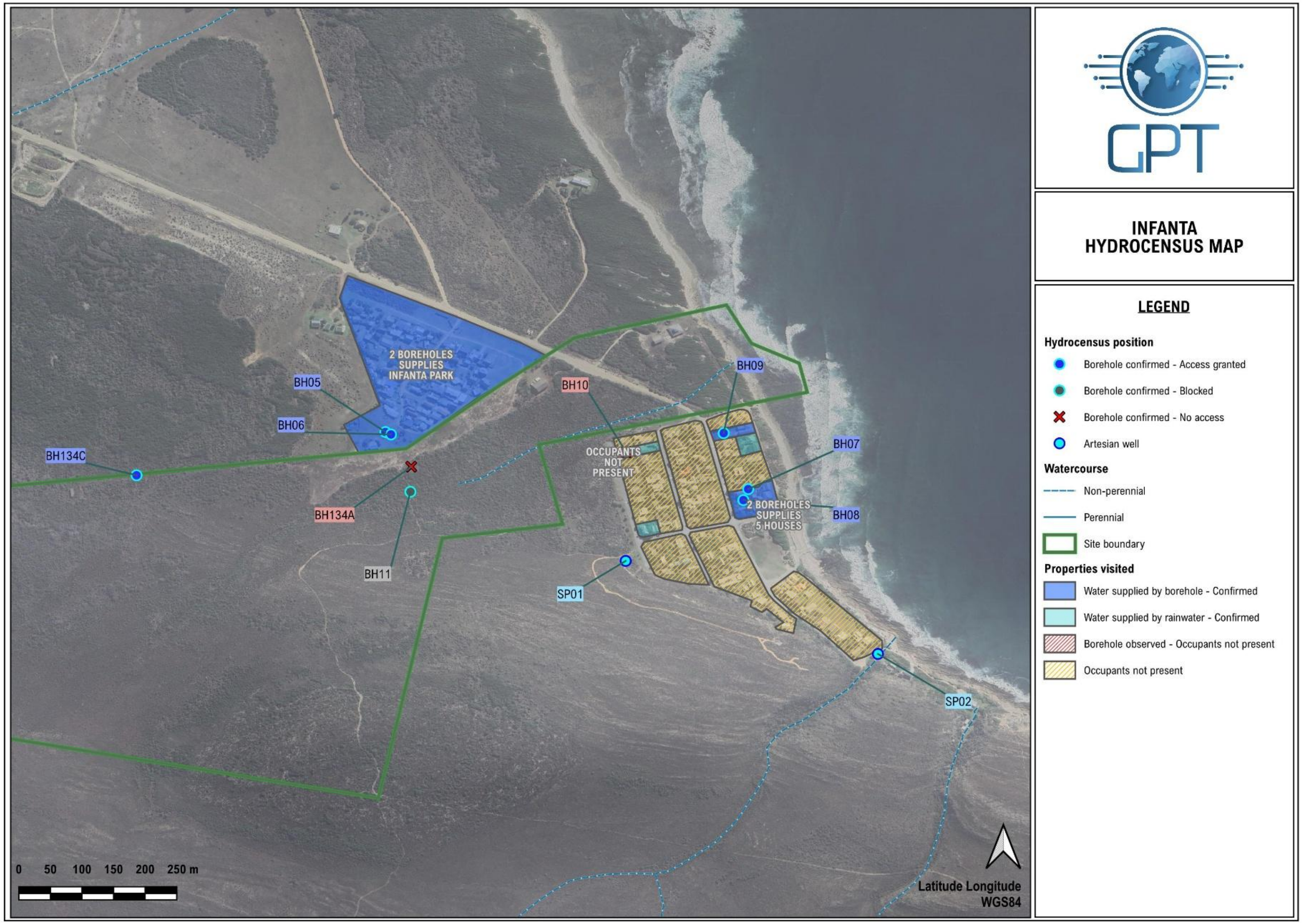


Figure 4: Hydrocensus Map.

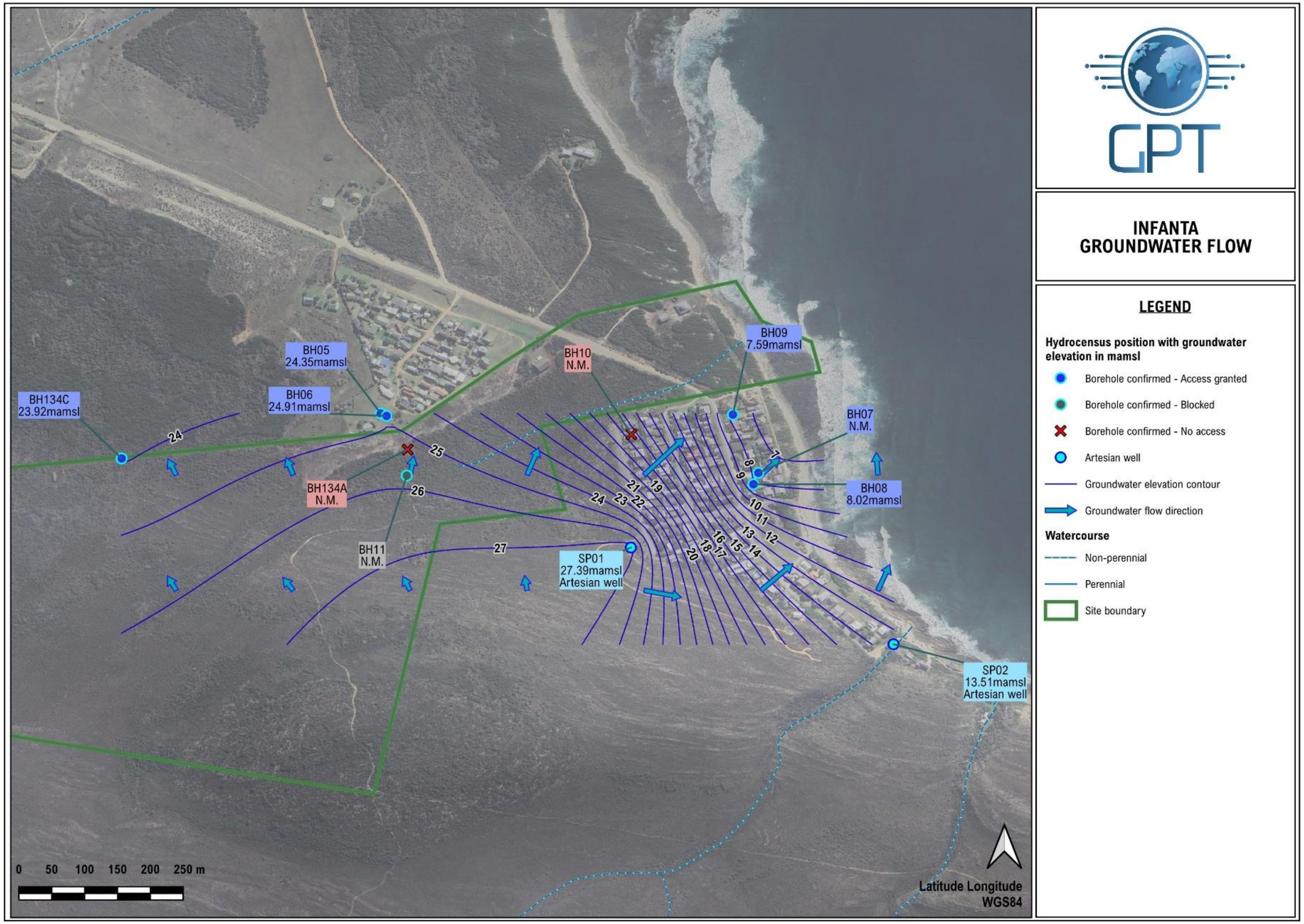


Figure 5: Groundwater Flow Direction Map

6.2 Hydrocensus Groundwater Quality

Three (3) boreholes were selected from the operational boreholes to be tested for groundwater quality. Boreholes BH05, BH07 and BH09 were selected from the hydrocensus. Borehole 134C was also sampled after the hydrocensus and results is provided in the following section. The samples were submitted to a SANS accredited laboratory for major anion and cation analysis as well as microbial analysis. The water quality results are compared with the maximum recommended concentrations for drinking water as defined by the SANS 241-1: 2015 target water quality limits. The SANS 241-1: 2015 standard is applicable to all water services institutions and sets numerical limits for specific determinants to provide the minimum assurance necessary that the drinking water is acceptable for lifetime consumption. Colours of individual cells refer to the drinking water classification of the specific groundwater sample.

The results of the screening for groundwater are presented in Table 3 and discussed in the sections below:

- Conductivity and TDS in all three boreholes exceed aesthetic limits.
- Sodium (Na) and Chloride (Cl) concentrations exceed aesthetic limits in all three boreholes.
- Iron levels in BH07 exceed the aesthetic limit.
- E. coli in BH07 exceeds the acute health limit.
- Total coliform counts in BH05 and BH07 exceed operational limits.

The exceedances of Na and Cl are indicative of saline water which is associated with the Bokkeveld Group. The high EC and TDS in turn can be related to the high salt load in the groundwater. Total coliforms are bacteria that are found in soils. E. coli is associated with soils and groundwater that has been affected by the faecal matter of warm-blooded animals, possibly due to french drains.

Table 3: Water qualities compared to SANS 241-1:2015 guidelines for Hydrocensus Boreholes.

Determinant	Risk	Unit	Standard limits	BH05	BH07	BH09
Physical and aesthetic determinants						
Conductivity at 25 °C	Aesthetic	mS/m	170	238.8	197.3	181.9
Total dissolved solids	Aesthetic	mg/L	1 200	1672	1381	1273
pH at 25 °C [b]	Operational	pH units	5 to 9.7	7.94	7.3	8.06
Chemical determinants — macro-determinants						
Nitrate as N (NO_3 - N)	Acute health	mg/L	11	BDL	BDL	BDL
Nitrite as N (NO_2 - N)	Acute health	mg/L	0.9	BDL	BDL	BDL
Sulfate as SO_4^{2-}	Acute health	mg/L	500	53.57	44.46	56.5
	Aesthetic	mg/L	250	53.57	44.46	56.5
Fluoride as F^-	Chronic health	mg/L	1.5	0.15	0.26	0.29
Ammonia as N	Aesthetic	mg/L	1.5	0.14	BDL	0.08
Chloride as Cl^-	Aesthetic	mg/L	300	582.1	457.4	427.9
Sodium as Na	Aesthetic	mg/L	200	287.7	237.4	230.8
Zinc as Zn	Aesthetic	mg/L	5	BDL	BDL	0.1
Chemical determinants — micro-determinants						
Arsenic as As	Chronic health	mg/L	0.01	BDL	BDL	BDL
Boron as B	Chronic health	mg/L	2.4	0.62	BDL	0.59
Total chromium as Cr	Chronic health	mg/L	0.05	BDL	BDL	BDL
Copper as Cu	Chronic health	mg/L	2	BDL	BDL	BDL
Iron as Fe	Aesthetic	mg/L	0.3	0.06	0.44	BDL
Lead as Pb	Chronic health	mg/L	0.01	BDL	BDL	BDL
Manganese as Mn	Aesthetic	mg/L	0.1	BDL	0.09	BDL
Nickel as Ni	Chronic health	mg/L	0.07	BDL	BDL	BDL
Aluminium as Al	Operational	mg/L	0.3	0.2	0.08	0.16
Microbiological determinants						
E. coli [a] or faecal coliforms [b]	Acute health	cfu/100 mL	0	0	6	0
Total coliforms [d]	Operational	cfu/100 mL	10	16	900	0
BDL = Below Detection Limit						

7 AQUIFER TESTING

A 48-hour pumping test was conducted on borehole BH134C, located on the site, by Pumpcor from Riversdale in June 2020.

A Stepped Discharge Test, Constant Discharge Test & Recovery Monitoring was performed on the borehole. Background information on the details of pump testing is presented in the following paragraphs.

7.1 Description of a pump test

The efficient operation and utilisation of a borehole requires insight into and an awareness of its productivity and that of the groundwater resource from which it draws water. This activity, which is also known as test pumping, provides a means of identifying potential constraints on the performance of a borehole and on the exploitation of the groundwater resource. It also provides data to calculate aquifer parameters such as Transmissivity (T) values.

The following tests were performed on the boreholes: (1) Stepped Discharge Test; (2) Constant Discharge Test and (3) Recovery Monitoring.

7.1.1 Stepped Discharge Test

Also known as a step drawdown test, it is performed to assess the productivity of a borehole. It also serves to more clearly define the optimum yield at which the borehole can be subjected to constant discharge testing. The test involves pumping the borehole at three or more sequentially higher pumping rates each maintained for an equal length of time, generally not less than 60 minutes. The magnitude of the water level drawdown in the borehole in response to each of these pumping rates is measured and recorded in accordance with a prescribed time schedule.

7.1.2 Constant Discharge Test

A constant discharge test is performed to assess the productivity of the aquifer according to its response to the abstraction of water. This test entails pumping the borehole at a single pumping rate which is kept constant for an extended period of time. The test duration is usually between 8 and 72 hours.

7.1.3 Recovery Monitoring

This test provides an indication of the ability of a borehole and groundwater system to recover from the stress of abstraction. This ability can again be analysed to provide information with regards to the hydraulic properties of the groundwater system and arrive at an optimum yield for the medium to long term utilisation of the borehole.

7.2 Calculating the sustainable yield of the borehole

Data acquired during pump testing of the borehole was used to calculate the sustainable yield of the tested borehole. The sustainable yield of a borehole can be defined as the discharge rate that will not cause the water level to drop below the major fracture network supplying water to the borehole. The distance between the static water level and this position is also generally referred to as the available drawdown (AD). The major water strike is obtained through observation during drilling supervision or can be more accurately detected from diagnostic plots compiled from the pumping test data. The water level in the borehole should never drop below the position of the main fracture.

The Flow Characterisation Method (more commonly referred to as the "FC-Method") developed by the Institute of Groundwater Studies at the University of the Free State was used to calculate the sustainable yield of the boreholes. The FC-Method calculates the sustainable yield of a borehole by using recharge, derivatives, boundary information and error propagation. The results of the calculation of the sustainable yield are presented in Table 4.

Table 4: Results of the sustainable yield calculations.

Borehole nr.	Coordinates (WGS 84)	Depth (m)	Static Water Level (m)	Available Drawdown (m)	Sustainable Yield (l/h) Pumping 15 hours/day	Volume/day (m^3)
BH 134C	S34.420930° E20.844446°	79.4	15.47	30	2 160	32.4
				TOTAL VOLUME/DAY (m^3)		**32.4**

Based on the available data, it can be concluded that a total volume of 32.4 **m^3/day** can be abstracted from the tested borehole.

7.3 Groundwater Quality of BH134C

A water sample was taken at the end of the pump tests (June 2020) and submitted to a SANS accredited laboratory for major anion and cation analysis as well as microbial analysis. A second sample was taken during on the 12th of September 2025 and also submitted for major anion and cation analysis as well as microbial analysis. A number of micro determinants were also analysed in the most recent sampling that was not analysed for during the first sampling.

The water quality results are compared with the maximum recommended concentrations for drinking water as defined by the SANS 241-1: 2015 target water quality limits. The SANS 241-1: 2015 standard is applicable to all water services institutions and sets numerical limits for specific determinants to provide the minimum assurance necessary that the drinking water is acceptable for lifetime consumption. Colours of individual cells refer to the drinking water classification of the specific groundwater sample.

The results of the screening for groundwater are presented in Table 4. Exceedances and observations for the most recent results (Sep 2025) are discussed in the section below:

- EC conductivity & TDS exceeded aesthetic limits.
- Na & Cl exceeded aesthetic limits.
- Fe exceeds aesthetic limits.
- Total Coliforms exceeded operational limits.

The exceedances of Na and Cl are indicative of saline water which is associated with the Bokkeveld Group. The high EC and TDS in turn can be related to the high salt load in the groundwater. Total coliforms are bacteria that are found in soils.

Overall, constituent concentrations have remained stable and are within similar ranges to those observed in the June 2020 analysis. The increase in total coliforms is most likely due to the stagnant conditions in the borehole, which has not been in use since the test pumping. The newly elevated iron concentration may also be attributed to rust formation on the steel casing. In both cases, these higher concentrations are expected to decrease once regular abstraction takes place.

Table 5: Water qualities compared to SANS 241-1:2015 guidelines for BH134C.

Determinant	Risk	Unit	Standard limits	134C June 2020	134C September 2025
Physical and aesthetic determinants					
Conductivity at 25 °C	Aesthetic	mS/m	170	189	224.4
Total dissolved solids	Aesthetic	mg/L	1 200	1230	1571
pH at 25 °C [b]	Operational	pH units	5 to 9.7	7.9	7.39
Chemical determinants — macro-determinants					
Nitrate as N (NO_3 - N)	Acute health	mg/L	11	0.21	<0.5
Nitrite as N (NO_2 - N)	Acute health	mg/L	0.9	<0.03	<0.13
Sulfate as SO_4^{2-}	Acute health	mg/L	500	44.3	46.2
	Aesthetic	mg/L	250	44.3	46.2
Fluoride as F^-	Chronic health	mg/L	1.5	<0.20	0.09
Ammonia as N	Aesthetic	mg/L	1.5	<0.05	0.67
Chloride as Cl^-	Aesthetic	mg/L	300	422	497.5
Sodium as Na	Aesthetic	mg/L	200	220	272.5
Zinc as Zn	Aesthetic	mg/L	5	<0.17	<0.05
Chemical determinants — micro-determinants					
Arsenic as As	Chronic health	mg/L	0.01	NA	<0.05
Boron as B	Chronic health	mg/L	2.4	0.2	<0.5
Copper as Cu	Chronic health	mg/L	2	<0.04	<0.05
Iron as Fe	Aesthetic	mg/L	0.3	0.12	1.36
Lead as Pb	Chronic health	mg/L	0.01	NA	<0.05
Manganese as Mn	Aesthetic	mg/L	0.1	<0.04	<0.05
Nickel as Ni	Chronic health	mg/L	0.07	NA	<0.05
Aluminium as Al	Operational	mg/L	0.3	NA	0.07
Microbiological determinants					
E. coli [or] faecal coliforms [b]	Acute health	cfu/100 mL	0	<1	0
Total coliforms [d]	Operational	cfu/100 mL	10	33	9400
< = Below Detection Limit					
NA = Constituent not analysed.					

8 AQUIFER CHARACTERISATION

The term aquifer refers to a strata or group of interconnected strata comprising of saturated earth material capable of conducting groundwater and of yielding usable quantities of groundwater to boreholes and /or springs (Vegter, 1994). In the light of South Africa's limited water resources, it is important to discuss the aquifer sensitivity in terms of the boundaries of the aquifer, its vulnerability, classification and finally protection classification, as this will help to provide a framework in the groundwater management process.

8.1 Aquifer Vulnerability

Aquifer vulnerability assessment 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. Stated in another way, it is a measure of the degree of insulation that the natural and manmade factors provide to keep contamination away from groundwater.

- Vulnerability is high if natural factors provide little protection to shield groundwater from contaminating activities at the land surface.
- Vulnerability is low if natural factors provide relatively good protection and if there is little likelihood that contaminating activities will result in groundwater degradation.

The following factors have an effect on groundwater vulnerability:

- Depth to groundwater: Indicates the distance and time required for pollutants to move through the unsaturated zone to the aquifer.
- Recharge: The primary source of groundwater is precipitation, which aids the movement of a pollutant to the aquifer.
- Aquifer media: The rock matrices and fractures which serve as water bearing units.
- Soil media: The soil media (consisting of the upper portion of the vadose zone) affects the rate at which the pollutants migrate to groundwater.
- Topography: Indicates whether pollutants will run off or remain on the surface allowing for infiltration to groundwater to occur.
- Impact of the vadose zone: The part of the geological profile beneath the earth's surface and above the first principal water-bearing aquifer. The vadose zone can retard the progress of the contaminants.

The Groundwater Decision Tool (GDT) was used to quantify the vulnerability of the aquifer underlying the site using the below assumptions.

- Depth to groundwater below the site was estimated from water levels measured during the hydrocensus inferred to be at mean of ~4.35 mbgl.
- Groundwater recharge of ~12.87 mm/a (~3.1% recharge),
- Sandy vadose zone
- Gradient of 3% were assumed and used in the estimation.

The aquifer vulnerability for a contaminant released from surface to a specified position in the groundwater system after introduction at some location above the uppermost aquifer was determined using the criteria described below and assuming a worst-case scenario:

- Highly vulnerable (> 60), the natural factors provide little protection to shield groundwater from contaminating activities at the land surface.
- Medium Vulnerable = 30 to 60%, the natural factors provide some protection to shield groundwater from contaminating activities at the land surface, however based on the contaminant toxicity mitigation measures will be required to prevent any surface contamination from reaching the groundwater table.
- Low Vulnerability (< 30 %), natural factors provide relatively good protection and if there is little likelihood that contaminating activities will result in groundwater degradation
- The GDT calculated a vulnerability value of 58%, which is medium.

8.2 Aquifer Classification

The aquifer(s) underlying the subject area were classified in accordance with "A South African Aquifer System Management Classification, December 1995."

The main aquifers underlying the area were classified in accordance with the Aquifer System Management Classification document[6]. The aquifers were classified by using the following definitions:

- Sole Aquifer System: An aquifer which is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
- Major Aquifer System: Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (Electrical Conductivity of less than 150 mS/m).
- Minor Aquifer System: These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important for local supplies and in supplying base flow for rivers.
- Non-Aquifer System: These are formations with negligible permeability that are regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.

Based on information collected during the hydrocensus it can be concluded that the aquifer system in the study area can be classified as a "Minor Aquifer System", based on the fact that the local population is not dependent on groundwater.

In order to achieve the Aquifer System Management and Second Variable Classifications, as well as the Groundwater Quality Management Index, a points scoring system as presented in Table 6 and Table 7 was used.

Table 6: Ratings – Aquifer System Management and Second Variable Classifications

[6] Department of Water Affairs and Forestry & Water Research Commission (1995). A South African Aquifer System Management Classification. WRC Report No. KV77/95.

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System:	6	
Major Aquifer System:	4	
Minor Aquifer System:	2	2
Non-Aquifer System:	0	
Special Aquifer System:	0 - 6	
Second Variable Classification (Weathering/Fracturing)		
Class	Points	Study area
High:	3	
Medium:	2	2
Low:	1	

Table 7: Ratings - Groundwater Quality Management (GQM) Classification System

Aquifer System Management Classification		
Class	Points	Study area
Sole Source Aquifer System:	6	
Major Aquifer System:	4	
Minor Aquifer System:	2	2
Non-Aquifer System:	0	
Special Aquifer System:	0 - 6	
Aquifer Vulnerability Classification		
Class	Points	Study area
High:	3	
Medium:	2	2
Low:	1	

As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. The GQM index for the study area is presented in Table 8.

The vulnerability, or the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer, in terms of the above, is classified as **medium.**

The level of groundwater protection based on the Groundwater Quality Management Classification:

GQM Index = Aquifer System Management x Aquifer Vulnerability

=2 x 2 = 4

Table 8: GQM Index for the Study Area

GQM Index	Level of Protection	Study Area
<1	Limited	
1 – 3	Low Level	
3 – 6	Medium Level	4
6 – 10	High Level	
>10	Strictly Non-Degradation	

8.3 Aquifer Protection Classification

A Groundwater Quality Management Index of 4 was estimated for the study area from the ratings for the Aquifer System Management Classification. According to this estimate a **medium level of groundwater protection** is required for the aquifer. Reasonable and sound groundwater protection measures based on the modelling will therefore be recommended to ensure that no cumulative pollution affects the aquifer, even in the long term.

DWA's water quality management objectives are to protect human health and the environment. Therefore, the significance of this aquifer classification is that measures must be taken to limit the risk to the following environments.

- The protection of the underlying aquifer.

9 RESERVE DETERMINATION

9.1 Introduction

Definition of Reserve: *"The quantity and quality of water required to supply basic needs of people to be supplied with water from that resource and to protect aquatic ecosystems in order to secure ecologically sustainable development and use of water resources".*

To be able to quantify the groundwater component of the Reserve, the following relationship has to be solved:

$$GW_{allocate} = (Re + GW_{in} - GW_{out}) - BHN - GW_{Bf}$$

where:

$GW_{allocate}$	=	groundwater allocation
Re	=	recharge
GW_{in}	=	groundwater inflow
GW_{out}	=	groundwater outflow
BHN	=	basic human needs
GW_{Bf}	=	groundwater contribution to baseflow

Under the National Water Act (Act No. 36 of 1998) the bulk water uses at Infanta must be authorised. The water will be abstracted from boreholes and used for irrigation and construction purposes. Under these circumstances, the following (ground) water use is recognised as being relevant to the licence application:

- Section 21 (a) – taking water from a resource.

9.2 Approach

The assessment was done on a "rapid" level using the software GRDM version 4.0.0.0. The data used for the calculation was derived from the WRC90 dataset contained in the "GRDM" software driven by the Resource Directed Measures from the Department of Water Affairs and FET water. The local catchment falls within the H70K quaternary catchment as shown in Figure 1. The default values were used in the assessment in order to develop some guidance on the potential impact of the proposed abstraction on the overall groundwater use in the catchment.

9.3 Description of the Study Area

The property, hereafter referred to as Infanta, has a total area of 10ha. The local catchment within which the site is located falls within the H70K quaternary catchment. The quaternary catchment has a total area of 207.3 km^2 and the catchment falls within the Breede River Water Management Area.

The dominant vegetation type is mountain Fynbos. Locally drainage is towards the Indian Ocean as well as the Bree River that flows from north east to south west to the north of the site.

9.4 Present Water Demand

A maximum projection of the planned water demand from the borehole is 16.8m^3/day (0.194 l/s) or 6132 m^3/annum.

9.5 Reserve Directed Measures Assessment

9.5.1 Classification

Groundwater classification is currently based on a Stress Index which relates water use to recharge. The quaternary catchments in which the study area falls is classified as category B which indicates low levels of stress in terms of abstraction/recharge (respectively). The resource is unstressed or slightly stressed. At this stage Classification is not directly linked to potential abstraction but is only indicative of the current situation.

Table 9: Catchment Stress Index Table

Present Status Category	Description	Stress Index (abstraction/recharge)
A	Unstressed or slightly stressed	<0.05
B		0.05-0.2
C	Moderately Stressed	0.2-0.4
D		0.4-0.65
E	Highly Stressed	0.65-0.95
F	Critically Stressed	>0.95

9.5.2 Reserve

The following table summarises the most salient parameters relevant to this catchment:

Table 10: Most salient parameters relevant to the catchment.

Quaternary Catchment	Area km^2	Population (2010)	General Authorisation (m^3/ha/a)	Rainfall (mm/a)	Recharge (mm/a)	Current Use (2010) (Mm^3/a)
H70K	207.3	500	150	458	14.2	0.06

*Groundwater recharge calculated as 3.1% of rainfall, see section 5.3.

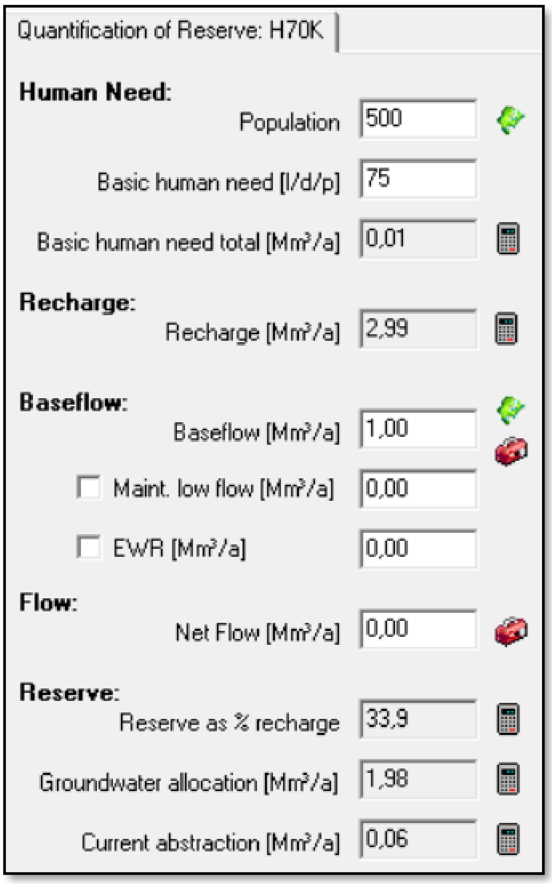
If the recharge is calculated on the actual area of the property within the affected quaternary catchments, the following emerges:

Table 11: Recharge to the property

Catchment	Actual area (ha) of property	Recharge in Quartenary Catchment (mm/a)	Recharge on property	
H70K	86.5	14.2	12283	m^3/a
Total	*86.5*	14.2	12283	m^3/a
			0.012	Mm^3/a
			34	m^3/day
			0.39	l/second

The following tables summarizes the Reserve for the catchment.

Table 12: A summary of the Reserve for the quaternary catchment H70K


Quantification of Reserve: H70K

Human Need:
Population: 500
Basic human need [l/d/p]: 75
Basic human need total [Mm³/a]: 0,01

Recharge:
Recharge [Mm³/a]: 2,99

Baseflow:
Baseflow [Mm³/a]: 1,00
Maint. low flow [Mm³/a]: 0,00
EWR [Mm³/a]: 0,00

Flow:
Net Flow [Mm³/a]: 0,00

Reserve:
Reserve as % recharge: 33,9
Groundwater allocation [Mm³/a]: 1,98
Current abstraction [Mm³/a]: 0,06

9.5.3 Water Use Authorization

The table below estimated the general authorization allowance.

Actual area of property (ha)	General Authorisation (m3/ha/a)	General Authorisation Volume Allowance on property (m3/a)
86.5	150	12975

The general authorisation volume for the area is calculated at 12 975 m^3/year, while the planned water demand is 6 132 m^3/year. Therefore, it can be concluded that the proposed demand falls within the scope of a general authorisation.

If the maximum volume that can be abstracted, according to the sustainable yield calculations (Section 7.2) of 32.4 m^3/day or 11 826 m^3/year, is applied for, this volume still remains within the general authorisation allowance.

9.5.4 Resource Quality Objectives

The Resource Quality Objectives are numerical or descriptive limits set out to maintain and protect the groundwater resource while also taking into account the need to develop and use a water resource[7].

Maintain regional groundwater table to:

- Ensure that schedule 1 water users adjacent to the site have adequate water supply to basic human need.
- Ensure that adequate water is available to maintain base flow in the tributaries of the Bree River.

[7] Department of Water Affairs and Forestry (DWAF). 2007. Resource directed management of water quality: management instruments. Volume 4.2.2: guideline for determining Resource Water Quality Objectives (RWQOs), allocatable water quality and the stress of the water resource. Training manual. Pretoria.

10 RISK ASSESSMENT

The groundwater risk assessment methodology is based on defining and understanding the three basic components of the risk, i.e. the source of the risk (source term), the pathway along which the risk propagates, and finally the target that experiences the risk (receptor). The risk assessment approach is therefore aimed at describing and defining the relationship between cause and effect. In the absence of any one of the three components, it is possible to conclude that groundwater risk does not exist.

10.1 Current Groundwater Conditions

The current groundwater conditions at the site are described in sections 5.2 and 0.

10.2 Risk Assessment

10.2.1 Assessment Criteria

The criteria for the description and assessment of groundwater impacts were drawn from the EIA Regulations, published by the Department of Environmental Affairs and Tourism (April 1998) in terms of the NEMA[8].

In order to determine the significance of an impact, the following criteria would be used: extent, duration, intensity and probability. The extent and probability criteria have five parameters, with a scaling of 1 to 5. Intensity also has five parameters, but with a weighted scaling.

The assessment of the intensity of the impact is a relative evaluation within the context of all the activities and other impacts within the framework of the project. The intensity rating is weighted as 2 since this is the critical issue in terms of the overall risk and impact assessment (thus the scaling of 2 to 10, with intervals of 2). The intensity is thus measured as the degree to which the project affects or changes the environment.

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria. For such purposes, each aspect was assigned a value, ranging from one (1) to five (5), depending on its definition. This assessment is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. An explanation of the impact assessment criteria is defined below in Table 13.

[8] Guideline document EIA regulations (April 1998): Implementation of sections 21, 22 and 26 of the environment conservation act.

Table 13: Explanation of the EIA criteria

Criteria	Description
Nature	Includes a description of what causes the effect, what will be affected and how it will be affected.
Extent	The physical and spatial scale of the impact.
Duration	The lifetime of the impact is measured in relation to the lifetime of the proposed development.
Intensity	Examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself.
Probability	This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the lifecycle of the activity, and not at any given time.
Status	Description of the impact as positive, negative or neutral.
Significance	A synthesis of the characteristics described above and assessed as low, medium or high. A distinction will be made for the significance rating without the implementation of mitigation measures and with the implementation of mitigation measures.
Confidence	This is the level of knowledge/information that the environmental impact practitioner or a specialist had in his/her judgement.
Reversibility	Examining whether the impacted environment can be returned to its pre-impacted state once the cause of the impact has been removed.
Replaceability	Examining if an irreplaceable resource is impacted upon
Cumulative	Synthesis of different impacts in concert, considering the knock-on impacts thereof.

10.2.2 Nature and Status

The nature of the impact is the consideration of what the impact will be and how it will be affected. This description is qualitative and gives an overview of what is specifically being considered. That is, the nature considers ‘what is the cause, what is affected, and how is it affected. The status is thus given as being positive, negative or neutral, and is deemed to be either direct or indirect in impact.

10.2.3 Extent

The physical and spatial scale of the impact is classified in Table 14.

10.2.4 Duration

The lifetime of the impact is measured in relation to the lifetime of the project, as per Table 15.

10.2.5 Intensity

This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project, as per Table 16.

10.2.6 Probability

This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the lifecycle of the activity, and not at any given time. The probability classes are rated in Table 17.

10.2.7 Level of Significance

The level of significance is expressed as the sum of the area exposed to the risk (extent), the length of time that exposure may occur over in total (duration), the severity of the exposure (intensity) and the likelihood of the event occurring (probability). This leads to a range of significance values running from ‘no impact’ to ‘extreme’.

The significance of the impacts has been determined as the consequence of the impact occurring (reflection of chance of occurring, what will be affected (extent), how long will it be affected, and how intense is the impact) as affected by the probability of it occurring, this translates to the following formula:

Significance value = (Extent + Duration + Intensity) x Probability

Each impact is considered in turn and assigned a rating calculated using the results of this formula and presented as a final rating classification according to Table 16. A distinction will be made for the significance rating of (a) without the implementation of mitigation measures, and, (b) with the implementation of mitigation measures.

10.2.8 Identifying Potential Impacts with Mitigation Measures

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale as contemplated in Table 16 below.

Low (L): The impact is mitigated to the point where it is of limited importance.

Medium (M): Notwithstanding the successful implementation of the mitigation measures, to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.

High (H): The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance, after mitigation could render the entire development option or entire project proposal unacceptable.

10.2.9 Impact Assessment

Based on the impact assessment criteria as detailed in the preceding paragraph an impact rating is given in Table 18. The table also summarises all the groundwater related EMP’s and should be implemented during the operation of the development.

Table 14: Impact Extent

Criteria	Description	Scoring	Lowering of Groundwater Levels	Groundwater Contamination
Without Mitigation (WOM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	3	2
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		
With Mitigation (WM)				
Footprint	The impacted area extends only as far as the activity, such as footprint occurring within the total site area.	1	1	1
Site	The impact could affect the whole, or a significant portion of the site.	2		
Local	Impact could affect the adjacent landowners.	3		
Regional	Impact could affect the wider area around the site, that is, from a few kilometres, up to the wider Council region	4		
National	Impact could have an effect that expands throughout a significant portion of South Africa - that is, as a minimum has an impact across provincial borders.	5		

Table 15: Impact Duration

Criteria	Description	Scoring	Lowering of Groundwater Levels	Groundwater Contamination
Without Mitigation (WOM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	4	4
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		
With Mitigation (WM)				
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than any of the development phases (i.e. less than 2 years).	1	4	4
Short to Medium term	The impact will be relevant through to the end of the construction phase (i.e. less than 5 years).	2		
Medium term	Impact will last up to the end of the development phases, where after it will be entirely negated (i.e. related to each phase development thus less than 10 years).	3		
Long term	The impact will continue or last for the entire operational lifetime of the development, but will be mitigated by direct human action or by natural processes thereafter (i.e. during decommissioning) (i.e. more than 10 years, or a maximum of 60 years).	4		
Permanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient (i.e. will remain once the site is closed).	5		

Table 16: Impact Intensity

Criteria	Description	Scoring	Lowering of Groundwater Levels	Groundwater Contamination
Without Mitigation (WOM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	4	4
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		
With Mitigation (WM)				
Low	The impact alters the affected environment in such a way that the natural processes or functions are not affected.	2	2	2
Low-Medium	The impact alters the affected environment in such a way that the natural processes or functions are slightly affected.	4		
Medium	The affected environment is altered, but functions and processes continue, albeit in a modified way.	6		
Medium-High	The affected environment is altered, and the functions and processes are modified immensely.	8		
High	Function or process of the affected environment is disturbed to the extent where the function or process temporarily or permanently ceases.	10		

Table 17: Impact Probability

Criteria	Description	Scoring	Lowering of Groundwater Levels	Groundwater Contamination
Without Mitigation (WOM)				
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	3	3
Possible	The possibility of the impact occurring is very low, either due to the circumstances,	2		
Likely	There is a possibility that the impact will occur to the extent that provisions must	3		
Highly likely	It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 – 89%).	4		
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 – 100%).	5		
With Mitigation (WM)				
Improbable	The possibility of the impact occurring is none, due either to the circumstances, design or experience (less than 24% chance of occurring).	1	2	2
Possible	The possibility of the impact occurring is very low, either due to the circumstances,	2		
Likely	There is a possibility that the impact will occur to the extent that provisions must	3		
Highly likely	It is most likely that the impacts will occur at some stage of the Development. Plans must be drawn up before carrying out the activity (70 – 89%).	4		
Definite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied upon (90 – 100%).	5		

Table 18: Impact Significance

Criteria	Description	Scoring	Lowering of Groundwater Levels	Groundwater Contamination
Without Mitigation (WOM)				
No Impact	There is no impact.	0-9	33	30
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 - 49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		
With Mitigation (WM)				
No Impact	There is no impact.	0-9	14	14
Low	The impacts are less important, but some mitigation is required to reduce the negative impacts.	10 - 24		
Medium	The impacts are important and require attention; mitigation is required to reduce the negative impacts.	30 -49		
Medium to High	The impacts are of medium to high importance; mitigation is necessary to reduce negative impacts.	50 - 74		
High	The impacts are of high importance and mitigation is essential to reduce the negative impacts	75 - 89		
Extreme	The impacts present a fatal flaw, and alternatives must be considered.	90 - 100		

10.3 Mitigation Measures

The suggested mitigation measures for the operation are summarised in the following paragraphs based on the risk assessment performed.

10.3.1 Lowering of Groundwater Levels

The mitigation measures/management measures applicable to the lowering of groundwater levels during operations are listed in Table 19.

Table 19: Mitigation Measures for the Management of Lowering of Groundwater Level

Lowering of Groundwater Levels			
Significance Rating (WOM)	**Impact**	**Management Options**	**Significance Rating (WM)**
33	Drawdown of water table	Groundwater levels should be monitored on the frequency as specified in the monitoring plan	14
		Pumped water volumes should be recorded at the production boreholes on a monthly basis	
		Water levels in production boreholes should be recorded on a monthly basis. If a declining trend in water levels is observed, the pumping volumes should be reduced until the water level is stabilized.	
		Recommended yields and pumping cycles should be adhered to	
		Rainfall readings should be recorded	

10.3.2 Spread of Groundwater Pollution

The mitigation measures/management measures applicable to the spread of groundwater contamination after operations are listed in Table 20.

Table 20: Mitigation Measures for the Management of the Spread of Groundwater Contamination

Groundwater Contamination			
Significance Rating (WOM)		**Management Options**	**Significance Rating (WM)**
30	Groundwater contamination	Appropriate sewerage systems should be designed according to the development's demand and installed	14
		Sewerage systems must be maintained in order to prevent groundwater contamination	
		Storm water must be diverted away from abstraction boreholes to prevent any contamination from entering the boreholes	
		Contamination sources such as workshops etc should be lined in order to prevent groundwater contamination	
		Water quality sampling should be conducted as specified in the monitoring requirements	

11 GROUNDWATER MONITORING SYSTEM

11.1 Groundwater Monitoring Network

A groundwater monitoring system has to adhere to the criteria mentioned below. As a result, the system should be developed accordingly.

11.1.1 Impact and background monitoring

A groundwater monitoring network should contain monitoring positions which can assess the groundwater status at certain areas. The boreholes can be grouped classification according to the following purposes:

- **Impact monitoring:** Monitoring of possible impacts of contaminated groundwater on sensitive ecosystems or other receptors. These monitoring points are also installed as early warning systems for contamination break-through at areas of concern.
- **Background monitoring:** Background groundwater levels is essential to evaluate the impact of a specific action on the groundwater level.

11.1.2 System Response Monitoring Network

Groundwater levels: The response of water levels to abstraction is monitored. Static water levels are also used to determine the flow direction and hydraulic gradient within an aquifer. Where possible all of the above-mentioned borehole's water levels need to be recorded during each monitoring event.

11.1.3 Monitoring Frequency

Quarterly monitoring of groundwater levels and measurement of pumped volumes is recommended. It is important to note that a groundwater-monitoring network should also be dynamic. This means that the network should be extended over time to accommodate the migration of potential contaminants through the aquifer as well as the expansion of infrastructure and/or addition of possible pollution sources.

11.2 Monitoring Parameters

Physical Parameters:

- Groundwater levels
- Pumping volumes

Chemical Parameters:

- Laboratory analyses:
  - Anions and cations (Ca, Mg, Na, K, NO3, Cl, SO4, F, Fe, Mn, Al, & Alkalinity)
  - Other parameters (pH, EC, TDS)
  - Petroleum hydrocarbon contaminants (where applicable, near workshops and petroleum handling facilities)
  - Sewage related contaminants (E.Coli, faecal coliforms) in borehole in proximity to septic tanks or sewage plants

11.3 Monitoring Network

DWAF (1998) states that “A monitoring hole must be such that the section of the groundwater most likely to be polluted first, is suitably penetrated to ensure the most realistic monitoring result.”[9]

The abstraction borehole located on the Infanta site as well as the hydrocensus boreholes will serve as monitoring points. The details for the borehole can be seen in Table 21 below.

Table 21: Details of the monitoring boreholes

ID	Latitude (South)	Longitude (East)	Requirement	Frequency	Existing/New
BH134C	34° 25′ 15.35″	20° 50′ 40.01″	Abstraction, Water Level & Quality Monitoring	Quarterly	Existing
BH134A	34° 25' 14.3040"	20° 50' 57.0624"	Water Level & Quality Monitoring	Quarterly	Existing
BH05	34° 25' 12.3060"	20° 50' 55.8096"	Water Level	Quarterly	Existing
BH06	34° 25' 12.1548"	20° 50' 55.4644"	Water Level	Quarterly	Existing
BH07	34° 25' 15.6952"	20° 51' 17.9658"	Water Level	Quarterly	Existing
BH09	34° 25' 12.2236"	20° 51' 16.4459"	Water Level	Quarterly	Existing

[9] Department of Water Affairs and Forestry (DWAF). (1998). Minimum Requirements for the Water Monitoring at Waste Management Facilities. CTP Book Printers. Cape Town.

12 CONCLUSIONS AND RECOMMENDATIONS

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by Doug Jefferies Consulting (Pty) Ltd to conduct a hydrogeological study in support of the water use license to be applied for the by the client on behalf of the proposed Infanta Development.

The site is located in Infanta near Witsand, in the Western Cape.

The area is characterised by a gently undulating topography and in the area of the site the slope is more or less in the order of 3% (0.03).

Locally drainage is towards the Indian Ocean as well as the Bree River that flows from northwest to southeast to the north of the site.

Climatic data was obtained from the GRDM V4.0 database as developed by the DWA and FetWater. The average annual rainfall is approximately 458mm/a.

The site is underlain by light grey to red sandy soil and calcrete with alluvium deposits to the coastline. Furthermore, the underlying geology in the region consist of the Skurweberg Formation as well as the Rietvlei Formation of the Nardouw Subgroup, Table Mountain Group, as well as the Robberg Formation of the Uitenhage Group. The Skurweberg Formation mainly comprises of light grey quarzitic sandstone. The Reitvlei Formation consists of light grey feldspathic sandstone with occasional thin siltstone and shale beds. The Robberg Formation consists of silicified sandstone and conglomerate. These formations all strike in an east west direction with a northward dip of between 30 and 40 degrees.

According to Meyer (2001), the Table Mountain Group (TMG), notably the often fractured arenaceous components, is largely anisotropic and thus does not display uniform aquifer characteristics. An intricate network of fissures, joints, fractures and even cavities govern the infiltration, storage and transmission of groundwater in the largely competent and brittle natured arenaceous units of the TMG. The TMG generally constitutes the mountainous areas which, in turn influence precipitation to a significant extent. An abundance of springs is a further characteristic of the TMG

A hydrocensus was conducted on the 28 & 29th of July 2025 within a 1km radius form the property boundary. Seven (7) operational boreholes were located as well as two (2) springs. The hydrocensus recorded an average groundwater level of 4.35 m below ground level (mbgl), with measured depths ranging from 3.60 mbgl to 5.04 mbgl. The general groundwater flow direction is towards the northeast in the direction of the ocean. Boreholes BH05, BH07 and BH09 were selected to be tested for groundwater quality. The water quality results are compared with the SANS 241-1: 2015 target water quality limits.

A Stepped Discharge Test, Constant Discharge Test & Recovery Monitoring was performed on borehole 134C. Based on the available data, it can be concluded that a total volume of 32.4 m^3/day can be abstracted from the tested borehole. The water quality were sampled and results are compared with the SANS 241-1: 2015 target water quality limits.

The GDT calculated a vulnerability value of 58% for the aquifer which is classified as medium. Based on information collected during the hydrocensus it can be concluded that the aquifer system in the study area can be classified as a “Minor Aquifer System”, based on the fact that the local population is not dependent on groundwater. A Groundwater Quality Management Index of 4 was estimated for the study area from the ratings for the Aquifer System Management Classification. According to this estimate a medium level of groundwater protection is required for the aquifer.

The general authorisation volume for the area is calculated at 12 975 m^3/year, while the planned water demand is 6 132 m^3/year. Therefore, it can be concluded that the proposed demand falls within the scope of a general authorisation. If the maximum volume that can be abstracted, according to the sustainable yield calculations (Section 7.2) of 32.4 m^3/day or 11 826 m^3/year, is applied for, this volume still remains within the general authorisation allowance.

12.1 Recommendations

The following actions are recommended to be implemented during the construction and the implementation phases:

- Groundwater quality exceedances in the boreholes above the SANS 241 drinking water standards indicated that the groundwater at the site is not suitable for use as potable water without prior treatment. The exceedances in total coliforms can be addressed by improving sanitation systems and ensuring human or animal wastes are properly disposed of.
- The monitoring as recommended in the report should be established prior to operation. The water level monitoring should be conducted weekly for the first three months of operation and if no significant water level decline is observed, the monitoring can be conducted on a monthly basis. Alternatively, automatic water level measurement in the form of pressure transducers can be installed to aid in this process. Logs of flow meter readings should also be kept and the flowmeter should also be read once per month.
- Seawater intrusion may become a concern during extended abstraction periods and should be monitored.
- A rainfall gauge should be installed on the site and rainfall readings should be taken after every rainfall event and the time and date of the reading recorded.
- The monitoring data (water levels, rainfall and chemistry) should be kept in an electronic database for further analysis should this be required.
- The recommended pump cycle for the borehole is 12 hours per day. If the pump cycle is to be extended, the maximum daily volume for each borehole must not be exceeded and the pumping rate must be reduced to sustainable rates. Refer to management recommendations in Table 22.
- It is recommended that the hydrocensus be repeated once every 2 years to ensure that no new groundwater users are affected. The hydrocensus should extend to a 1km radius around the site boundary.
- The regional groundwater table must be maintained to:
  - Ensure that schedule 1 water users adjacent to the site have adequate water supply to basic human need.
  - Ensure that adequate water is available to maintain base flow in the tributaries of the Breede River.

Table 22: Management Recommendations for the Infanta Production Borehole

Borehole nr.	Coordinates (WGS84)		Depth (m)	Static Water Level (m)	#Dynamic WL (m)	Diameter (mm)	Sustainable Yield (l/h) Pumping 16 hours/day	Volume/day (m^3)	Proposed depth of pump installation (m)	Maximum Volume per Day (m^3)
	S	E								
BH134C	25.79058	29.48482	74.5	15.47	45	165	2160	34.6	60	34.6
					Total Volume/Day (m^3)			**34.6**		

 # Dynamic water level - Level at which the water level in the borehole stabilises after continuous pumping. To be used to calculate hydraulic heads when sizing submersible pumps.

APPENDIX I: HYDROCENSUS DATA

APPENDIX II: WATER QUALITY DATA

APPENDIX III: PUMPTESTING FIELD DATA

APPENDIX IV: FC INTERPRETED PUMP TEST DATA