

Geohydrological Services to Ntshele and Mpozolo Clinics

Report Prepared for

Coega Development Corporation



Report Number 609437/a



Report Prepared by



October 2024

Geohydrological Services to Ntshеле and Mpozolo Clinics

Coega Development Corporation

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Executive Summary

SRK Consulting (SA) (Pty) Ltd (hereafter SRK) was appointed on 5 September 2024 by Coega Development Corporation (hereafter the Client) to supply geohydrological services for the Ntshеле (south of Mthatha) and Mpozolo (east of Dutywa) clinics located in the Eastern Cape Province. The project included a hydrocensus, geophysical investigation (drill site selection), and reporting.

Summary of principal objectives

The project goal was to determine the groundwater potential at Ntshеле and Mpozolo Clinic Sites.

Outline of work programme

The principal stages of the project were planned and executed as follows:

- Appointment – 5 September 2024;
- Briefing meeting – 1 October 2024;
- Site meetings – 8 and 9 October at Mpozolo and Ntshélé clinics respectively;
- Hydrocensus and Geophysical Investigation – 7 to 9 October 2024; and
- Reporting – week of 16 October 2024.

Results

- Mpozolo Clinic is located on a catchment boundary with expected low groundwater recharge;
- Two existing boreholes are located within 1-km from Ntshélé Clinic, both were however found to be vandalised and no longer in use. Borehole EC/T20/0237 was reportedly yield tested in 2012 and recommended at 0.56 L/s for a 10-hr pumping period.
- Ntshélé Clinic is underlain by the Katberg Formation, consisting mostly of sandstone with an expected higher groundwater potential than the Adelaide Subgroup underlying the Mpozolo Clinic, consisting mostly of mudstones and having an expected lower groundwater potential.
- Both sites are intruded by dolerite sills and dykes, whereby these contact zones with the above mentioned sedimentary rocks form preferred groundwater flow paths with expected higher groundwater potential zones.
- The groundwater potential for both clinics are moderate and a chance of 30 – 40% for drilling a borehole yielding > 2 L/s are reported.
- Two geophysical traverses were undertaken at Ntshélé Clinic and three at Mpozolo Clinic.
- Three position for the drilling of boreholes were selected per clinic.

Recommendations

- The drilling of two boreholes should be allowed for with the yield testing of one successful borehole per clinic.
- The estimated costs (excluding VAT) will be in the order of R 488 000, inclusive of the drilling, yield- and water quality testing, supervision by a hydrogeologist on both activities and reporting on the results found.

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Disclaimer

Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

DWS	-	Department of Water and Sanitation
EC	-	Electrical Conductivity
L/s	-	litres per second
m amsl	-	metres above mean sea level
m bgl	-	metres below ground level
mg/L	-	milligrams per litre
NGA	-	National Groundwater Archive

1 Introduction and Scope of Report

SRK Consulting (SA) (Pty) Ltd (hereafter SRK) was appointed on 5 September 2024 by Coega Development Corporation (hereafter the Client) to supply geohydrological services for the Ntshеле (south of Mthatha) and Mpozolo (east of Dutywa) clinics located in King Sabata Dalindyebo and Mbashe Local Municipalities respectively of the OR Tambo and Amathole District Municipalities. The project included a hydrocensus, geophysical investigation (drill site selection) and reporting.

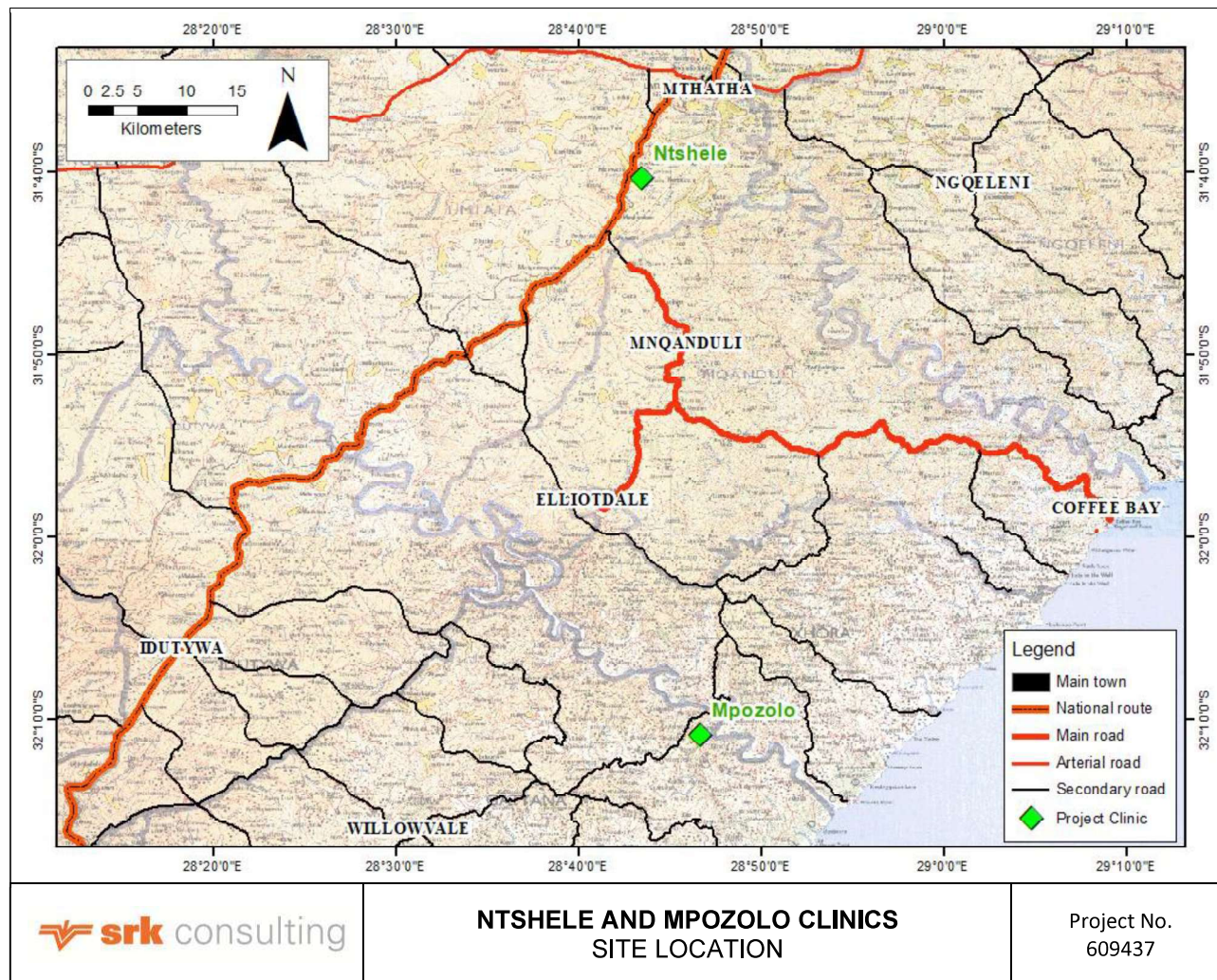


Figure 1-1: Site locations

2 Background and Brief

The Client was appointed by the Eastern Cape of Department of Health (ECDOH). The two clinics are intended to be developed for the construction of a Primary Healthcare Centre, with associated bulk services, roadworks, and residential accommodation for medical practitioners.

The geohydrological study is to assist the Client and ECDOH understanding the available groundwater resources within the two clinic sites.

The Client requested the following services:

- Groundwater feasibility study;
- Exploration of groundwater potential;
- Geological reconnaissance and verification of potential drilling targets;

- Groundwater supply cost assessment;
- Risk assessment on the potential impact of the abstraction of groundwater on the natural environment;
- Hydrocensus, verifying of existing boreholes;

No actual drilling and testing of boreholes were undertaken.

3 Project Objectives and Work Program

The project goal was to determine the groundwater potential at Ntshеле and Mpozolo Clinic Sites. The principal stages of the project were planned and executed as follows:

- Appointment – 5 September 2024;
- Briefing meeting – 1 October 2024;
- Site meetings – 8 and 9 October at Mpozolo and Ntshеле clinics respectively;
- Hydrocensus and Geophysical Investigation – 7 to 9 October 2024; and
- Reporting – week of 16 October 2024.

3.1 Reporting Standard

The Department of Water and Sanitation (DWS) published the latest “*Standard Operating Procedures for Groundwater Resource Development for Community Water Supply Projects*”, Version 4.0, 15 June 2023 (SOP). A presentation was given by the DWS to the groundwater fraternity, and it was explained that this document is applicable to all groundwater source development, inclusive of town or businesses water supply from boreholes.

This Report has been prepared to the latest SOP of DWS as well as to the “*Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme*”, of the DWS, and is aimed for internal distribution (the Client) and is not aimed for distribution to the public domain.

3.2 Project team

Eunice Goossens, a principal hydrogeologist, managed the project and Rob Gardiner, partner at the Gqeberha office, did the peer review. Mfundo Mari conducted the fieldwork components.

4 Project Results

4.1 Desk Study

4.1.1 Topography – Ntshеле Clinic

Ntshеле Clinic is located at c. 890 m amsl (meters above mean sea level). The topography dips eastwards with two rivers originating within 1 km from the site, flowing east, joining the Mbane and Zimbane Rivers respectively. The N2 highway is west of the clinic and located at the highest area and is c. 940 m amsl. The area is covered by the T20D catchment (drainage regions¹) and is mapped on 3128DA 1 : 50 000 topo-cadastral map. Refer to Figure 4-1.

¹ The drainage regions are as depicted by Department of Water and Sanitation (Refer to the 1: 2 000 000; “Water Management areas of the Republic of South Africa” Map, 2000; Map Author Directorate Catchment Management, DWAF, GIS and Cartographic: Helena Fourie)

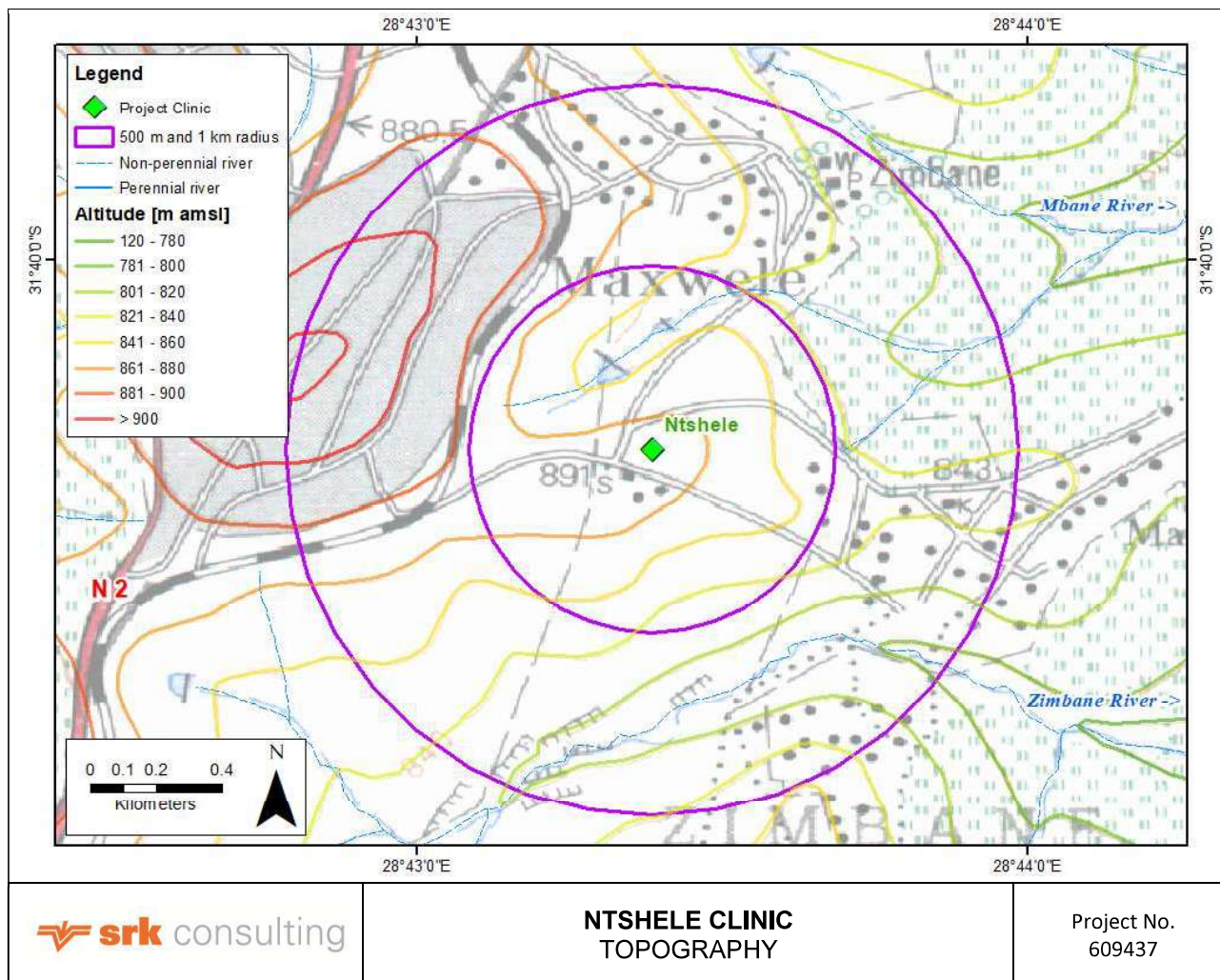


Figure 4-1: Ntshele Clinic - Topography

4.1.2 Topography – Mpozolo Clinic

Mpozolo Clinic is located at c. 370 m amsl (meters above mean sea level). The clinic is located on a catchment / drainage regions boundary (topography high area) with the western parts falling into T90B and the eastern parts in T13E. Streams originate around the clinic area, flowing in a 360° radius. The Mbashe River is located east of the clinic and the topography drop steep towards the river at c. 20 m amsl. The area is mapped on 3228BB 1 : 50 000 topo-cadastral map. Refer to Figure 4-1.

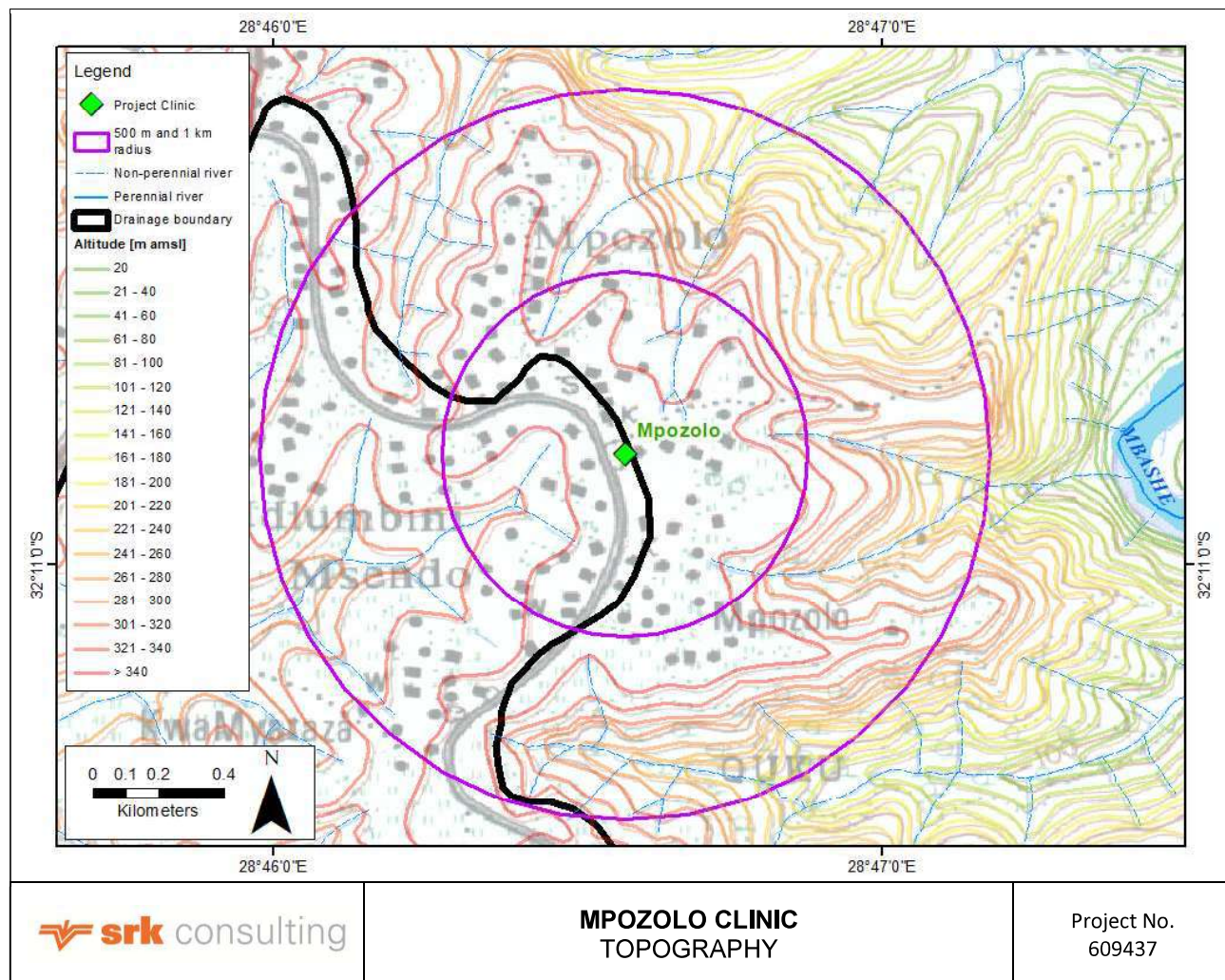


Figure 4-2: Mpozolo Clinic - Topography

4.1.3 Existing Borehole Datasets

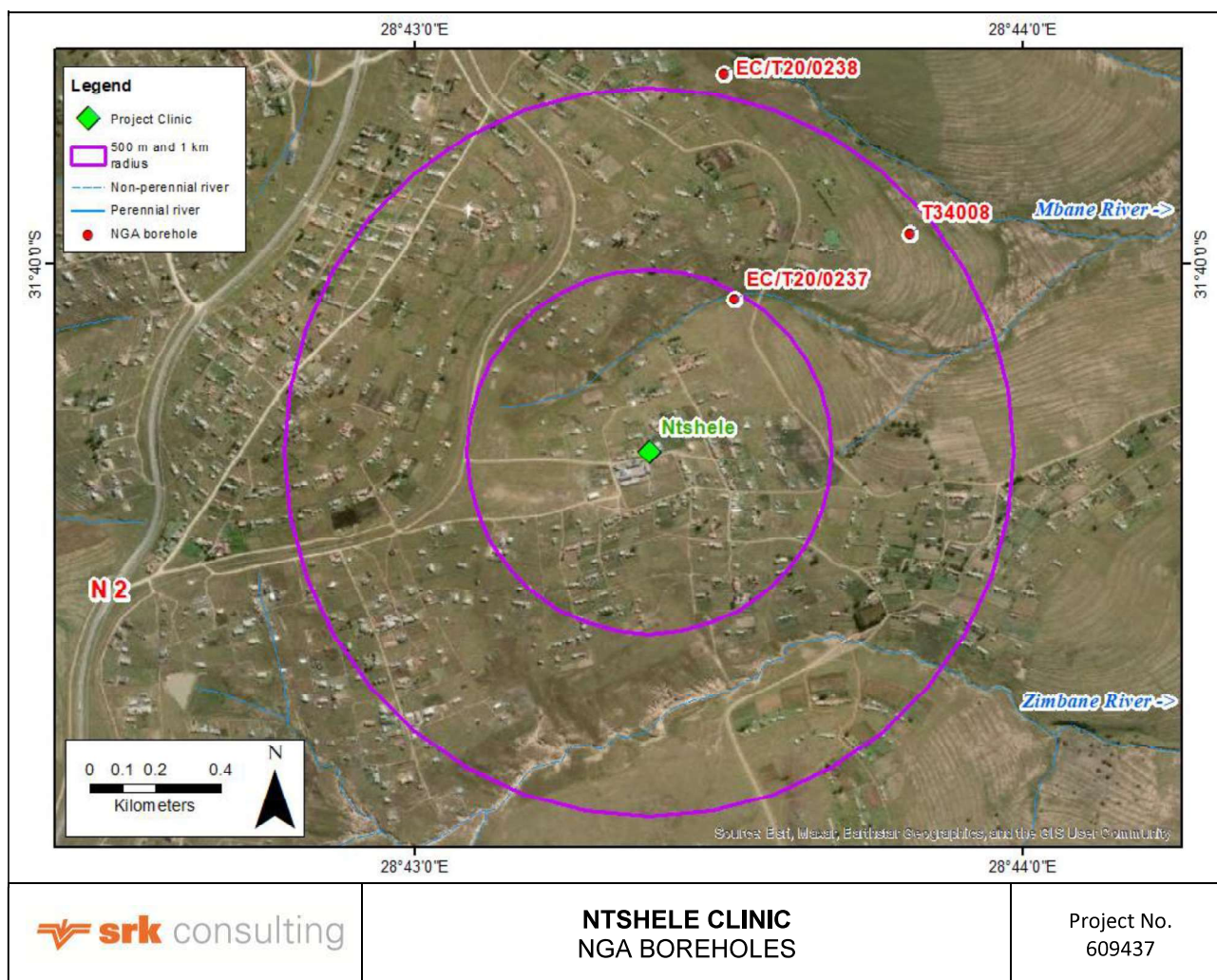
The National Groundwater Archive (NGA) dataset of the Department of Water and Sanitation (DWS) was queried for boreholes and springs within the clinic areas. This dataset includes the Groundwater Resource Information Project (GRIP) results done by DWS in 2008. A search radius of 1 km from each clinic was applied and three boreholes were found around Ntshale Clinic and no boreholes at Mpozolo Clinic. The following can be summarised on the three boreholes found around Ntshale Clinic:

- Borehole 3128DA00116 was reportedly drilled in 1988 but had a very low yield of 0.001 L/s and the groundwater level was measured as 14.54 m bgl.
- Borehole EC/T20/0237 was reportedly drilled in 2007 and yield tested in 2012. The borehole was recommended at 0.56 L/s for a 10-hr pumping period. The groundwater level was measured at 11.25 m bgl.
- Borehole EC/T20/0238 was reportedly drilled in 2006 and yield tested in 2012. The borehole was recommended at 1.67 L/s for a 14-hr pumping period. The groundwater level was measured at 6.23 m bgl.

Figure 4-3 present the three NGA boreholes on a map.

Table 4-1: NGA Dataset at Ntshеле

Identifier	Other number	Latitude	Longitude	Date Drilled	Depth [m bgl]	Ground-water level [m bgl]	Comment
3128DA00116	T34008	-31.66582	28.7302	05/10/1988	81	14.54	The borehole had a reported water strike at 50 m and the yield was very low, 0.001 L/s
EC/T20/0237	EC-T20-021	-31.66762	28.72541	19/07/2007	75	11.25	The borehole was tested in 2012 and was recommended at 0.56 L/s for a 10-hour pumping period
EC/T20/0237		-31.66142	28.7251	2006		6.23	The borehole was tested in 2012 and was recommended at 1.67 L/s for a 14-hour pumping period

**Figure 4-3: Ntshеле Clinic – NGA Boreholes Map**

4.1.4 Geology– Ntshеле Clinic

As per the Explanation booklet for Sheet 3128 1: 250 000, Umtata, Geological Survey, the Site is underlain by the Katberg Formation, intruded by dolerite dykes and sheets.

The Katberg Formation forms part of the Tarkastad Subgroup and Beaufort Group and consist of sandstone and mudrock. The sandstones are lenticular, with large scale trough crossbedding, horizontal lamination and flow lineations on bedding planes being common features. Thin clay-pellet and conglomerates often occur at the base of sandstone lithosomes. The pinkish to yellowish colour

of the rather uniformly fine-grained sandstones contrasts with the greenish- or bluish-grey colour of the same rock type in the underlying Adelaide Subgroup. The interbedded mudstones are reddish or greenish grey.

The sedimentary rocks were intruded by numerous dykes, sills and inclined sheets of dolerite during the Jurassic period. Dykes are normally not more than 10 m wide and extend for a few kilometres.

Refer to Figure 4-4 for a map showing the regional geology of the area and the proposed target zones.

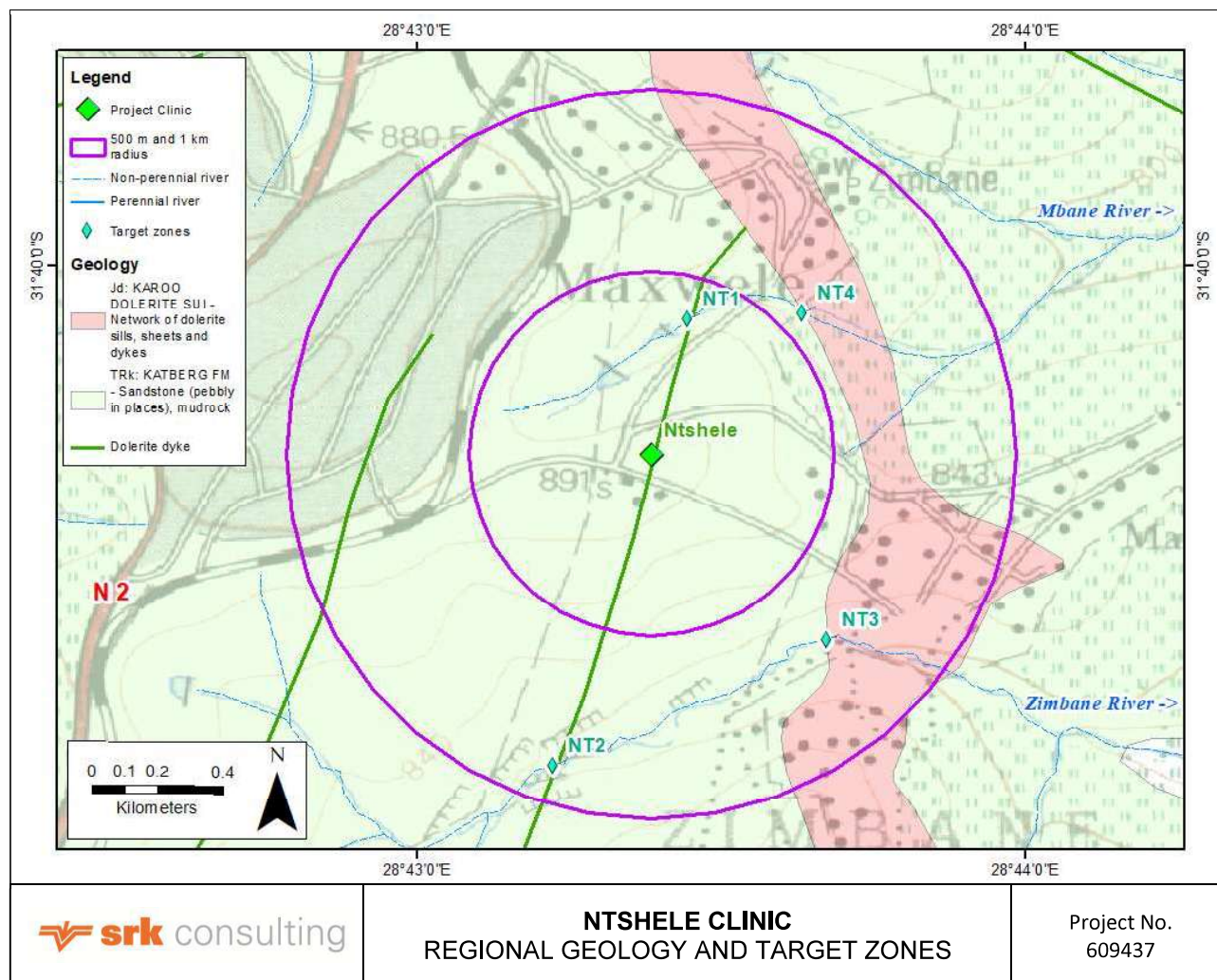


Figure 4-4: Ntshele Clinic - Regional Geology and Target zones

4.1.5 Geology – Mpozolo Clinic

As per the Explanation booklet for Sheet 3228 1: 250 000, Kei Mouth, Geological Survey, the Site is underlain by the Adelaide Subgroup, intruded by dolerite dykes and sheets.

The Adelaide Subgroup consist of alternating units a few meters to a few tens of meters thick of grey, fine-grained ultra-lithofeldspathic sandstone (+/- 20%) and greenish-grey, bluish-grey or greyish-red mudstone (+/- 80%).

The sedimentary rocks were intruded by numerous dykes, sills and inclined sheets of dolerite during the Jurassic period. Dykes are normally not more than 10 m wide and extend for a few kilometres.

Refer to Figure 4-4 for a map showing the regional geology of the area and the proposed target zones.



The main drilling target areas will include the dolerite dyke and sill contact zones with the sedimentary rocks. Expected high groundwater potential zones (dolerite dyke and sill contact zones) were verified using satellite imagery. Based on the previously completed projects by SRK within the area and similar geology, the regional dolerite dykes and sill contact zones were found to deliver higher yielding boreholes along rivers where high groundwater recharge is expected. These dykes and contact zones form preferred flow paths with expected high groundwater potential. The criteria for the target selections therefore included geological targets such as dolerite dykes and dolerite sill contact zones with the sedimentary rocks.

The last criteria included in the target selection is accessibility. Dense vegetation as well as steep topography limits access to certain geological targets. These areas will still need to be verified on site for accessibility purposes.

NOTE: These coordinates are not drilling positions, merely the centre point of areas for further geophysical investigation.

Table 4-2: Target Zones

Clinic	No	Latitude	Longitude	Comment
Ntshele	NT1	-31.66810	28.72404	Dolerite dyke - 420 m from the Clinic
Ntshele	NT2	-31.68036	28.72036	Dolerite sill - 600 m from the Clinic
Ntshele	NT3	-31.67693	28.72786	Dolerite dyke - 980 m from the Clinic
Ntshele	NT4	-31.66794	28.72720	Dolerite sill - 730 m from the Clinic
Mpozolo	MP1	-32.18252	28.77128	Dolerite dyke and sill - two geophysical traverses proposed - 540 m from the Clinic
Mpozolo	MP3	-32.17330	28.77904	Dolerite dyke - access seem from the Satellite image to be limited - 800 m from the Clinic
Mpozolo	MP2	-32.17054	28.77513	Dolerite dyke and sill - 1 km from the Clinic

4.1.7 General Hydrogeology

The following key information sources were consulted:

- Vegter, J.R., Seymour A., 1995. Groundwater Resources of the Republic of South Africa – Two Map sheets and explanatory brochure. DWAF.
- Parsons, R., Conrad, J., WRC Report No KV 116/98, “Explanatory Notes for the Aquifer Classification Map of South Africa”.
- Groundwater Resource Assessment Phase 2 (GRA 2), DWS, 2003.
- Department of Water Affairs and Forestry. Hydrogeological Map Series of the Republic of South Africa. Completed in 2002.

The Site area has a moderate groundwater potential of 30 – 40% reported by Vegter and Seymore (1995). These percentages indicate the probability of drilling a successful borehole (airlift yield > 2 L/s). In the Hydrogeological Map Series, an expected borehole yield of 0.5 – 2.0 L/s was reported within an intergranular and fractured aquifer.

DWS initiated a project in 2003, referred to as the Groundwater Resource Assessment Phase 2 (GRA 2). The main aim of the project was the quantification of the groundwater resources of South Africa on a national scale. The project included the quantification of recharge, storage and sustainable yield of the aquifer systems throughout South Africa. The expected average groundwater exploitation potential (AGEP) for the Site is 10 000 to 15 000 m³/km²/annum (0.3 to 0.5 L/s).

According to the GRA2 the expected Electrical Conductivity will be below 70 mS/m at Mphozolo Clinic, indicating acceptable water quality but the expected Electrical Conductivity will be from 70 to 300 mS/m at Ntshele Clinic, indicating a moderate water quality.

Based on the Aquifer Classification Map, the aquifer is classified as a minor aquifer region, therefore being a moderately-yielding aquifer of variable water quality.

4.2 Site Investigations

4.2.1 Hydrocensus

The hydrocensus was undertaken in the week of 7 October 2024. The existing boreholes were photographed and current statuses captured. Boreholes EC/T20/0237 and EC/T20/0238 were found at Ntshele Clinic, but T34008 is believed to be destroyed and could not be found. Both these boreholes are in brick pumphouses, but the equipment was not in working condition. No boreholes were found at Mpozolo Clinic. Refer to Table 4-3 for a summary of the borehole details and photographs.

Table 4-3: Hydrocensus results

Site Type	Allocated number	Latitude	Longitude	Equipment	COMMENTS	PHOTO
Clinic	Mpozolo Clinic Contact person: M. Mhlahlo, Community member, 076 764 0344	-32.1801	28.77623		There is currently no structure on the proposed new site. No boreholes were found in the village. The village was reported to get water from the neighbouring village (borehole / dam).	
Clinic	Ntshele Clinic Contact person: Sicelo Tuswa, Sub-headman, 078 695 3041	-31.6716	28.72351			
Borehole	EC-T20-237	-31.6677	28.72551	Submersible pump (not working)	The pump house was found open and vandalised. The pump was not working.	
Borehole	EC-T20-238	-31.6614	28.72512	None	Borehole house is not locked, and the pump is vandalised. The groundwater level could be measured as 18 m bgl, but the borehole depth could not be measured.	

4.2.2 Geophysical Investigation

The targets selected during the desk study were verified on site for accessibility. No geophysical traverses could be undertaken at target zones NT2 and NT3 at Ntsele Clinic. The area at NT2 were found to be allocated to private owners and could not be accessed and the topography at NT3 was very steep and can not be accessed by a vehicle. Traverses NT-004 and NT-005 were undertaken in the vicinity of the existing borehole EC/T20/0237 that is not in a working condition, and the pump was found to be vandalised.

Traverses number MP-001 and MP-002 at Mpozolo Clinic are located on the territory of a different chief from that on which the clinic is located, and Mr Zeka from CDC indicated that liaison will be undertaken by the CDC before commencing of drilling new boreholes.

The EM-34 and Magnetometer were applied to the five areas that were accessible and five geophysical traverses completed. Readings were taken at 5 m and 10 m intervals and every 10 m position marked by creating a soil mound using a spade.

Refer to Table 4-4 for the geophysical traverses start and end coordinates as well as the results in the comment column. Refer to Appendix A for the geophysical graphs and Figure 4-6 and Figure 4-7 shows the geophysical traverse positions.

Table 4-4: Geophysical traverses start and end coordinates

Traverse No.	Target	Direction	Station	Latitude	Longitude	Priority	Drilling Position
Mpozolo Clinic							
MP-001	Dyke	S-N	0	-32.18298	28.77179		
			130	-32.18212	28.77103		
MP-002	Sill	W-E	0	-32.18208	28.7725	1	130
			180	-32.18320	28.77122	2	100
MP-003	Sill	W-E	0	-32.16963	28.77288	3	80
			110	-32.16901	28.77379	4	35
Ntshele Clinic							
NT-004	Dyke	SWW-NEE	0	-31.66881	28.7233	1	130
			200	-31.66732	28.72458		
NT-005	Dolerite Sill	NW-SE	0	-31.66772	28.72554	2	140
			200	-31.66798	28.72765	3	100

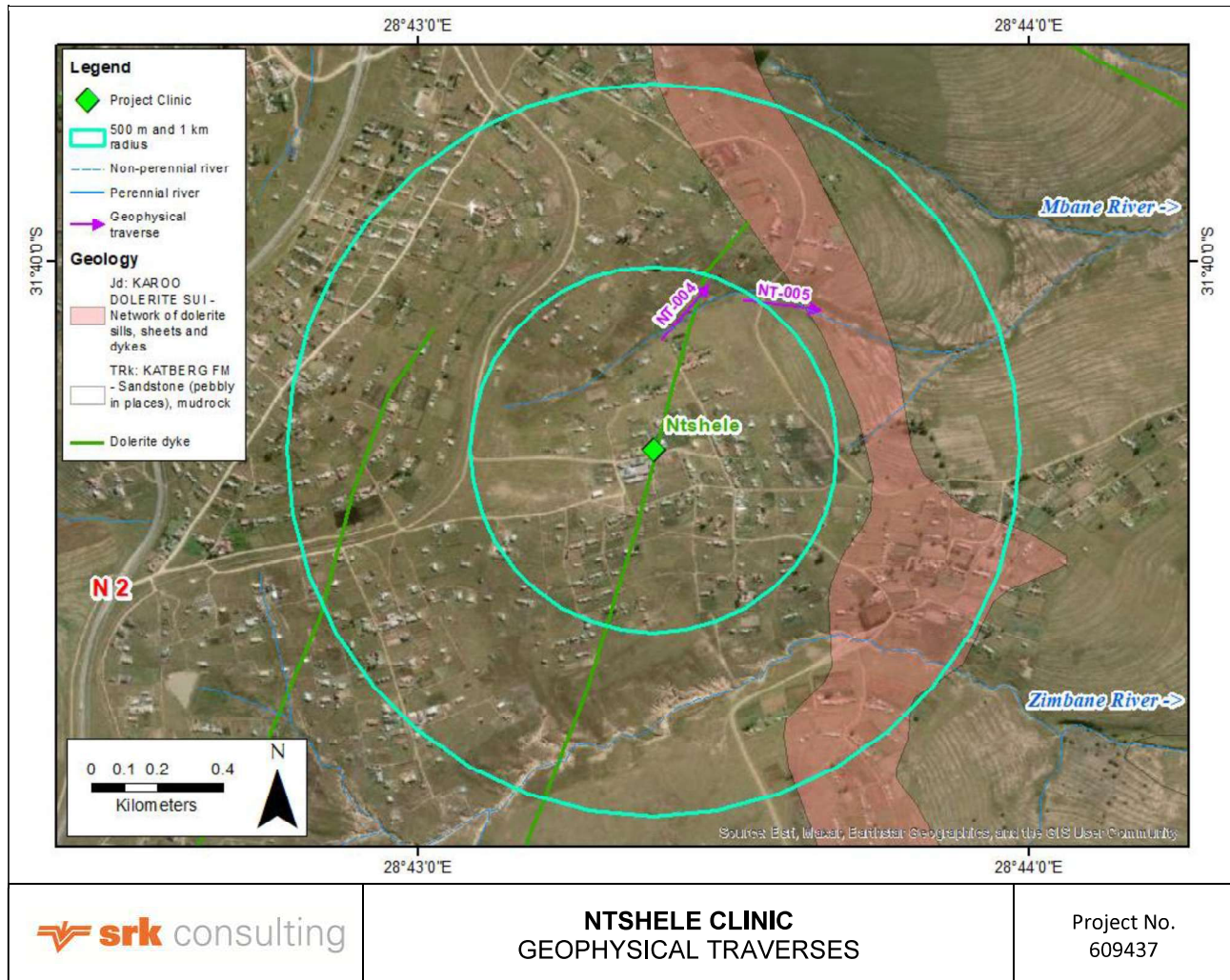


Figure 4-6: Ntshele Clinic – Geophysical Traverses

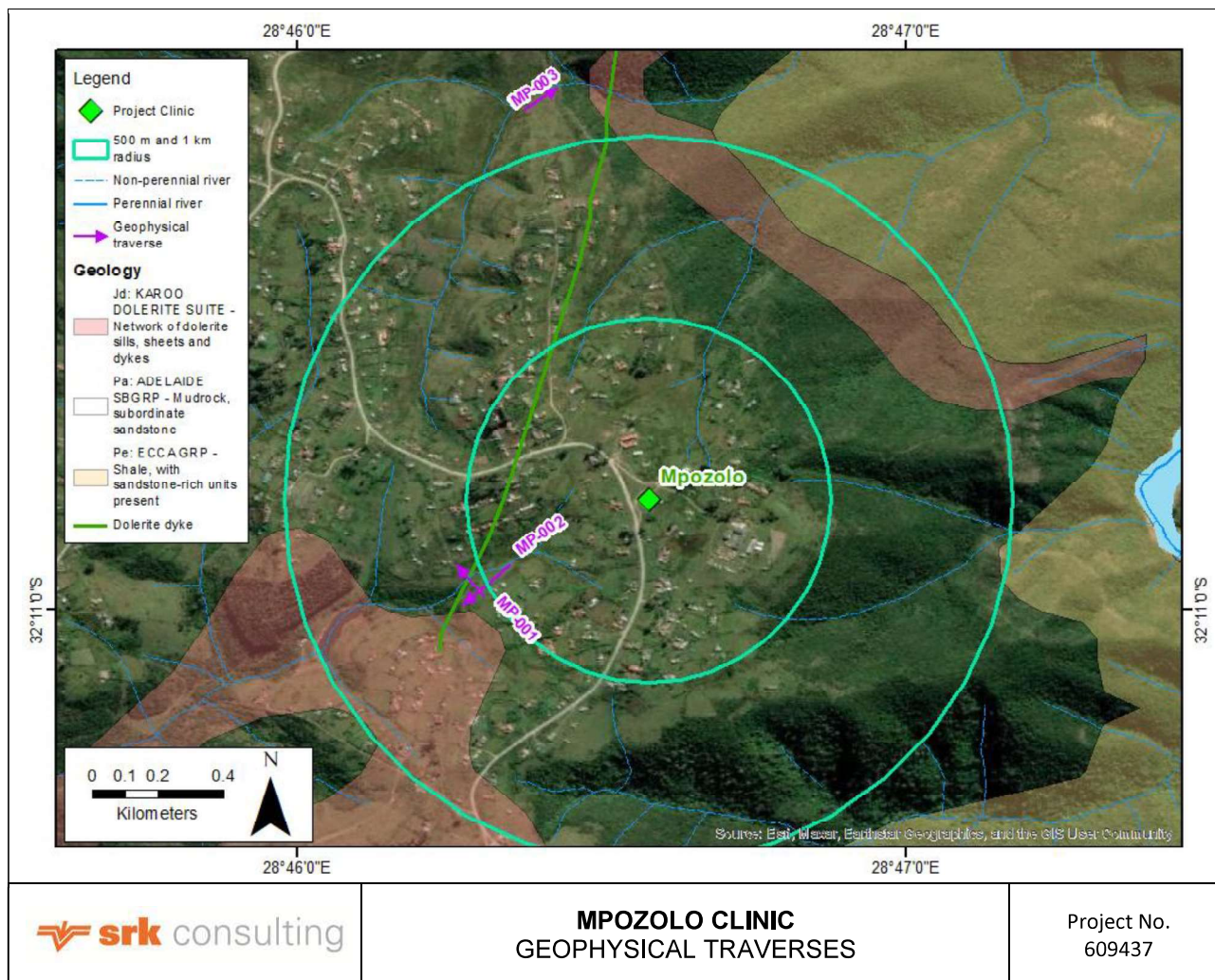


Figure 4-7: Mpozolo Clinic - Geophysical Traverses

4.3 Groundwater Impact Assessment

No impacts on other groundwater users are expected, due to the absence of other groundwater users in the vicinity of the target drilling sites.

No impact of the abstraction of groundwater from a borehole and its activities on the natural environment are expected. It is however required that boreholes must be drilled and successful boreholes, yield tested according to the DWS and SANS standards. Proper drilling methods, i.e. installation of sanitary seals, concrete collars, etc. will ensure that the aquifer is not contaminated by inflow from surface, and the analyses of the pump test by a professional hydrogeologist will ensure that the groundwater is not over abstracted and the aquifers damaged.

Management of the boreholes are crucial to the sustainability of the sources and should include monitoring of groundwater levels and yields. The DWS published the latest “Standard Operating Procedures (SOP) for Groundwater Resource Development for Community Water Supply Projects”, Version 4.0, 15 June 2023. DWS have made it widely known to hydrogeologist that this document is applicable to all groundwater source development, inclusive of town or businesses water supply from boreholes.

Typical management measures that can mitigate groundwater impacts are outlined below:

- Installation of a monitoring device during installation of a production pump;
- The installation must include a piezometer tube that is large enough to accommodate the monitoring probes and should be a standard item of the down-hole equipment;

- The monitoring system must monitor the number of hours and yield the borehole is pumped and reported in relation to the management recommendation done by the hydrogeologist.
- The groundwater level must be monitored daily and reconcile with the dynamic groundwater levels calculated from the pump test data.
- A daily report must be produced that reflects the operational status of the borehole over the last 24 hours.
- A monthly report must reflect the borehole reaction to the pumping cycles of the month.
- An annual report must be electronically submitted and be made available on request as part of an information database.
- These monitoring reports must be electronically submitted and available on request as part of an information database.

In accordance with General Notice (GN) 509 of 2016, a regulated area of a watercourse for Section 21(c) and 21(i) of the NWA, 1998 is defined as:

- the outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
- in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or
- a 500 m radius from the delineated boundary (extent) of any wetland or pan.

The National Freshwater Ecosystem Priority Areas (NFEPA) wetlands were plotted and compared to the proposed drilling positions. Except for MP-003, geophysical traverses MP-002, NT-004 and NT-005 were all found to be within 500 m from a mapped wetland zone. The proposed drilling positions are all located next to non-perennial streams as well, but no crossings will be required with infrastructure from the source to the clinic. It will however be applicable to apply for a license when authorising the water source with the DWS.

Table 4-5: Drilling position coordinates and distances form wetlands

Traverse No.	Priority	Drilling Position	Drilling coordinates		Distance from NFEPA wetland [m]
			Latitude	Longitude	
Mpozolo Clinic					
MP-002	1	130	-32.182900	28.771500	290
	2	100	-32.182706	28.771729	315
MP-003	3	80	-32.169178	28.773544	> 500
	4	35	-32.169428	28.773176	>500
Ntshele Clinic					
NT-004	1	130	-31.667865	28.724112	100
NT-005	2	140	-31.667900	28.727000	350
	3	100	-31.667848	28.726579	300

4.4 Cost estimation for the establishment of groundwater sources

The required water demand of the clinics will predict the number of boreholes to be drilled. It is recommended that the drilling of two boreholes at each clinic be allowed for with the construction of one borehole for abstraction purposes per clinic.

It is recommended to allow for the following:

- Drilling:
 - Two boreholes to depths of 120 m each per clinic;
 - Drilling diameter of 165 mm should be undertaken;
 - The exact depth of the casing will be determined during the drilling of the borehole. The geological log will indicate the depth that unstable formation was encountered, and the depth the casing should be installed to;
 - For budgeting purposes, 30 m of 165 mm inner diameter steel casing was allowed for to be installed in one of the boreholes per clinic;
 - The successful borehole should be reamed to a diameter of 215 mm, to the depth of the casing to be installed;
 - A sanitary seal shall be installed in the successful boreholes;
 - A concrete collar shall be installed at the successful boreholes;
 - Dry boreholes will be backfilled and concrete plug installed at surface to ensure no surface water can access the boreholes;
 - Borehole numbers shall be obtained from the DWS, as per the catchment numbers and allocated to each borehole; and
 - The casing shall be closed at the top to secure the borehole from vandalism.
- Yield and water quality testing:
 - Yield testing of one successful borehole per clinic;
 - Test pump installation at 90 m;
 - Step test – four steps of one hour each with increasing yields and four hours recovery;
 - Constant discharge rate test – 24 hours of pumping at a constant yield with 24 hours of recovery;
 - Collection of a water sample will be undertaken towards the end of the constant discharge rate test and submitted for analytical purposes to be classed for human consumption;
 - The water quality results shall be classed according to the SANS241:2015 guidelines and determined if it is safe for human consumption.
- Drilling-, yield testing control and reporting by a professional hydrogeologist:
 - Drilling control should be undertaken and the success of the targeted formation identified;
 - Construction of the borehole shall be determined, based on the geological formation encountered in the successful borehole;
 - Yield testing control will be undertaken and the step yields and constant discharge rate yields determined by the hydrogeologist;

- Analyses of the yield test results will be undertaken and recommended abstraction rates calculated for long term use of the boreholes and the water quality results analysed for human consumption;
- Reporting on the above results to be undertaken by the hydrogeologist.

The estimated costs will be as follows:

Item	Description	Unit	Qty	Rate	Total
1	Drilling of two boreholes at Ntshale Clinic, one constructed for abstraction purposes	Sum	1	R 160 000.00	R 160 000.00
2	Drilling of two boreholes at Mpozolo Clinic, one constructed for abstraction purposes	Sum	1	R 160 000.00	R 160 000.00
3	Yield testing of one borehole at Ntshale Clinic	Sum	1	R 31 500.00	R 31 500.00
4	Yield testing of one borehole at Mpozolo Clinic	Sum	1	R 31 500.00	R 31 500.00
5	Hydrogeological supervision, analyses and reporting	Sum	1	R 105 000.00	R 105 000.00
Total (Excluding VAT)					R 488 000.00

5 Conclusions and Recommendations

From the above activities completed the following can be concluded and recommended:

- Mpozolo Clinic is located on a catchment boundary with expected low groundwater recharge;
- Two existing boreholes are located within 1-km from Ntshale Clinic, both were however found to be vandalised and no longer in use. Borehole EC/T20/0237 was reportedly yield tested in 2012 and recommended at 0.56 L/s for a 10-hr pumping period.
- Ntshale Clinic is underlain by the Katberg Formation, consisting mostly of sandstone with an expected higher groundwater potential than the Adelaide Subgroup underlying the Mpozolo Clinic, consisting mostly of mudstones and having an expected lower groundwater potential.
- Both sites are intruded by dolerite sills and dykes, whereby these contact zones with the above mentioned sedimentary rocks form preferred groundwater flow paths with expected higher groundwater potential zones.
- The groundwater potential for both clinics are moderate and a chance of 30 – 40% for drilling a borehole yielding > 2 L/s are reported.
- Two geophysical traverses were undertaken at Ntshale Clinic and three at Mpozolo Clinic.
- Three position for the drilling of boreholes were selected per clinic.
- The drilling of two boreholes should be allowed for with the yield testing of one successful borehole per clinic.
- The estimated costs (excluding VAT) will be in the order of R 488 000, inclusive of the drilling, yield- and water quality testing, supervision by a hydrogeologist on both activities and reporting on the results found.

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Principal Hydrogeologist

Project Manager**Reviewed by**

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Rob Gardiner, Pr Sci Nat, Reg. EAP (EAPASA)

Partner

Project Partner

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

7 References

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Appendices

Appendix A: Geophysical Graphs

Magnetic method

Magnetic surveys indicate anomalies (changes) in the earth's magnetic field due to rock types having different magnetic susceptibilities. Magnetic bearing formation such as intrusive dykes, faults, lithological contacts and weathered/fractured bedrock will most likely have an impact on the earth's magnetic field.

These geological structures are primary targets in the selection of drilling sites for groundwater exploration.



A Geotron model G5 Proton-precession magnetometer was utilized in the survey. This instrument measures the total field component of the earth's magnetic field. A default station interval of 5 m was adapted in order to delineate the geological structures.

Geonics EM34 (Electromagnetic Instrument)

In this method, the ground is subjected to an artificially produced magnetic field and the response,



which is a combination of the artificial field and the field produced by the geological body affected by it, is measured. The apparent conductivity of the underlying geology is measured in mS/m. This property is proportional to the amount of weathering and/or fracturing encountered in the underlying geology.

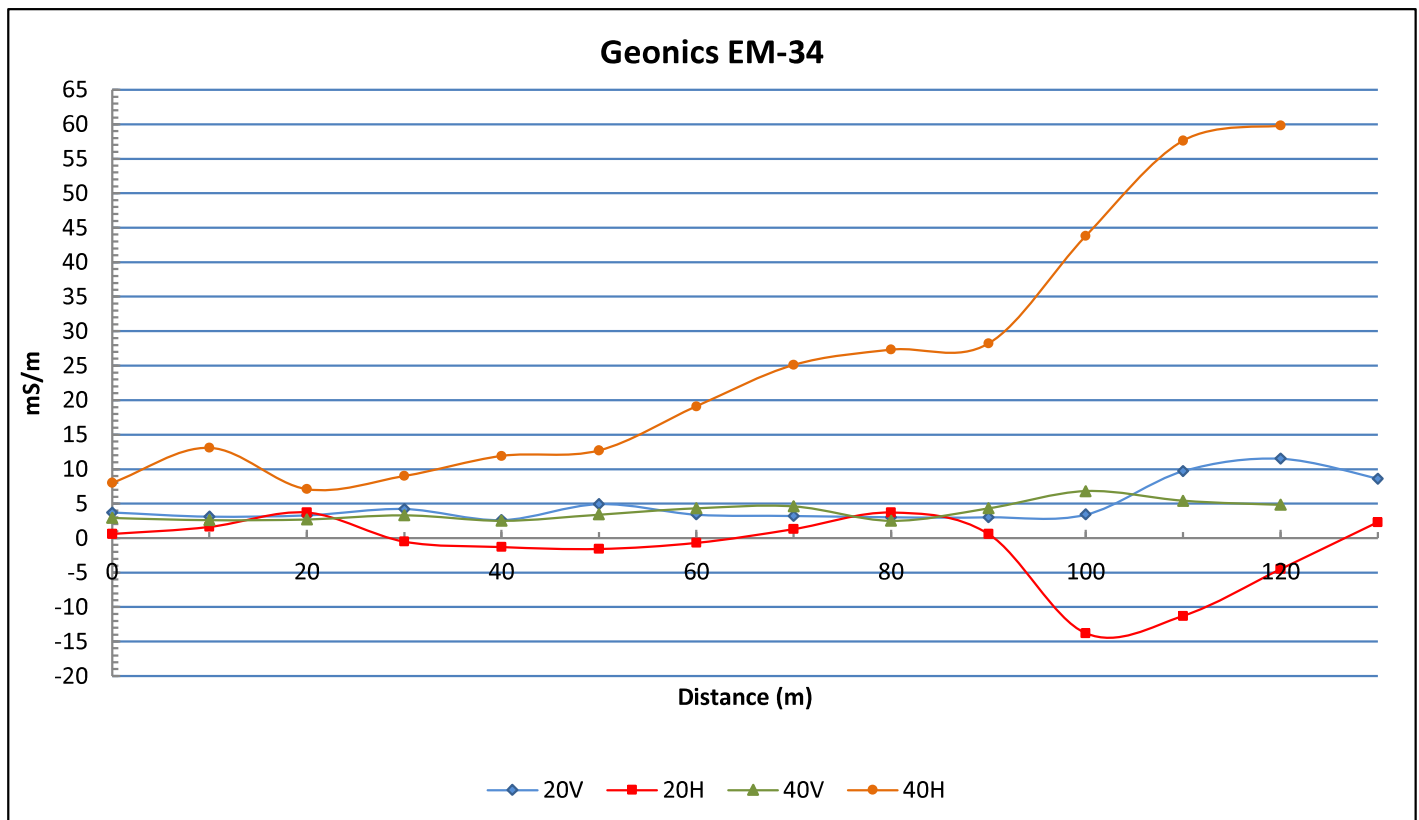
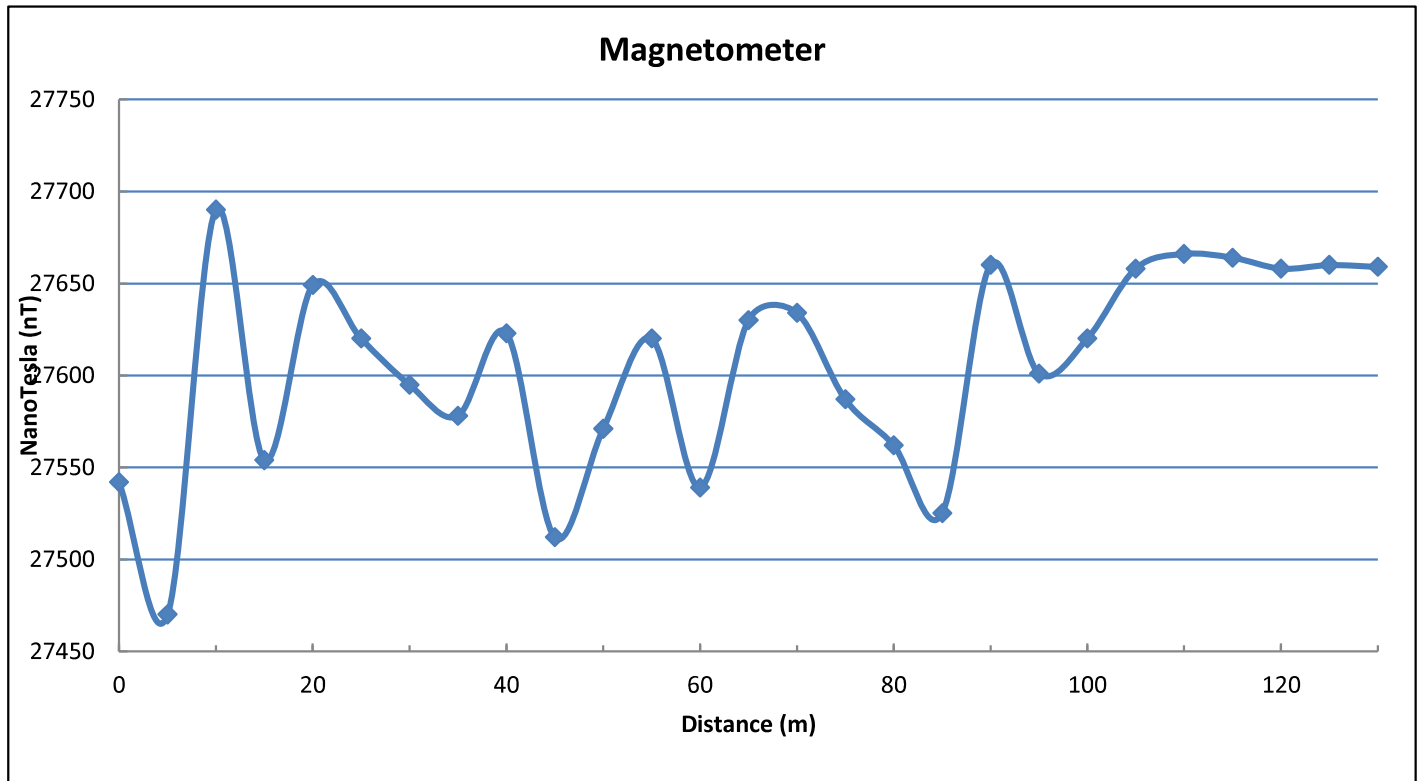
The EM-34 consists of a large transmitter and receiver coil connected by a reference cable. The EM34-3 uses

2 inter-coil separations (20 or 40 m) to measure conductivity at variable depths of exploration down to 60 meters.

Investigation depths of the EM34 at variant coil spacing

Coil Spacing (m)	Investigation Depth (m)	
	Vertical Coils	Horizontal Coils
20	15	30
40	30	60

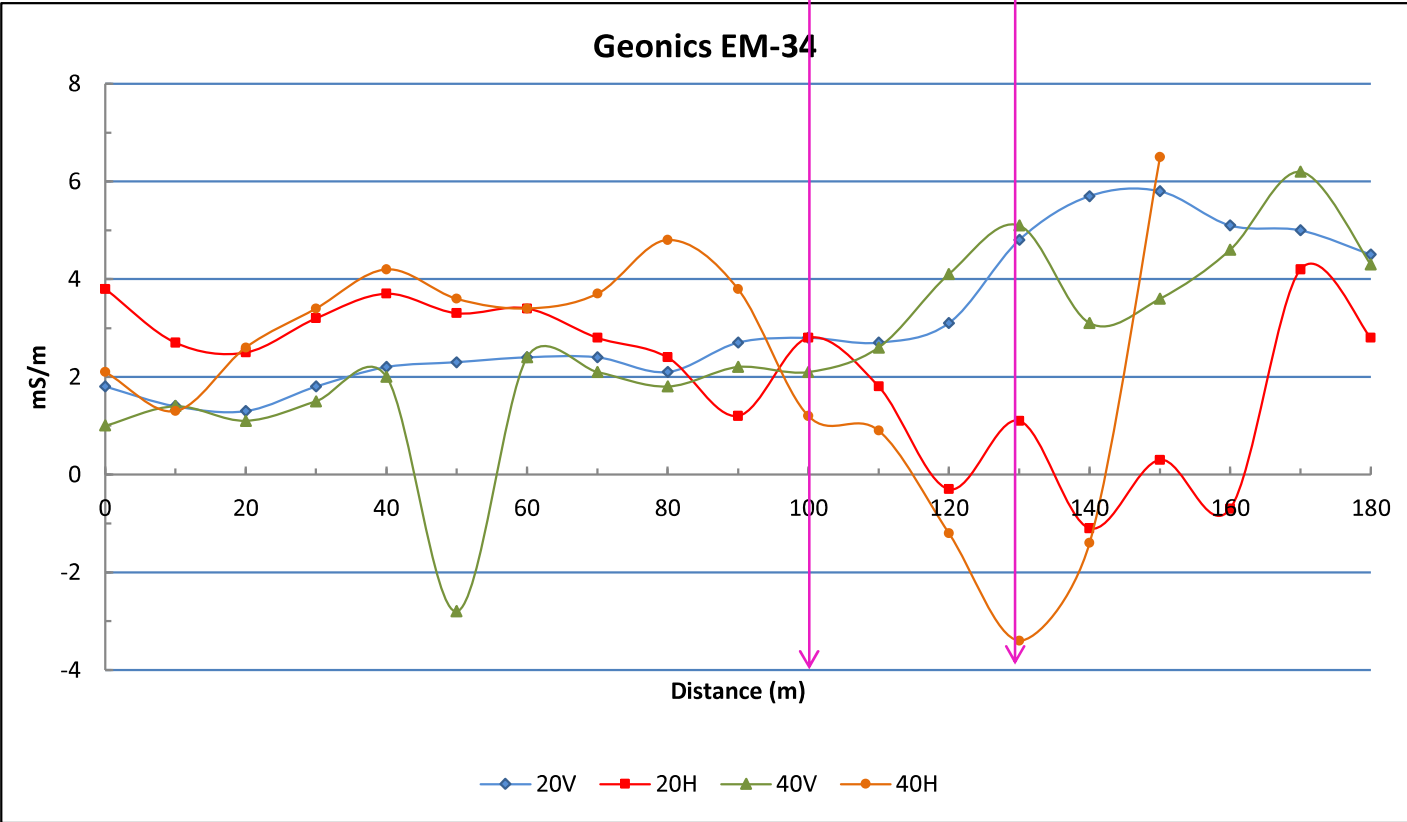
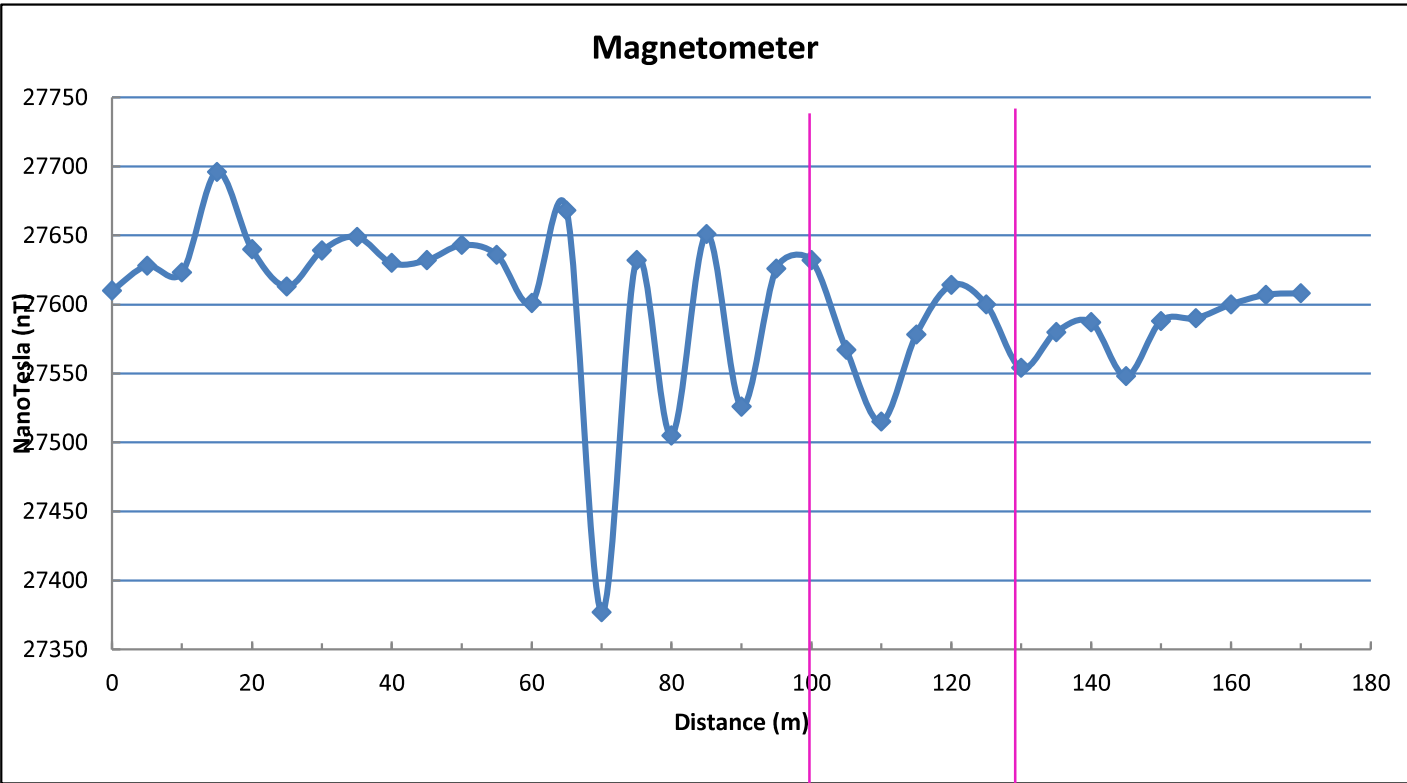
Project Name: CdcGW2Clinics
 Project Number: 609437
 Traverse Number: MP-001



Co-ordinates				Traverse Direction	Target	Drilling Positions		
Start Lat	Start Long	End Lat	End Long			1	2	3
-32.18298	28.77179	-32.18212	28.77103	S-N	Dyke			

Comment: 20m - 40m cable powerline influence, 130m - 20m from fence

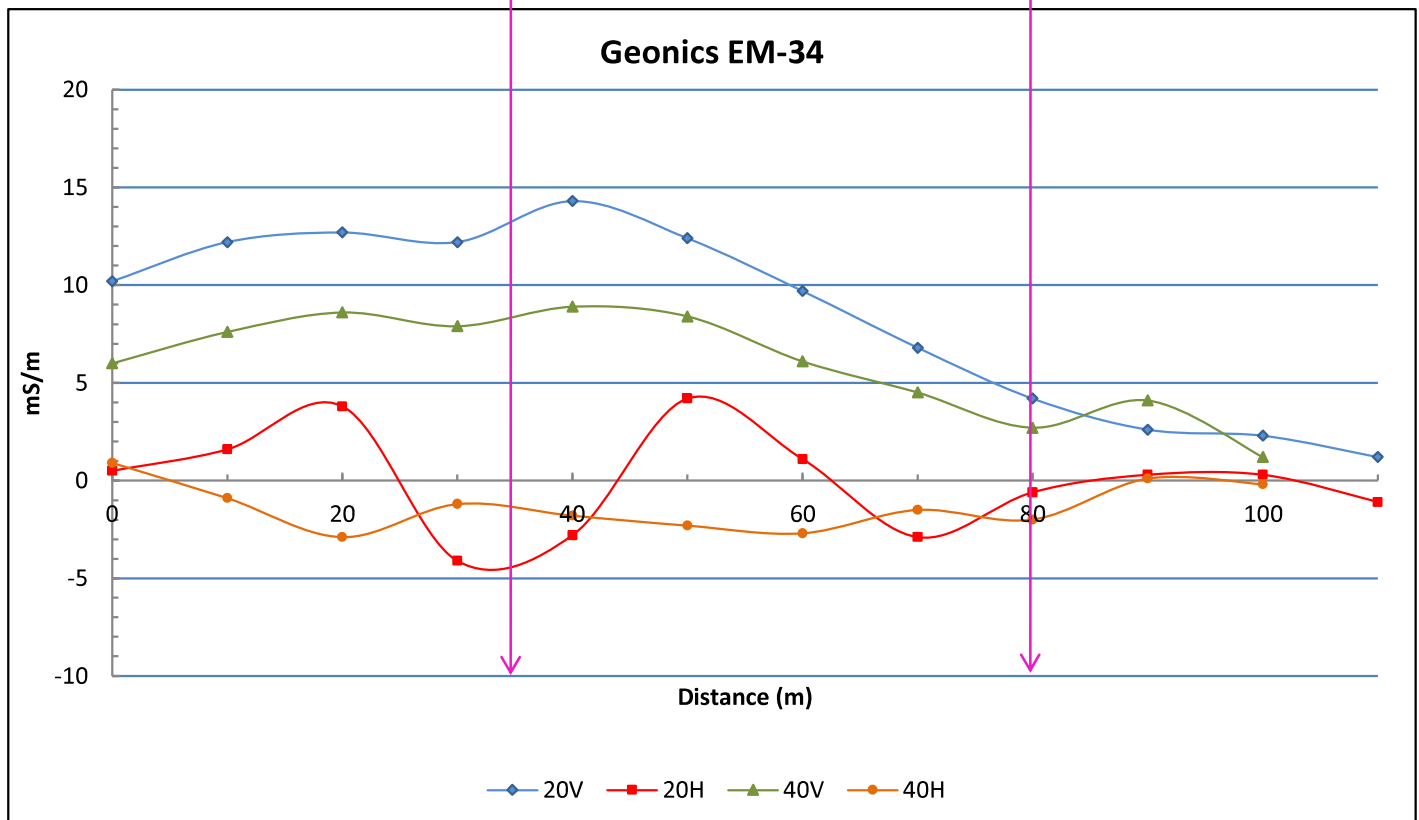
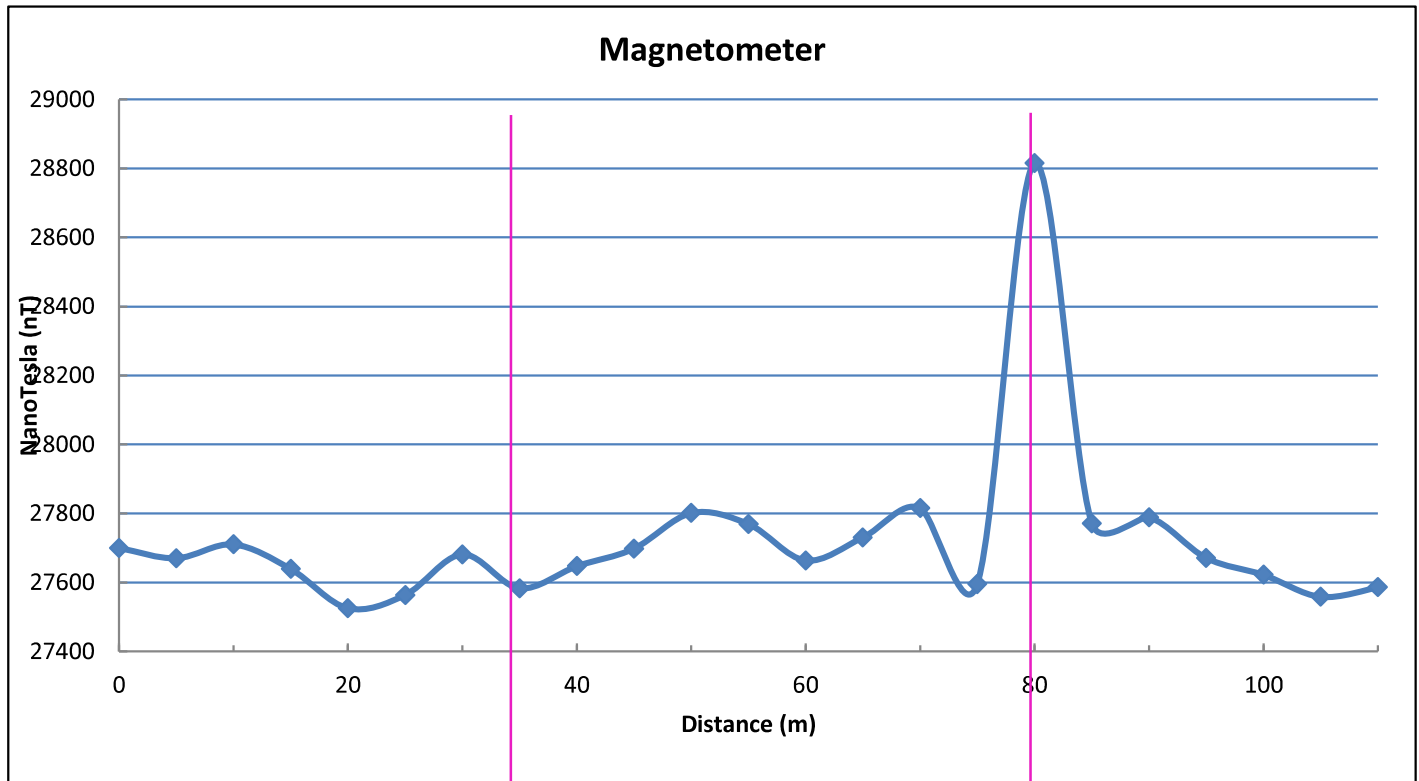
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Project Number: 609437
Traverse Number: MP-002



Co-ordinates				Traverse Direction	Target	Drilling Positions		
Start Lat	Start Long	End Lat	End Long			1	2	3
-32.18208	28.7725	-32.1832	28.77122	W-E	Dolerite sill	130	100	

Comment: 150-160m - Powerline

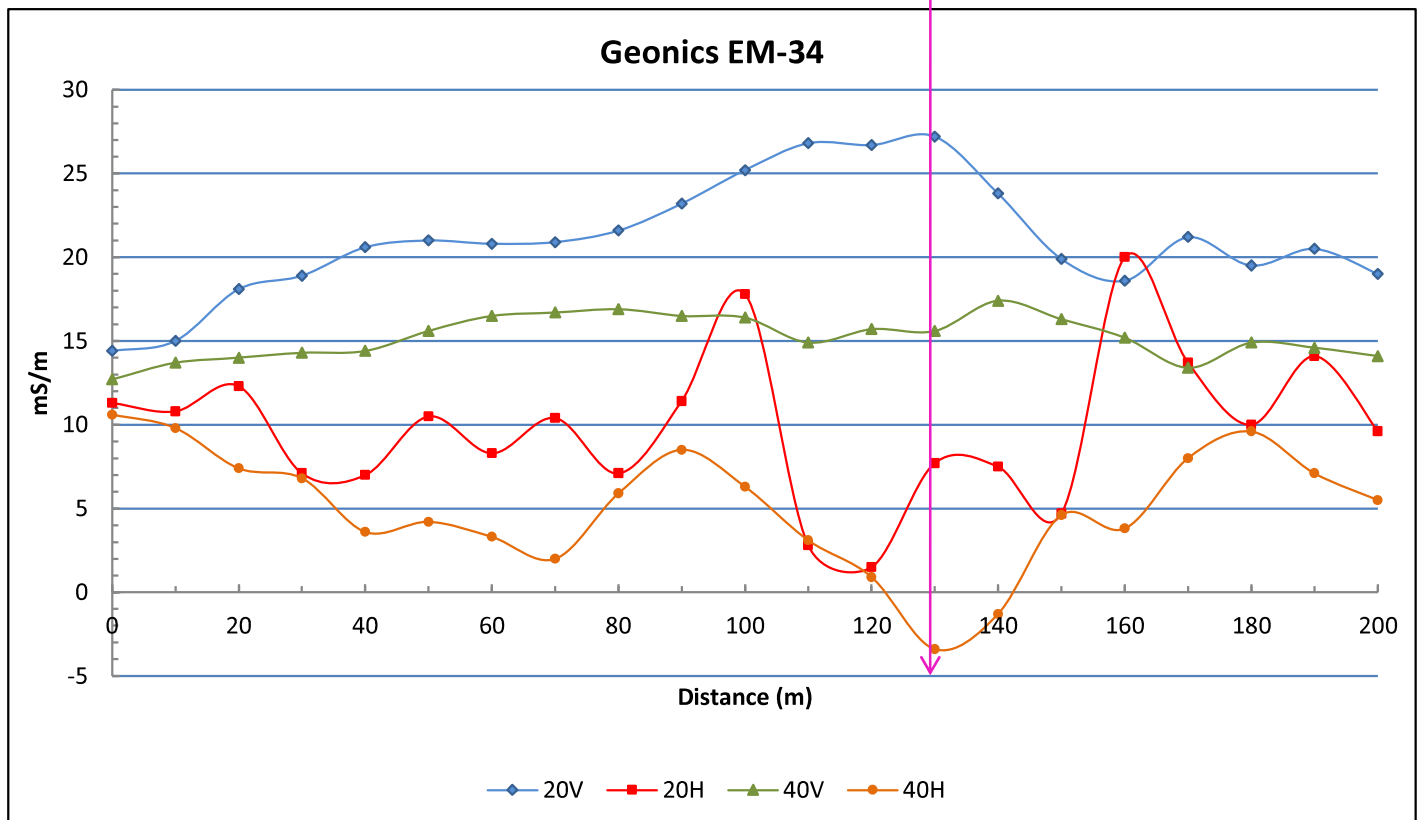
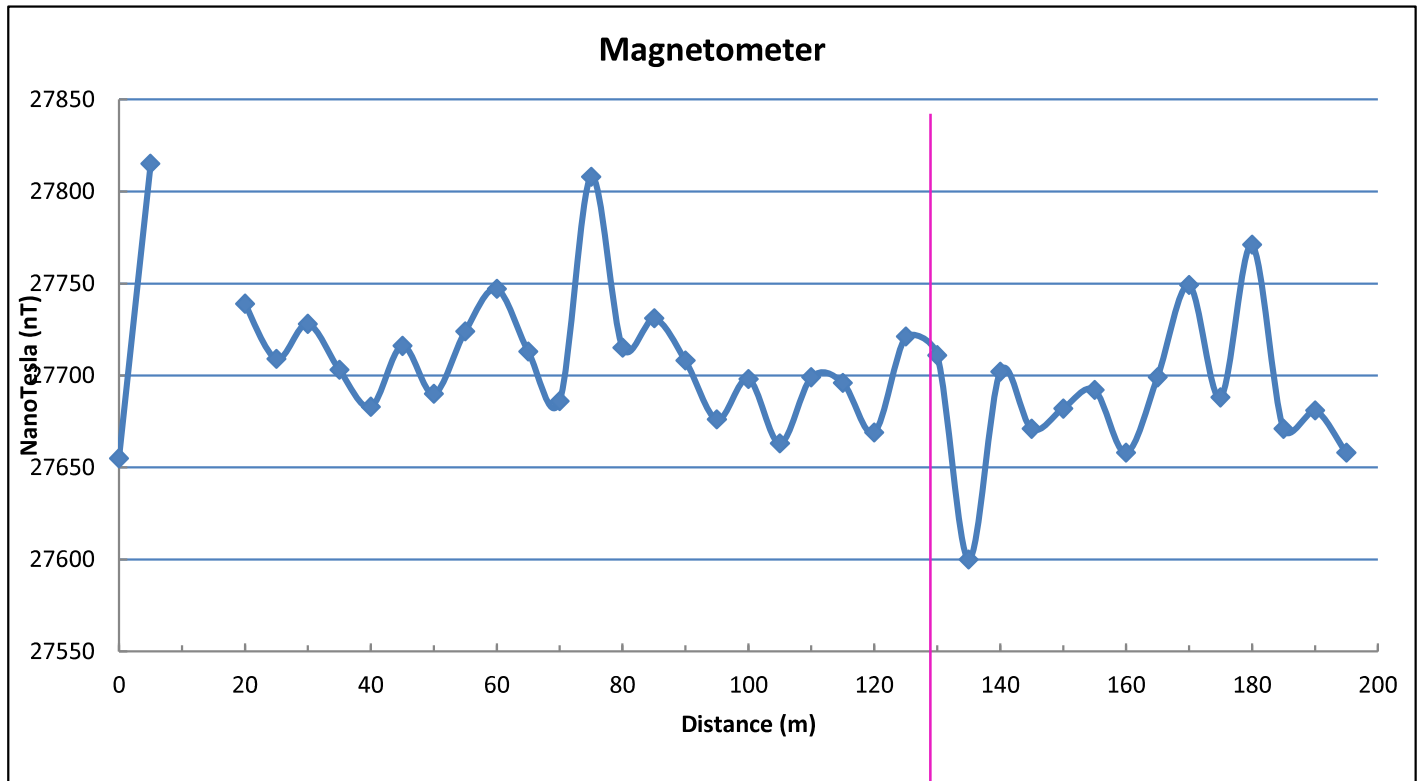
Project Name: CdcGW2Clinics
 Project Number: 609437
 Traverse Number: MP-003



Co-ordinates				Traverse Direction	Target	Drilling Positions		
Start Lat	Start Long	End Lat	End Long			1	2	3
-32.16963	28.77288	-32.16901	28.77379	W-E	Sill	80	35	

Comment:

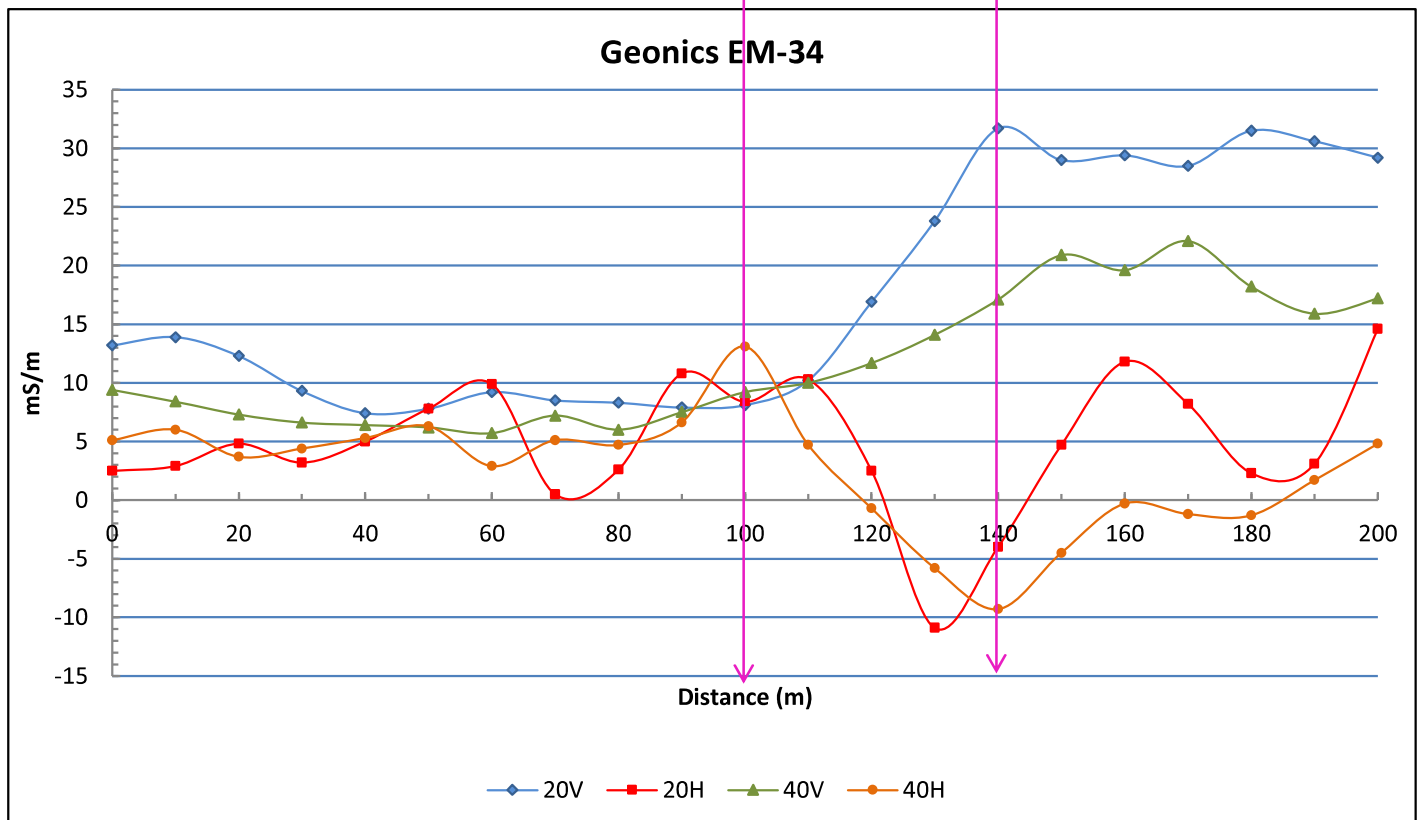
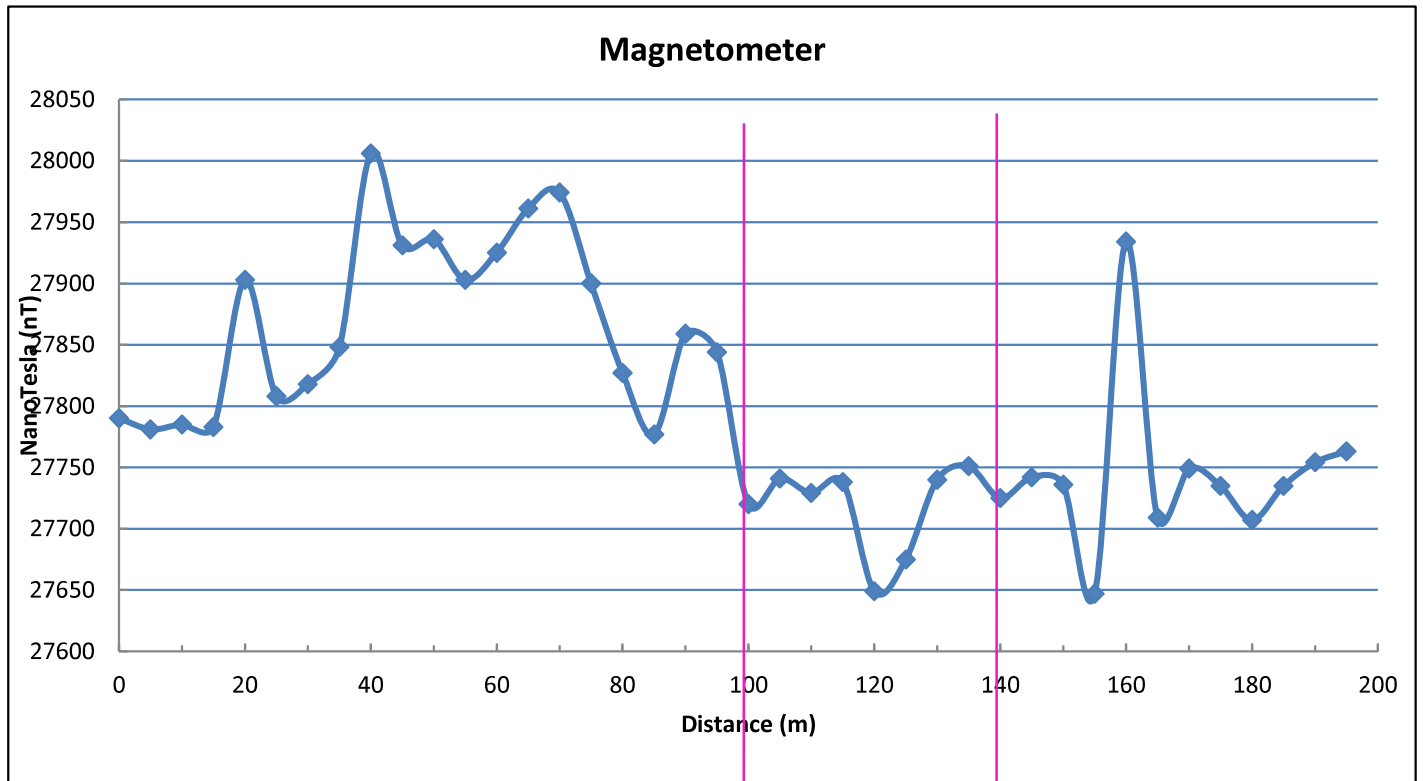
Project Name: CdcGW2Clinics
 Project Number: 609437
 Traverse Number: NT-004



Co-ordinates				Traverse Direction	Target	Drilling Positions		
Start Lat	Start Long	End Lat	End Long			1	2	3
-31.66881	28.7233	-31.66732	28.72458	SWW-NEE	Dyke	130		

Comment: 0m - Under powerline, 90-105m - Under powerline, 100m - Stream.

Project Name: CdcGW2Clinics
 Project Number: 609437
 Traverse Number: NT-005



Co-ordinates				Traverse Direction	Target	Drilling Positions		
Start Lat	Start Long	End Lat	End Long			1	2	3
-31.66772	28.72554	-31.66798	28.72765	NW-SE	Dolerite Sill	140	100	

Comment: 0m - 10m from borehole, 45-50m - Road