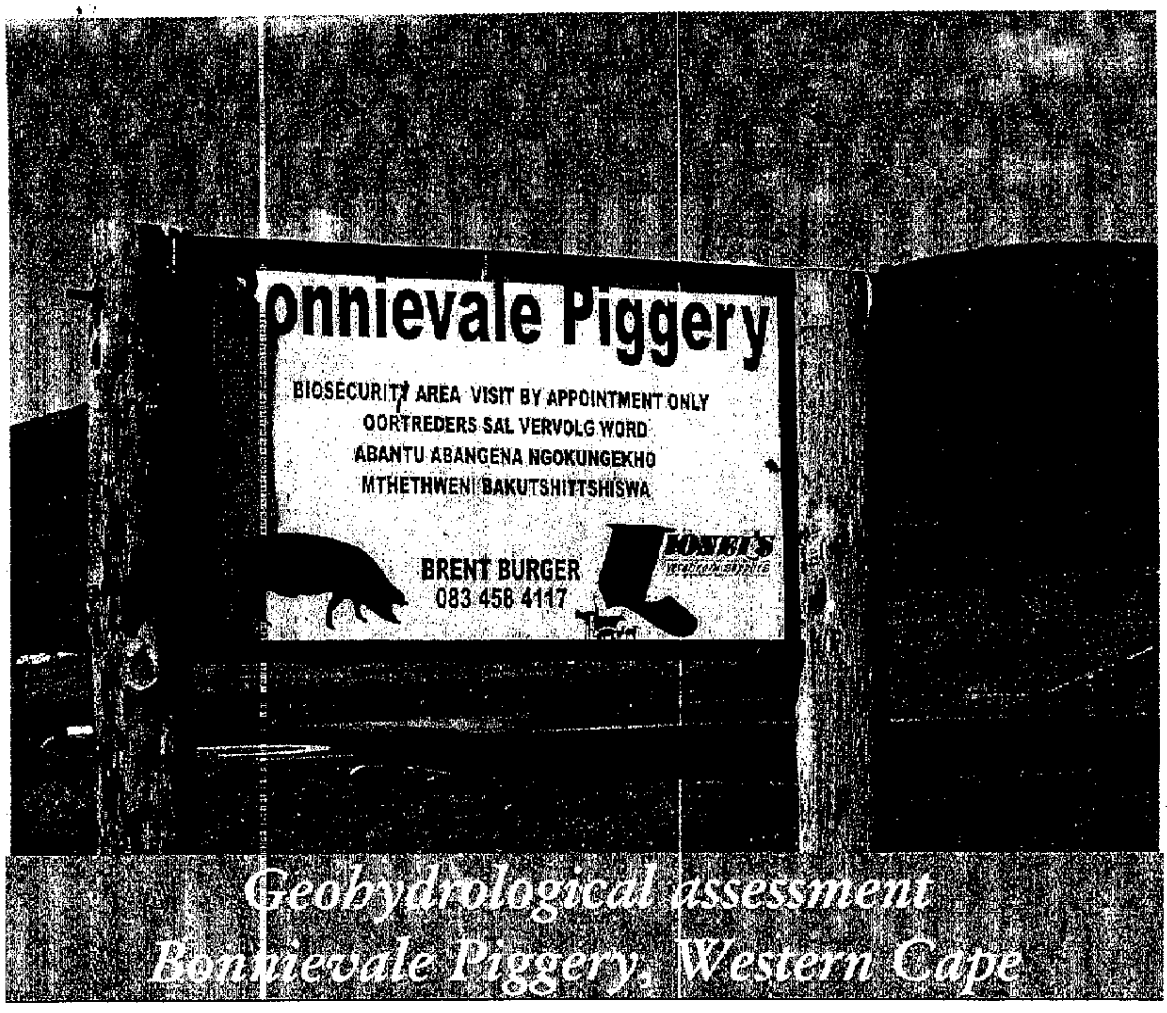

Geohydrological assessment Bonnievale Piggery, Western Cape

REPORT:	*PREPARED BY:*
GEOSS Report No: G2007/10-01 GEOSS Project No: 2007/05-237	Julian Conrad GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd Unit 19, TechnoStel, 9 Quantum Street, TechnoPark Stellenbosch 7600 Tel: (021) 880-1079 Email: julian@geoss.co.za (www.geoss.co.za)
PREPARED FOR: Brent Burger Bonnievale Piggery PO Box 327 Bonnievale 6730	

GEOHYDROLOGICAL AND SPATIAL SOLUTIONS INTERNATIONAL (PTY) LTD
GEOSS

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EXECUTIVE SUMMARY

Following on from a request from Bonnievale Piggeries, GEOSS conducted a geohydrological assessment of the piggery site and environs.

Two key issues were considered. Firstly to assess the possible risk of groundwater contamination from the piggery, and secondly, to assess the possible risk of contamination to surface water resources, particularly the Breede River.

The geological map of the area indicates that the entire area of interest is underlain by the Adolfspoort Formation, (Traka Sub-group/Bidouw Sub-group), of the Bokkeveld Group. This formation comprises mainly of siltstone, shale and argillaceous sandstone. This Formation is typically known as a non-aquifer.

A site visit was completed on 6th September 2007. Based on this visit it was confirmed that there is essentially no groundwater within 3 km of the piggery and there are definitely no aquifers in the area. The possible risk of contamination of groundwater is considered to be zero. To the north of the piggery there is a small ephemeral stream channel (which was dry at the time of the visit) called the Seeboskloof River Valley. However due to the low rainfall of the area (~ 272 mm/a) and the on-site surface flow management measures, the risk of overland flow to the Seeboskloof River Valley, approximately 0.6 km to the north, is considered extremely low. The risk to the Breede River, some 4.7 km away is considered to be essentially zero.

If public opinion demands or if it is felt necessary by relevant authorities to install monitoring boreholes, then 4 sites have been selected and the positions indicated in the report. These will be shallow boreholes through the cover material into 2 m of the bedrock shale. The anticipated depth of these fully screened boreholes, with a minimum ID of 100 mm is approximately 10 m. If the borehole programme is implemented the boreholes should be checked monthly for the presence of water and the depth to the water level also measured and recorded. The boreholes should be sampled monthly and field measurements of pH, temperature and Electrical Conductivity also recorded. A full sample should be collected and analysed in June each year. These results also need to be recorded.

In closing the piggery site does not pose a threat to groundwater (as there is no groundwater in the vicinity) and the probability of contamination of the nearby Seeboskloof River Valley via overland or inter-flow is extremely low. The probability of contamination of the Breede River is essentially zero. If it is deemed necessary a monitoring system of "sentry" boreholes can be installed at pre-selected sites. The results of the water monitoring and sampling must then also be documented.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF MAPS

ABBREVIATIONS

m	metres
mamsl	metres above mean sea level
mS/m	milliSiemens per meter
mg/ℓ	milligrams per litre
WGS84	Since the 1st January 1999, the official co-ordinate system for South Africa is based on the World Geodetic System 1984 ellipsoid, commonly known as WGS84, with the ITRF91 (epoch 1994.0) co-ordinates of the Hartebeesthoek Radio Astronomy Telescope used as the origin of this system. This new system is known as the Hartebeesthoek94 Datum.

GLOSSARY OF TERMS

Aquifer: a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].

Borehole: includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].

Confined aquifer: Groundwater below a layer of solid rock or clay is said to be in a confined aquifer. The rock or clay is called a confining layer. A borehole that goes through a confining layer is known as an artesian well. The groundwater in confined aquifers is usually under pressure. This pressure causes water in an artesian well to rise above the aquifer level. If the pressure causes the water to rise above ground level, the well overflows and is called a flowing artesian well.

Electrical Conductivity: Electrical conductivity (EC) estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water.

Groundwater: Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.

Hydraulic conductivity: measure of the ease with which water will pass through earth 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 (in m/d)

Unconfined aquifer: these are sometimes also called water table or phreatic aquifers, because their upper boundary is the water table or phreatic surface. Typically (but not always) the shallowest aquifer at a given location is unconfined, meaning it does not have a confining layer between it and the surface. Unconfined aquifers usually receive recharge water directly from the surface, from precipitation or from a body of surface water (e.g., a river, stream, or lake) which is in hydraulic connection with it.

Water Table: the upper surface of the saturated zone of an unconfined aquifer at which pore pressure is at atmospheric pressure, the depth to which may fluctuate seasonally.

1. INTRODUCTION

GEOSS was appointed to complete a preliminary geohydrological assessment of the Bonnievale Piggery by Mr. Jan van der Merwe and Mr Brent Burger. The Regional Office of the Department of Water Affairs and Forestry (DWAF) requested that the geohydrology of the site be assessed and that the issue of long-term groundwater monitoring be addressed. The position of the Bonnievale Piggery is shown in Map 1 (Appendix A). Once the field work was complete a meeting was held with Melissa Lintnaar–Strauss of DWAF (Bellville) on 26th October 2007 to discuss the findings from the field work and to review the project report.

2. TERMS OF REFERENCE

The project Terms of Reference are to complete a preliminary geohydrological assessment of the Bonnievale Piggery and to make recommendations on the way forward in terms of establishing groundwater monitoring systems. This is considered the first phase of the project, thereafter the installation of monitoring systems will commence (the second phase of the project) if deemed necessary.

3. SITE GEOLOGY AND GEOHYDROLOGY

The geology of the area as indicated on Map 2 (Appendix A) taken from the Council for GeoScience's 1:250 000 geological map sheet (3320 Ladismith). The greater farm boundary is indicated on Map 2. The entire area of interest is underlain by the Adolfspoort Formation (Da), Traka Sub-group/Bidouw Sub-group, of the Bokkeveld Group. This formation comprises mainly of siltstone, shale and argillaceous sandstone. The younger Wagen Drift Formation (Dwa), of the Witteberg Group, is exposed to the north and north-west of the site. The Wagen Drift Formation (a sub-set of the Weltevrede Formation and Weltevrede Sub-group, within the Witteberg Group), comprises siltstone, arenaceous shale, thin light-grey sandstone beds, is exceptionally micaceous and weathers to a red-brown product. To the north of the piggery there is a valley with the drainage flowing from east to west. This small valley is in-filled with alluvial material of Quaternary age.

Generally speaking, borehole yields in the Bidouw Sub-group seldom exceed 3 ℓ/s, even if recharge conditions are favourable and yields of < 1 ℓ/s can generally be expected (Meyer, 2001). Sodium, calcium, magnesium, chloride, sulphate and total alkalinity commonly exceed maximum recommended limits in the Bidouw Subgroup. The Bidouw Sub-group can yield water with an Electrical Conductivity (EC) of ~ 1 320 mS/m.

The Weltevrede Sub-group seldom yields more than 2 ℓ/s and brackish water can be anticipated (Meyer, 2001).

No groundwater is present within the Quaternary age alluvial deposits; although during rainfall events this is likely to change as overland flow will recharge the alluvial deposits.

A search of National Groundwater Databases also indicated no boreholes within the study area.

4. FIELD PROCEDURE

4.1 Site visit

A hydrocensus of the area was completed on 6th September 2007. No groundwater whatsoever is used in the study area. The Adolfspoort Formation is a non-aquifer and in discussion with local farmers, approximately 21 boreholes have been drilled over time in the area. Only two were marginally successful, however the yields were so low and the quality so bad that they were never used as boreholes. One was equipped with a wind pump, for a sheep drinking trough, some 30 years ago. The first water strike was intersected at 100 m below the ground's surface (pers. comm.., Sarel Rossouw, Modderkuil, 2007). The yield of the borehole later dropped and the wind pump has been abandoned (see Photo Gallery, Appendix B). The foot plate had completely sealed the borehole / wind pump so a water level could not be measured, not a water sample taken, as the wind pump mechanism was non-functional.

Longitude (WGS84):	20.12882 E
Latitude (WGS84):	33.90881 S
Elevation (mamsl):	218

Table 1 Abandoned wind pump details

Thus the nearest sign of groundwater use was an abandoned wind pump 2.5 km to the north of the piggery

4.2 Groundwater assessment

There is essentially no groundwater within a 3 km radius of the piggery. The Adolfspoort Formation is impermeable and the only occurrence of intersecting a very limited amount of groundwater was at a depth of 100 m. The very limited amounts of groundwater within the formation are anticipated to be of very poor quality as well.

4.3 Rainfall - run-off assessment

The rainfall for the area is low. For the town of Bonnievale, the mean annual precipitation is 272 mm/a (Schulze, 1111), whilst the South African Weather Services indicated a long term mean precipitation of 266 mm/a. The mean annual average precipitation for the entire quaternary catchment (H50B) is 389 mm/a. However the possibility of overland flow does exist during rainfall events, due to the impermeable nature of the underlying

geology (see Photo Gallery, Appendix B). Thus this intermittent superficial flow, which is not considered groundwater, may need to be monitored. Any pollution from the piggery may be carried by this overland flow during a rainstorm event towards the drainage channel/valley (Seeboskloof River Valley) to the north of the piggery and then carried in a westerly direction. The probability of this occurring is considered extremely low. During the site visit, the wash water from the piggery and any rainfall derived flow was being correctly handled.

5. RESULTS AND DISCUSSION

There is no groundwater in the vicinity of the Piggery. There will be limited overland flow and inter-flow during rainfall events and it is only during such events that the slight possibility may exist of pollution being transported off the site. The nearest natural river channel, that extends over a significant distance, to the Piggery is the Seeboskloof River. This river channel is 0.6 km from the piggery. The risk of contamination to this river course is considered extremely low, as long as no overland flow is permitted from the piggery. The Seeboskloof River is ephemeral, only flowing after significant rainfall events. The Breede River is ~4.7 km from the Piggery, following natural drainage courses and the risk of contamination of the Breede River by the Piggery is essentially zero.

6. RECOMMENDATIONS

1. Regarding groundwater:
   - No monitoring of groundwater (i.e. the saturated zone) is necessary as groundwater does not exist in the vicinity of the site. No monitoring boreholes need to be drilled with the intention of intersecting groundwater as there is no risk of contamination of groundwater occurring.
2. Regarding superficial/surface water flow:
   - Currently there is good management of the run-off from the site and immediate environs of the piggery. Thus it is not considered necessary to monitor for overland flow. However, as a principle no overland flow must ever be allowed to emanate from the site.
   - If due to public opinion or if it considered necessary to impose stringent monitoring measures by relevant authorities, 4 monitoring sites have been identified in the Seeboskloof River Valley. These are to be monitoring boreholes only. They should be constructed of PVC and fully screened with a minimum inner diameter of 100 mm. They need only be drilled through the superficial cover material and then 2 metres into the underlying bedrock. It is anticipated that these boreholes will be not much deeper than 10 m (although this depth will vary from site to site). The drilling should be supervised by a qualified hydrogeologist. The boreholes should be enclosed in a cement block with a lockable cap and clearly marked. The site coordinates are as follows:

Site_ID	Latitude (WGS84)	Longitude (WGS84)
1	33.92567	20.12808
2	33.92482	20.12045
3	33.92708	20.11596
4	33.92864	20.12780

Table 2 Monitoring borehole positions

The monitoring positions are also shown in Map 4 (Appendix A). Groundwater levels in the boreholes need to be measured on a monthly basis and recorded. If groundwater is present in the boreholes, the groundwater should also be sampled on a monthly basis and the pH, temperature and Electrical Conductivity (EC) measured of the samples. The EC needs to be recorded in mS/m. During June each year a sample should be collected and be analysed by an accredited laboratory for the major cations and anions, including nitrate, as well as bacteriological sampling (total coliforms, e-coli and f-coli). The sampling must be completed as outline by Weaver et al (2007). These results must also be recorded.

3. General recommendations
   - If expansion of the piggery is planned, the carrying capacity of the soil zone must be assessed by a soil scientist, to ensure that the irrigated effluent does not run-off the site.
   - The irrigation of the piggery effluent should be avoided if there is a strong wind blowing.

7. ACKNOWLEDGEMENTS

- Mr. Brent Burger and Mr Jan van der Merwe are thanked for the site orientation and assistance with the hydrocensus.
- Ms Melissa Lintnaar-Strauss (DWAF) is thanked for the valuable discussion.

8. REFERENCES

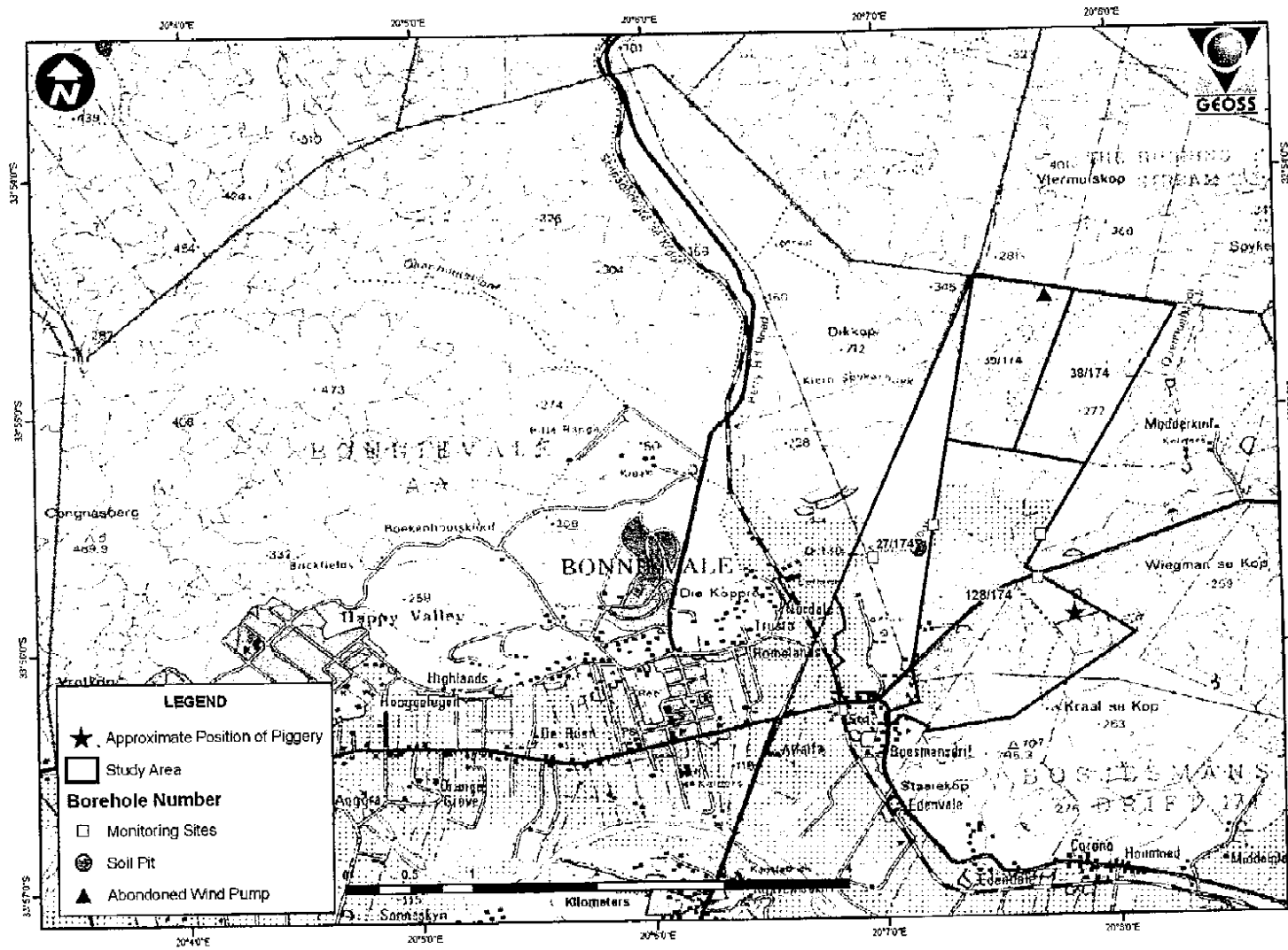
Meyer, 2001. An explanation of the 1:500 000 general hydrogeology map of Cape Town 3317. Compiled by Schalk Meyer, Department of Water Affairs and Forestry. Pretoria.

National Water Act (Act No. 36 of 1998). Department of Water Affairs and Forestry.

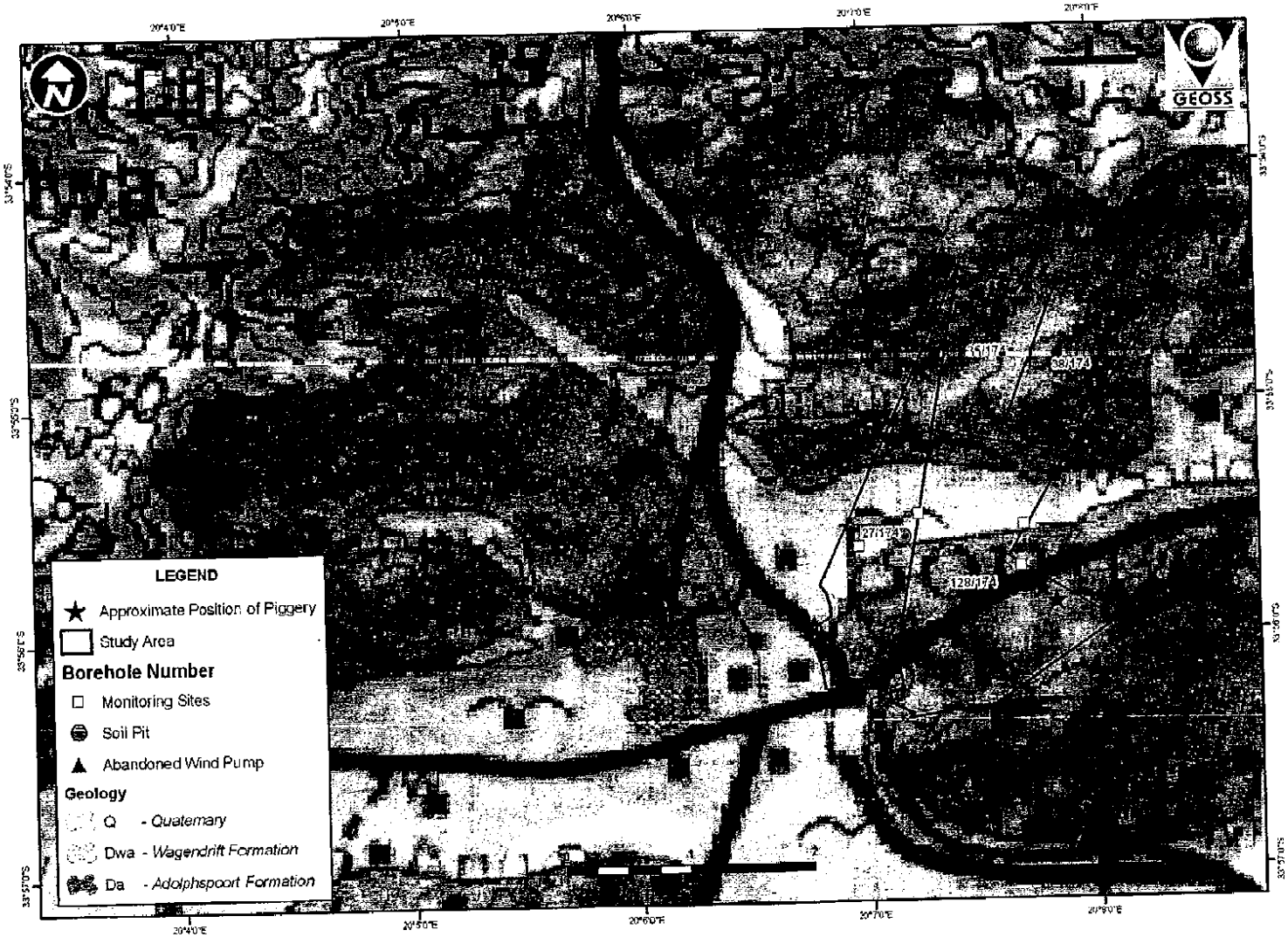
Schulze RE 1997. *South African atlas of agrohydrology and -climatology.* (Report No TT82/96). Pretoria: Water Research Commission.

Weaver, J.M.C., Cavé, L. and Talma, A.S., 2007. Groundwater sampling - A comprehensive guide for sampling methods (Second Edition). Prepared for the Water Research Commission by Groundwater Sciences, CSIR, South Africa. WRC Report No TT 303/07.

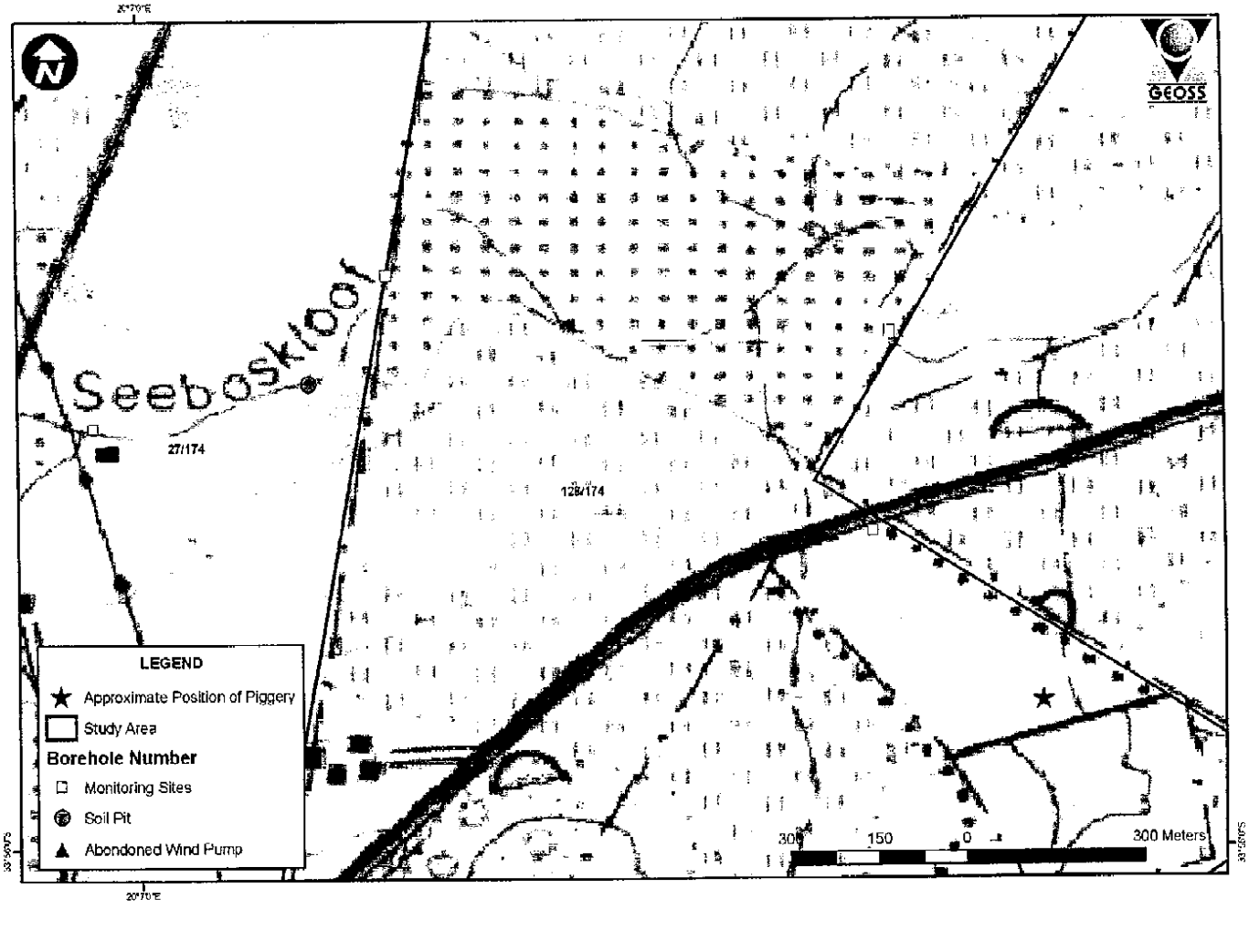
APPENDIX A: MAPS



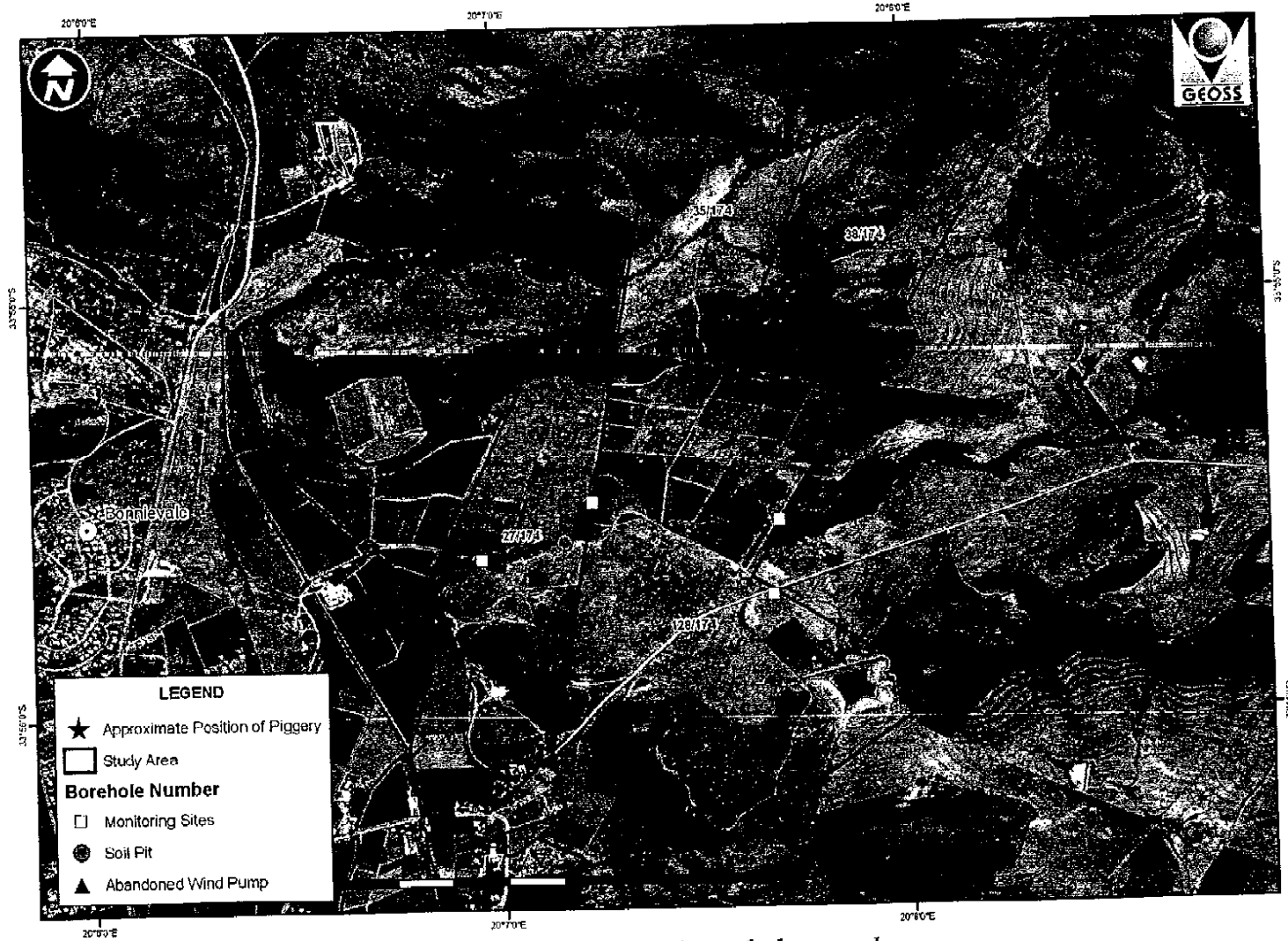
Map 1: The study site and surrounding area



Map 2: Geological setting of the study area



Map 4: Monitoring borehole positions (if deemed necessary)



Map 3: The study site and aerial photography

APPENDIX B: PHOTO GALLERY