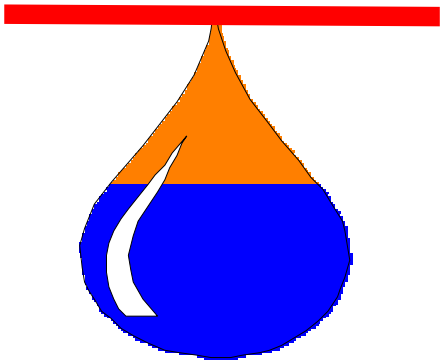
Parsons & Associates
specialist groundwater consultants cc
CK 96/27895/23



Report
356/EVER-D1

Everite Asbestos Waste Site: Hydrogeological Assessment

report prepared for

Group Five Properties

Ref: 356/EVER ***May 2015***

tel (028) 273-8676 ***PO Box 151 Pringle Bay 7196*** ***fax (086) 604 8082***

EXECUTIVE SUMMARY

As part of the proposed decommissioning of the now-closed Everite asbestos waste site in Brackenfell, the Department of Water and Sanitation requested additional hydrogeological information in support of the Basic Assessment submitted by Chand Environmental Consultants to the Department of Environmental Affairs. Consequently Parsons & Associates Specialist Groundwater Consultants[cc] was appointed by Group Five Properties to prepare a hydrogeological report of the site based on a site visit and existing information.

Detailed hydrogeological investigations into groundwater contamination resulting from historic activities at the Everite site were conducted between 1998 and 2005. Groundwater contamination was detected and the extent thereof delineated, but it was not possible to distinguish or separate that contamination emanating from the Everite asbestos waste site. No groundwater users had been impacted by the contamination from the Everite site in general and the Everite asbestos waste site in particular.

Monitored natural attenuation remains the preferred method of remediating the detected impacts. It is recommended that 3 monitoring boreholes be re-established at the asbestos waste site and quarterly sampling be undertaken for 2 years to define seasonal variation. Thereafter, the need for further monitoring can be assessed in light of observations to that point.

CONTENTS PAGE

LIST OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND NOTATIONS

DEA	Department of Environment Affairs
DWS	Department of Water and Sanitation (formerly Department of Water Affairs)
EC	electrical conductivity
K	potassium
km	kilometres
L	litres
L/s	litres per second
m	metres
MAE	mean annual evaporation
MAP	mean annual precipitation
mm/a	millimetres per annum
mS/m	milliSiemens per metre
SO_4	sulphate

LIST OF DEFINITIONS

Aquifer: a geological unit that contains sufficient saturated permeable material to store and transmit water; and to yield economical quantities of water to boreholes or springs.

Contamination: the introduction of any substance into the environment by the action of man.

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.

Hydrogeology: the study of the properties, circulation and distribution of groundwater; used interchangeably with geohydrology.

Monitoring: comprises the collection, analysis and storage of data on a regular basis to provide information for effective groundwater management.

Primary aquifer: an aquifer in which water moves through the original interstices of the geological formation.

Secondary aquifer: an aquifer that owes its water-bearing properties to secondary properties such as weathering and fracturing.

DECLARATION OF INDEPENDENCE, QUALIFICATION AND EXPERIENCE

Project:	Everite Asbestos Waste Site: Hydrogeological Assessment
Client:	Group Five Properties
EIA Consultant:	Chand Environmental Consultants

DECLARATION OF INDEPENDENCE

I, Roger Paul Parsons, hereby declare that:

- I acted as an independent groundwater specialist in this assessment;
- I regard the information contained in this report as it relates to my specialist input to be true and correct;
- I do not have and will not have any financial interest or vested interest in the undertaking of the activity, other than remuneration for work performed;
- I have disclosed to the client, environmental consultant and competent authority any material information that has or may have the potential to influence decisions relating to this matter; and
- I am aware false declaration is an offence.

QUALIFICATIONS AND EXPERIENCE

I have a Ph.D degree in Geohydrology from the University of the Free State and have practised as a Hydrogeologist since 1984. Prior to establishing Parsons & Associates Specialist Groundwater Consultants^{cc} in 1996, I worked for the Department of Water Affairs: Directorate of Geohydrology (1984 – 1990) and the CSIR: Groundwater Programme (1990 – 1996). I am a registered Professional Natural Scientist (400163/88) and a Fellow of both the Institute of Waste Management of Southern Africa (IWMSA) and the Water Institute of South Africa (WISA). I belong to a number of learned societies related to my profession (Ground Water Division, International Associations of Hydrogeologists, National Ground Water Association, International Association of Hydrological Sciences) and regularly attend conferences, lectures and training courses to remain abreast of developments in my field.

Dr Roger Parsons
Ph.D (U.F.S.) Pr.Sci.Nat.
29 May 2015

1 INTRODUCTION

1.1 Scope of Work

As part of the proposed decommissioning of the now-closed Everite asbestos waste site in Brackenfell (Figure 1), the Department of Water and Sanitation (DWS) requested additional hydrogeological information in support of the Basic Assessment submitted by Chand Environmental Consultants to the Department of Environmental Affairs (DEA). These information requirements were documented in a letter from Dr Mlindelwa Lupankwa dated 23 September 2014. Following discussions with Ms Ingrid Eggert of Chand Environmental Consultants, Parsons & Associates Specialist Groundwater Consultants[cc] was appointed by Group Five Properties to prepare a hydrogeological report of the site.

Parsons & Associates have previously undertaken four hydrogeological investigations at the Everite site as well as worked on the nearby Brackenfell waste site (see reference list). Consequently it was proposed that this existing information be used to address the information requirements of DWS. In a proposal to Group Five Properties dated 28 January 2015 it was proposed the following work be undertaken:

- Retrieve existing hydrogeological data, information and reports from our earlier work;
- Undertake a site visit to assess changes at the site during the past decade and a half;
- Prepare a report for the authorities describing prevailing groundwater conditions, groundwater use in the area and the contamination status of groundwater;
- Make recommendations for further work, if required.

On behalf of their client, Chand Environmental Consultants appointed Parsons & Associates on 11 May 2015 to proceed with the proposed work.

1.2 Work Undertaken

Following our appointment, all existing hydrogeological data and reports pertaining to the site were reviewed in light of the information requirements of DWS. A site visit was undertaken on 22 May 2015. Based on the existing hydrogeological information, this report was then

prepared with a view to making DWS aware of the earlier work undertaken and providing them with a summary of the status of groundwater contamination.

1.3 Limitations and Assumptions

This assessment was based on a site visit and reports from previous hydrogeological investigations of the Everite site between 1998 and 2005. It was assumed that the information is still valid. It was further assumed that most – if not all – of the wellpoints installed during the previous studies no longer exist and cannot be resampled.

2 SUMMARY OF PREVIOUS HYDROGEOLOGICAL WORK

2.1 Wastewater Dam Assessment

After initial work by Gibb Africa (1996) and the CSIR (1998), Parsons & Associates (1998) assessed the contamination status of soil and water on the wastewater dam property directly west of the Everite factory and some 400 m west of the asbestos waste site (Figure 1). This investigation included the installation and sampling of 15 wellpoints, taking 14 surface water samples and 41 soil and sediment samples. From the study it was concluded that:

- Effluent from the site was characterised by elevated levels of K, Ca, SO_4, EC, pH and $Cr_{(tot)}$.
- Contaminated groundwater displayed a $NaSO_4$ character and an elevated EC level. Elevated Cr levels were not detected.
- Groundwater contamination was limited to the area immediately adjacent to the canal, wetland and dam.
- Widespread soil contamination at the site had not occurred.

2.2. Everite Site Investigation

In 2001 the groundwater assessment was expanded to cover the entire Everite site, including the asbestos waste site. The purpose of the investigation was to identify the impact of past

activities on the hydrogeological regime and to identify remediation requirements and develop a site remediation plan. A total of 26 wellpoints and shallow boreholes were drilled and sampled. The siting of wellpoints was partially guided by the work of Bradshaw (2001) who dug trail pits across the Everite site to identify areas in which asbestos was disposed. Widespread groundwater contamination was detected across the site, with elevated electrical conductivity (EC) levels and concentrations of potassium (K) and sulphate (SO_4) being characteristic. It was noted the elevated concentrations were not considered harmful substances. It was not possible to delineate discrete plumes from individual sources of contamination and the extent of contamination could not be defined.

2.3 Off-site investigation

In light of the 2001 report, further work was commissioned in 2002 to delineate the extent of the contamination. A hydrocensus was conducted in the vicinity of the Everite site and a further 15 wellpoints installed in the areas north and west of the site. Both the private boreholes and investigative wellpoints were sampled and the samples analysed. The study allowed for ambient groundwater quality to be defined, the nature of groundwater contamination to be characterised and the extent of the contamination plume to be delineated. No groundwater users were located down gradient of the Everite site. It was found that the plume had migrated 1 km west of the wastewater dam, but that no groundwater users had been impacted. Monitored natural attenuation was considered the most appropriate remedial action.

2.4 Status report

In 2005, the status of the monitoring stations was assessed and 34 groundwater samples taken. This report is included as Appendix A. It was found the concentrations of K and SO_4 had reduced between 2001 and 2005. This improvement was attributed to natural attenuation, but it was recommended 6 monthly monitoring continue for a period of 2 years to rule out seasonal fluctuations accounting for the observed lower concentrations.

3 DESCRIPTION OF STUDY AREA

3.1 Location

The Everite site [1] is located in the suburb of Brackenfell, Cape Town (Figure 1). When established on farmlands in the 1940s, the factory was outside the urbanised area. The Everite site has since been enveloped by urbanisation. The factory was closed in 2000 and has been developed into an industrial business park. It is now bounded by industrial activities to the east, residential areas to the north and south and commercial properties to the north and west (Figure 2).

The Everite asbestos waste site is situated on a gentle north-west facing slope and is located almost 2.7 km east of the Kuils River. The area experiences a Mediterranean climate with hot dry summers and cool wet winter. Annual rainfall is in the order of 550 mm/a, most of which falls between the months of April and October. Pan evaporation is in the order of 1 500 mm/a.

3.2 Geology

The Everite site is located on the north-eastern extremities of the Cape Flats and is underlain by weathered sediments of the Malmesbury Group, weathered granites of the Cape Granite Suite and unconsolidated sands of the Sandveld Group. A conceptual cross-section of the geology of the area is presented in Figure 3.

Granite accounts for the hill on which much of the suburb of Brackenfell has developed. In places, the granite is highly weathered with BH126 encountering 20 m of clay interpreted to represent weathered granite. The granite - unconsolidated sand contact is in the vicinity of the Everite asbestos waste site. Unconsolidated sands cover much of the flat-lying area to the north and west of the site. As a result, little is known about the underlying bedrock. The published 1 : 50 000 geological map indicates much of the area to be underlain by sediments belonging to the Malmesbury Group with sand thickness ranging from 3 m to almost 25 m.

[1] Distinction is made between the Everite site (i.e. that area previously owned and operated by Everite and includes the factory, wastewater dam and asbestos waste sites) and the Everite asbestos waste site (i.e. that area used to dispose of waste product).

The geology (and hydrogeology) of the underlying hard rock aquifer system is unknown. This includes the lithology of the Malmesbury Group, the degree of weathering and the presence and position of the contact zone. Based on the generalised conceptual model of the Cape Flats Aquifer system, it was assumed the hydraulic properties of the unconsolidated sand are significantly greater than those of the underlying hard rock aquifer system. As a result, the hydrogeological investigations of the Everite site focussed on the unconsolidated sand or primary aquifer system.

3.3 Hydrogeology

A total of 56 wellpoints and boreholes were installed and sampled in the vicinity of the Everite site between 1998 and 2005 (Figure 4). This - together with data collected during a hydrocensus of the area and while investigating the nearby Brackenfell waste site - has allowed for detailed groundwater level and hydrochemistry data to be collected. However little detailed information pertaining to hydrogeological properties of the aquifers in the vicinity of the Everite site are available.

The study area is located on the north eastern extremities of the Cape Aquifer system, described in detailed Henzen (1973), Wright and Conrad (1995), Seyler (2008) and others. This aquifer is classified as a major aquifer system; but such a classification would not be applicable to the Everite asbestos waste site as (a) it is located on the transition between the minor granitic aquifer and the primary aquifer and (b) the saturated thickness of the sand is limited. A minor aquifer system classification is considered appropriate.

Based on the generalised conceptual model of the Cape Flats Aquifer system it was assumed the hydraulic properties of the unconsolidated sand are significantly greater than those of the underlying hard rock aquifer system. Unconsolidated sands are considered transmissive and have hydraulic conductivities between 1 m/d and 5 m/d. The hydraulic conductivity of the underlying bedrock is expected to be an order of magnitude lower.

Depth to groundwater at the Everite site is shallow. Groundwater levels range from surface in the low lying areas near the dam to 4.7 m below ground level, with an average depth of 1.8 m below surface. At the asbestos waste site, depth to groundwater ranges between 0.5 m and

2.5 m below ground level. Groundwater flows in a general westerly direction with an average hydraulic gradient of 0.025 (Figure 5).

From the various studies in the Brackenfell area and using a Durov diagram, it was possible to determine the ambient hydrochemistry of groundwater from the primary and granitic aquifer as well as identify those boreholes impacted by anthropogenic activities (Figure 6). The primary aquifer has a more Ca Alk character with a lower EC and higher pH than that of groundwater from the granitic secondary aquifer (Figure 7). The granitic aquifer has a Na Cl character, a higher EC and is more acidic.

3.4 History of the Everite Site

The Everite factory was established in Brackenfell in the 1940s to produce asbestos products. The total site covered an area of about 70 ha, while the asbestos waste site covers an area of some 9 ha. The sited included various activities including the factory itself, the wastewater dam, the AC Pipes area, the moulded goods yard and the asbestos waste disposal site.

The wastewater dam was used by the Everite factory both for the disposal of its effluent as well as a source of water. It was estimated some 30 000 m3 used to be abstracted from the dam each month for use in the factory. The volume of effluent discharged into the dam was not measured. The property around the dam was sold in 2000 and water is no longer abstracted from the dam. Though no longer used as a source of water, the wastewater dam still forms part of the municipal stormwater management system of the area. Subsurface drainage from the site continues to flow into the dam.

Discharged product and other waste generated by the factory were disposed in the waste disposal site directly east of the factory. The site was classified as a GCB+ facility and was issued with a permit by DWAF on 12 August 1992. Since closure of the factory in 2000, the site was used to dispose of waste generated during the factory clean-up process [2]. In 2001 the asbestos waste site was reshaped, capped and had vegetation established on it and is currently not used.

[2] Consulting engineers Jones & Wagner was commissioned to address this aspect of the work.

3.5 Detected Groundwater Contamination

The impact of the nearby Brackenfell waste site on groundwater is shown in Figure 5 to document the hydrochemical character of groundwater impacted by the municipal waste. The hydrochemistry of these waters is distinctly different to that found in the vicinity of the Everite site (i.e. dominant Na Cl character, EC greater than 500 mS/m, pH less than 6); and is not of further relevance to this study.

The impacted groundwaters in the vicinity of the Everite site have a similar hydrochemical character (Figure 8), and it is not readily possible to distinguish between waters in the vicinity of the asbestos waste site, the moulded goods yard and wastewater. While there are some differences, the data indicates that the nature and source of contamination is the same.

The extent of contamination at the Everite site was delineated in 2002 based on the maps presented in Figure 9 and 10. The extent of contamination is demarcated in Figure 11. It is noted contamination emanating from the asbestos waste site could not be individually delineated because that contamination could not be differentiated from that caused by other activities on the Everite site.

4 ASSESSMENT OF RISK

4.1 Asbestos in groundwater

It is documented in the literature that asbestos is practically immobile in the subsurface. The fibres are retarded from moving as they cannot pass through interstitial pores spaces in the subsurface. The expected migration rate of an asbestos fiber through soils by the forces of groundwater is approximately 1 to 10 cm per 3 000 to 40 000 years (NHDES, 2015). Thus, asbestos is not considered a groundwater contaminant of any significance [3]. It is for this reason that asbestos was not specifically analysed for during the groundwater investigations of the Everite site.

[3] It is well recognised that inhalation of absebestos posed the greatest risk to human health, and impacts resulting from the ingestion of contaminated water are much less significant.

4.2 Identified Contaminants

Potassium (K) and Sulphate (SO_4) – with an associated increase in EC – were identified as the groundwater contaminants resulting from historic activities across the site [4]. Neither of these contaminants are considered particularly harmful, particularly at the concentrations observed during the various groundwater investigations.

4.3 Groundwater Use

During the hydrocensus of 2001, no groundwater use was identified down gradient of the Everite site (Parsons & Associates, 2002). Noting that the hydrocensus was conducted some 14 years ago, it is unlikely that the situation has changes. At that time, the area had already developed into a commercial and industrial area; and since then further development of similar land use has taken place. The area is served with reticulated municipal water supplies.

4.4 Remedial Action

The nature of contamination and the absence of groundwater users down gradient of the Everite asbestos waste site support the proposal that monitored natural attenuation is the most appropriate remedial option. Based on observations in 2005 (see Appendix A) the concentrations of the key contaminants in groundwater reduced between 2001 and 2005 i.e. after the factory closed and remedial work at the site commenced. The absence of any groundwater monitoring in the past decade, however, prevents the effectiveness of the monitored natural attenuation strategy since then being assessed.

5 CONCLUSIONS

Detailed hydrogeological investigations into groundwater contamination resulting from historic activities at the Everite site were conducted between 1998 and 2005. Groundwater contamination was detected and the extent thereof delineated, but it was not possible to distinguish or separate that contamination emanating from the Everite asbestos waste site. No

[4] INFOTOX was commissioned to address the risk these contaminants in groundwater being exposure to man and the surrounding environment.

groundwater users had been impacted by the contamination from the Everite site in general and the Everite asbestos waste site in particular.

Monitored natural attenuation remains the preferred method of remediating the detected impacts. It is recommended that 3 monitoring boreholes be re-established at the asbestos waste site and quarterly sampling be undertaken for 2 years to define seasonal variation. Thereafter, the need for further monitoring can be assessed in light of observations to that point.

Dr Roger Parsons
Ph.D. (U.F.S.) Pr.Sci.Nat.

REFERENCES

Bradshaw, RA (2001) Everite factory Brackenfell – report on investigation of areas potentially contaminated by asbestos and related materials; Report 4-28200 prepared for Jones and Wagner, R.A. Bradshaw and Associates, Cape Town.

CSIR (1998) Everite-dam watergehalte; Report JW598 prepared by the Groundwater Group, CSIR for Andre van der Merwe and Associates.

Department of Water Affairs and Forestry (1998a) Minimum requirements for waste disposal by landfill; Second Edition, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry (1998b) Minimum requirements for water monitoring at waste management facilities; Second Edition, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry (1998c) Quality of domestic water supplies – Volume 1 – assessment guide; Second edition, Department and Water Affairs and Forestry, Pretoria.

DWAF (2001) An explanation of the 1 : 500 000 general hydrogeological map Cape Town 3317; Department of Water Affairs and Forestry, Cape Town.

Flanagan, LE (2004) Groundwater contamination assessment at the Brackenfell waste site: Drilling of additional monitoring boreholes; Report 153/ENT-D1 prepared for City of Cape Town, Parsons and Associates, Somerset West.

GIBB Africa (1996) Everite Brackenfell - Preliminary environmental contamination report; Report J19391B prepared for Group Five Properties (Pty) Ltd.

Jones and Wagener (2001) Closure of the Everite waste disposal site in Brackenfell, Cape Town; Report to Group Five, Jones and Wagener, Johannesburg.

Henzen, MR (1973) Die herwinning, opberging en ontrekking van gesuiwerde rioolwater in die Kaapse skiereiland. Council for Scientific and Industrial Research, Cape Town.

New Hampshire Department of Environmental Services – accessed 28 May 2015 http://des.nh.gov/organization/divisions/waste/orcb/prs/adsp/categories/faq.htm

Parsons, RP (1995) A South African aquifer system management classification. WRC Report No. 77/95, Water Research Commission, Pretoria.

Parsons, RP (1998) Everite, Brackenfell - Assessment of soil and water contamination status at adjacent dam property; Report 029/EVER-1 prepared for Group Five Properties, Parsons and Associates, Somerset West.

Parsons, RP (2001) Everite, Brackenfell – Preliminary results of investigation of groundwater contamination; Report 092/EVER-F1 prepared for Jones and Wagener Consulting Engineers, Parsons and Associates, Somerset West.

Parsons, RP (2002) Groundwater contamination assessment at the Brackenfell waste site; Report 114/ENT-F1 prepared for Entech Consultants, Parsons and Associates, Somerset West.

Parsons, RP (2005) Everite, Brackenfell - Groundwater contamination status report; Report 171/EVER-D1 prepared for Group Five (Pty) Ltd, Parsons and Associates, Somerset West.

Wright, AH and Conrad, JE (1995) The Cape Flats aquifer - current status. Report No. 11/95, Groundwater Programme, CSIR, Stellenbosch.

FIGURES

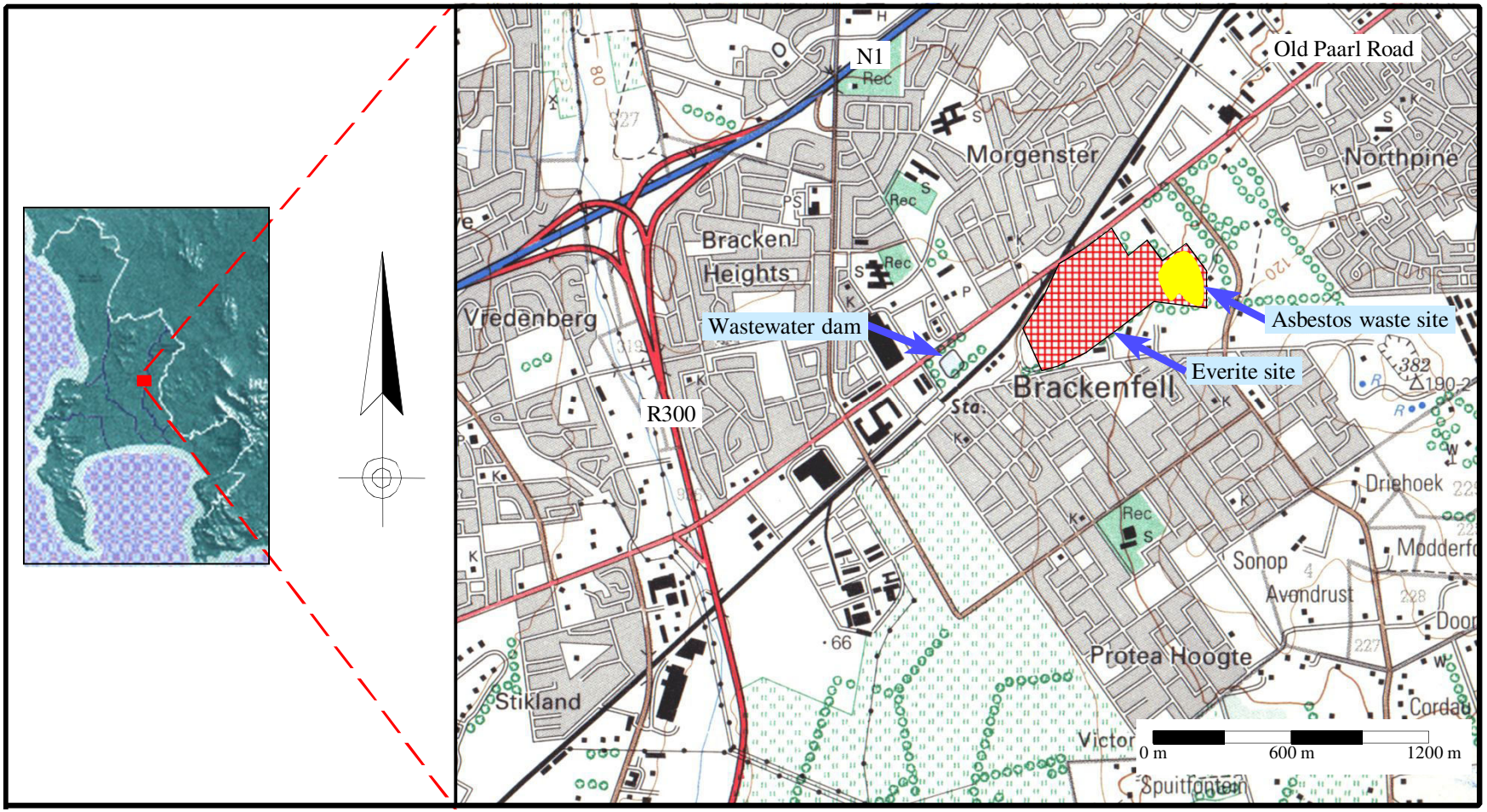


Figure 1: Locality map of the Everite site in Brackenfell, indicating the position of the wastewater dam and the asbestos waste site.

Figure 2: Recent aerial image of the Everite site, showing the position of the wastewater dam and the asbestos waste site.

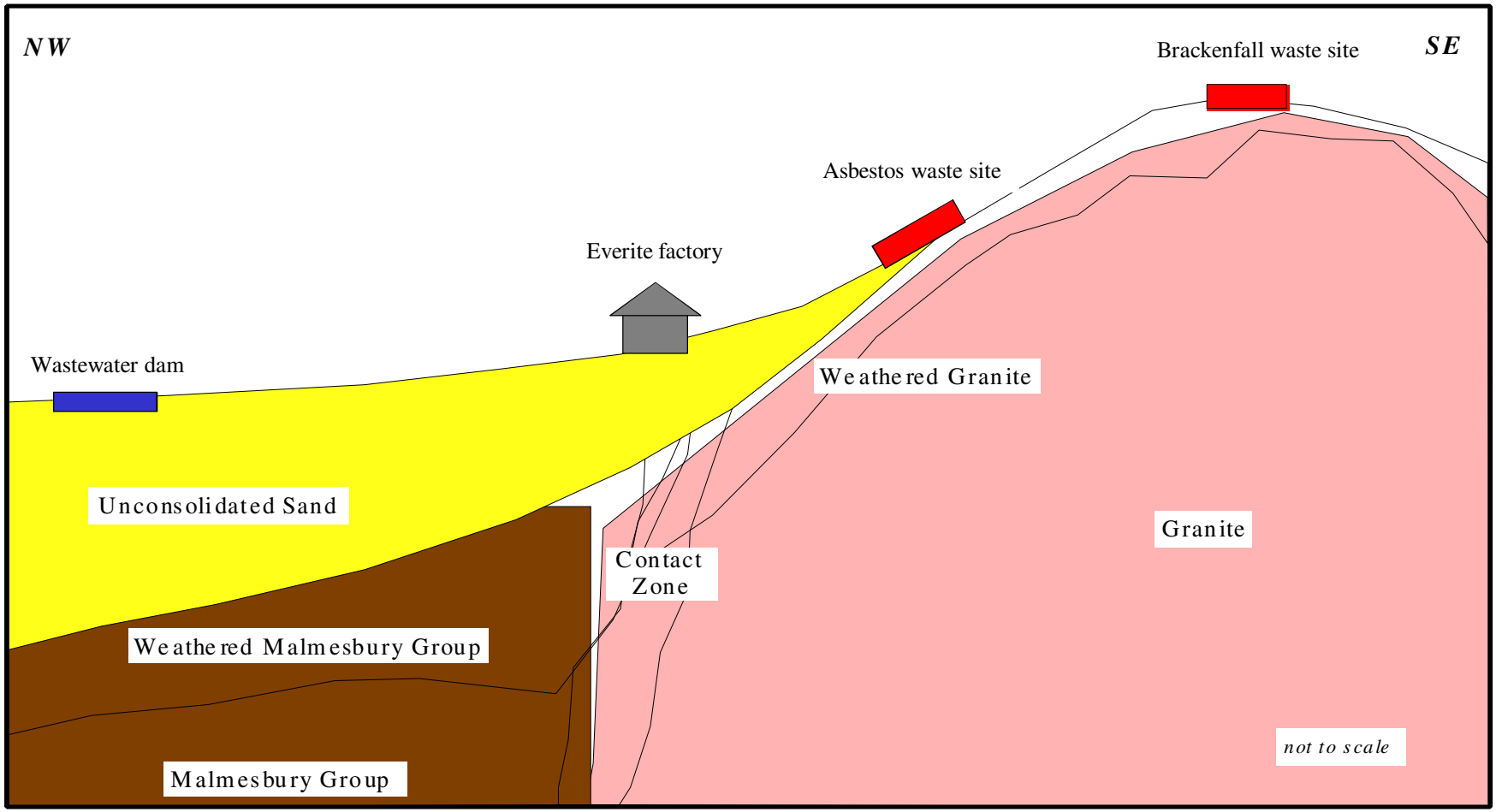


Figure 3: Conceptual geological cross-section of the Everite site.

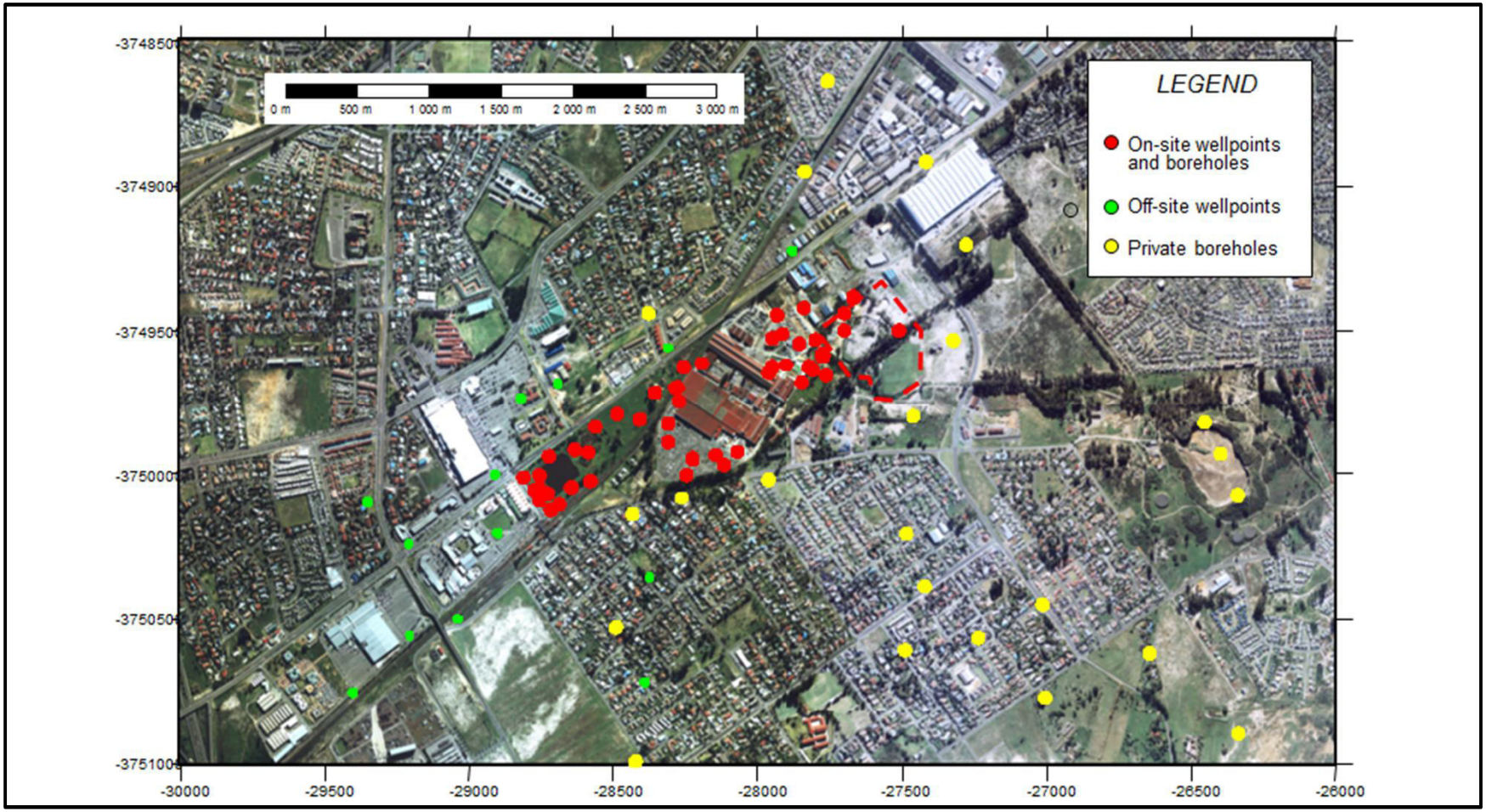


Figure 4: Position of boreholes and wellpoints in and around the Everite site.

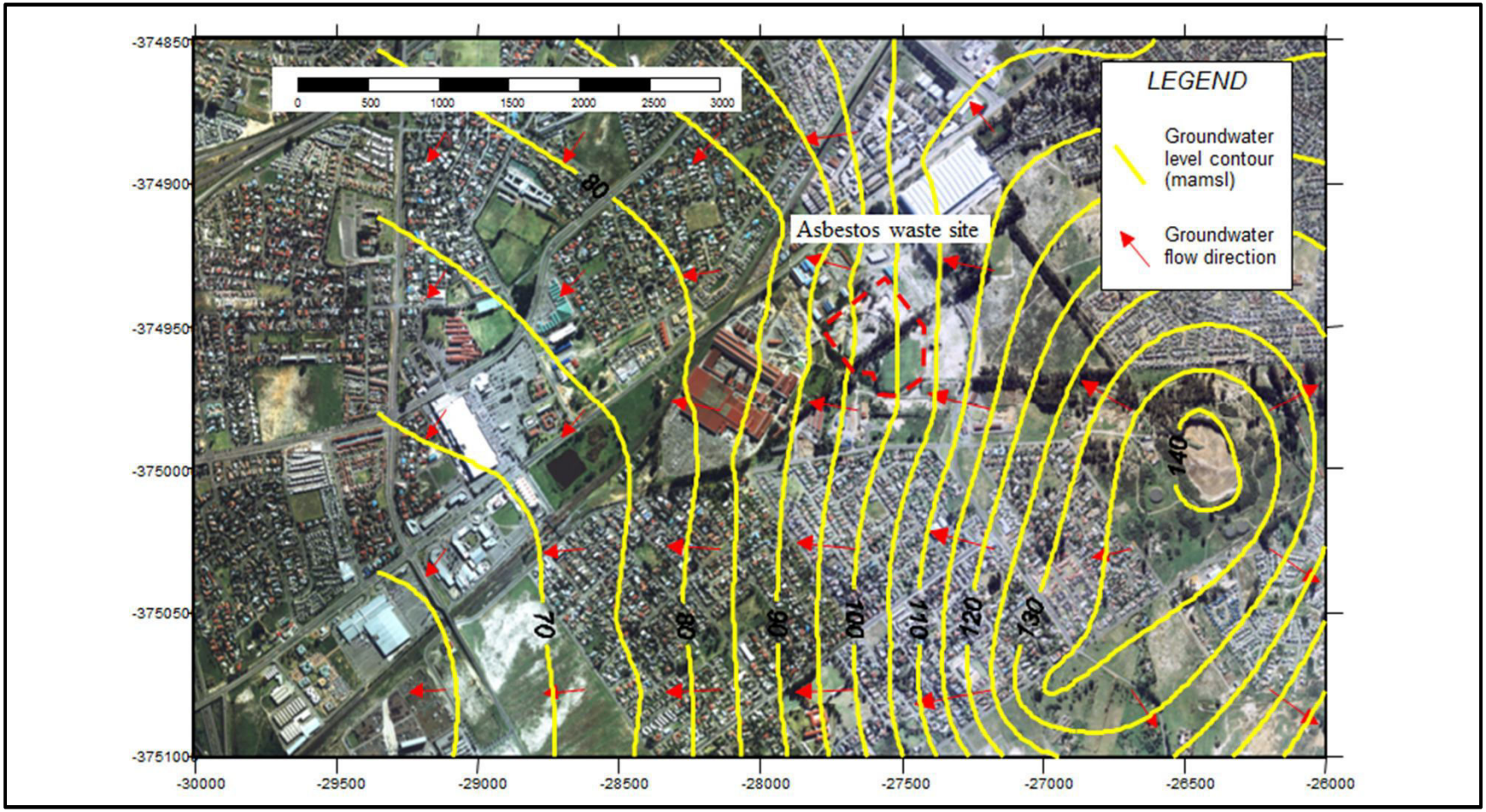


Figure 5: Groundwater level contour map showing direction of flow

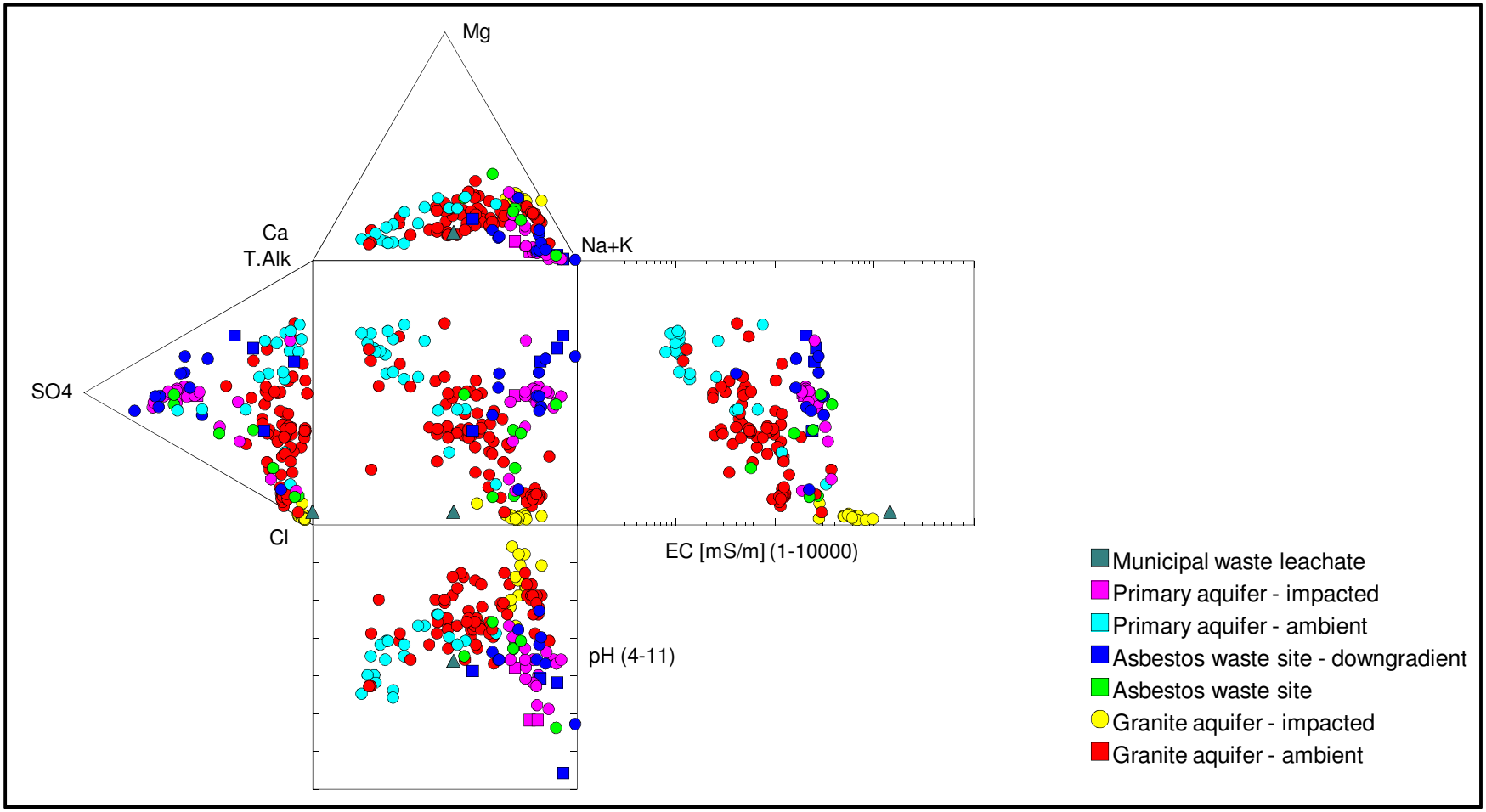


Figure 6: Durov diagram showing the hydrochemical character of different groundwater.

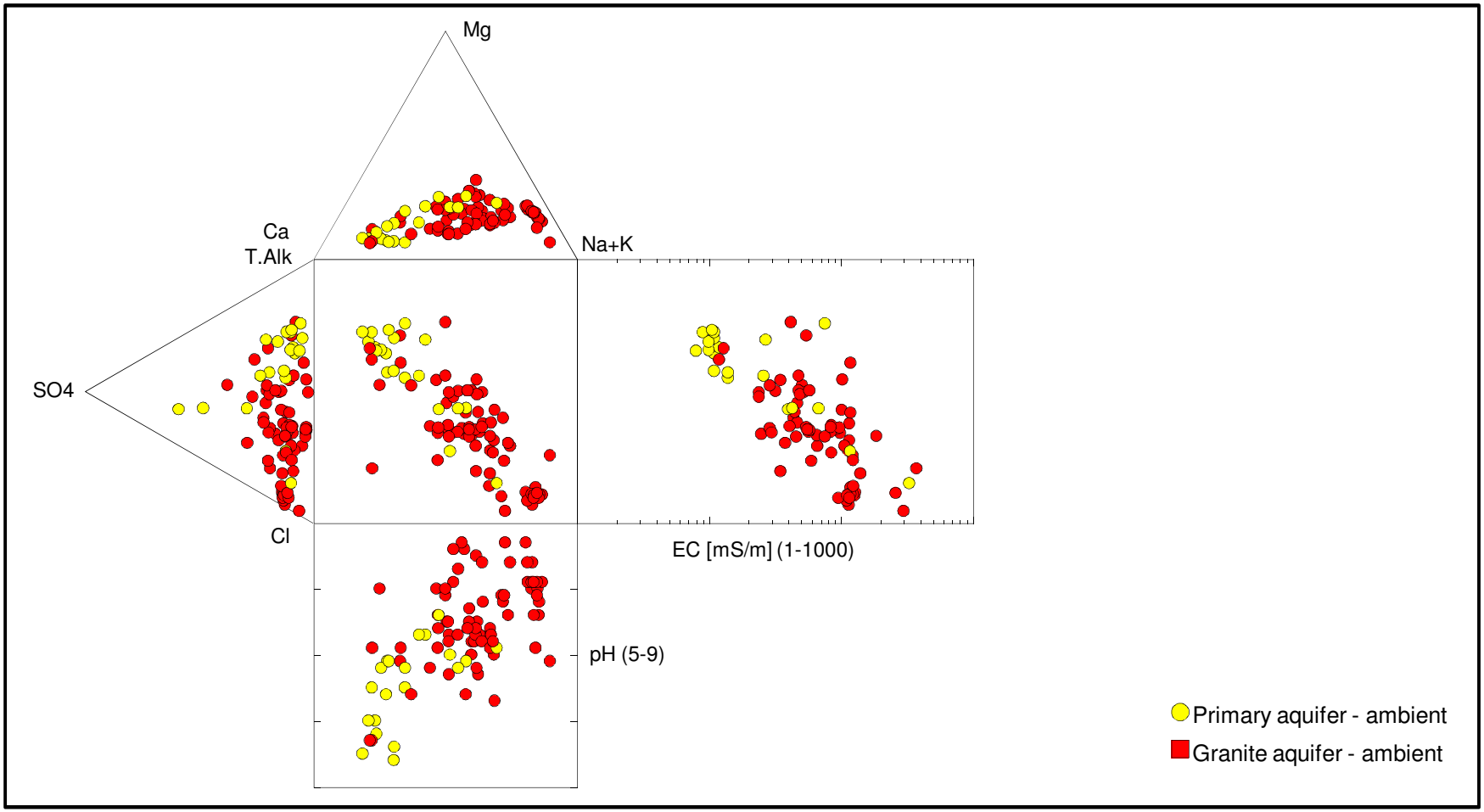


Figure 7: Durov diagram showing the hydrochemical character of ambient groundwater from the primary and granitic aquifers.

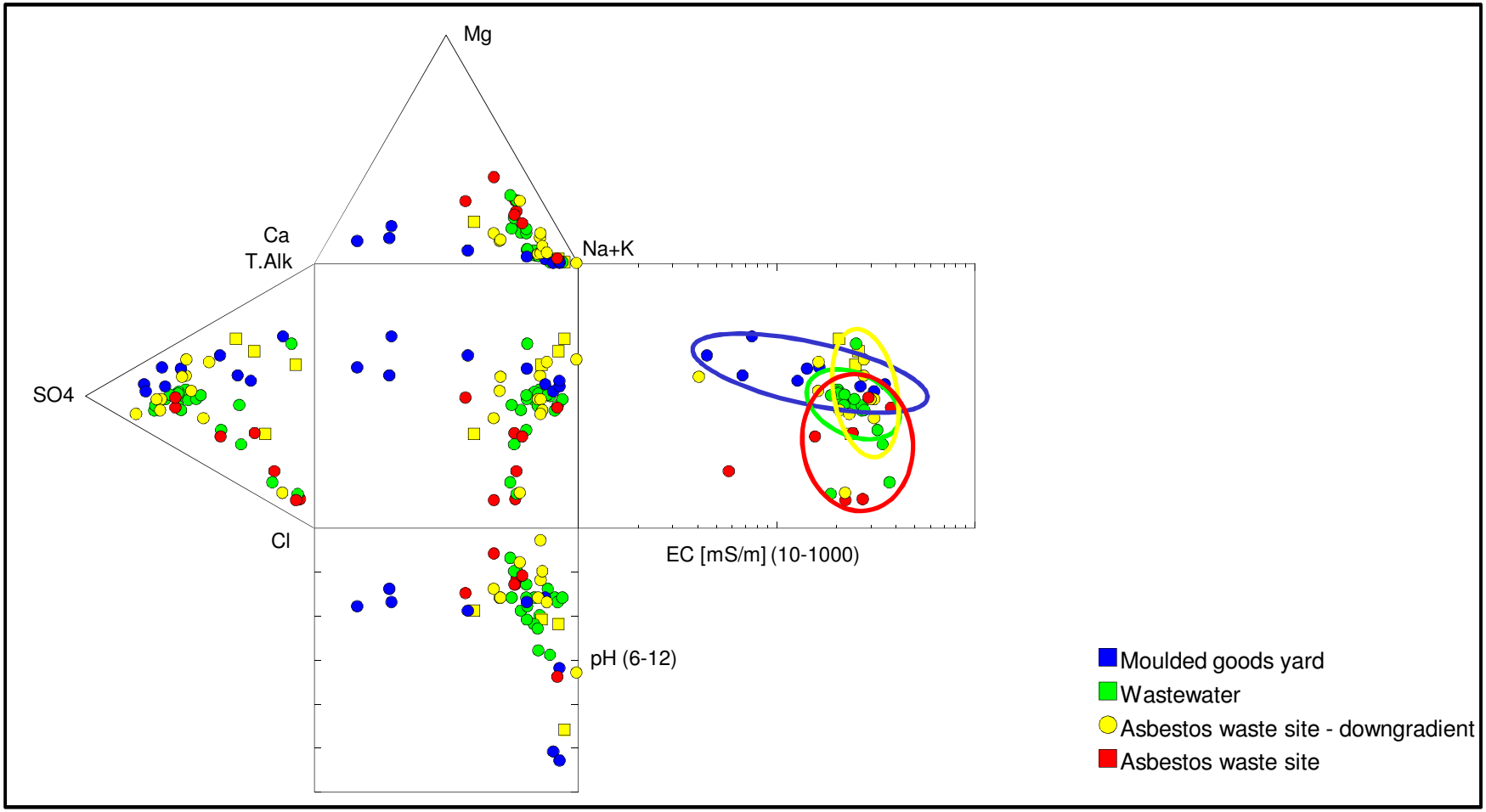


Figure 8: Durov diagram showing the hydrochemical character of groundwater impacted by different components at the Everite site.

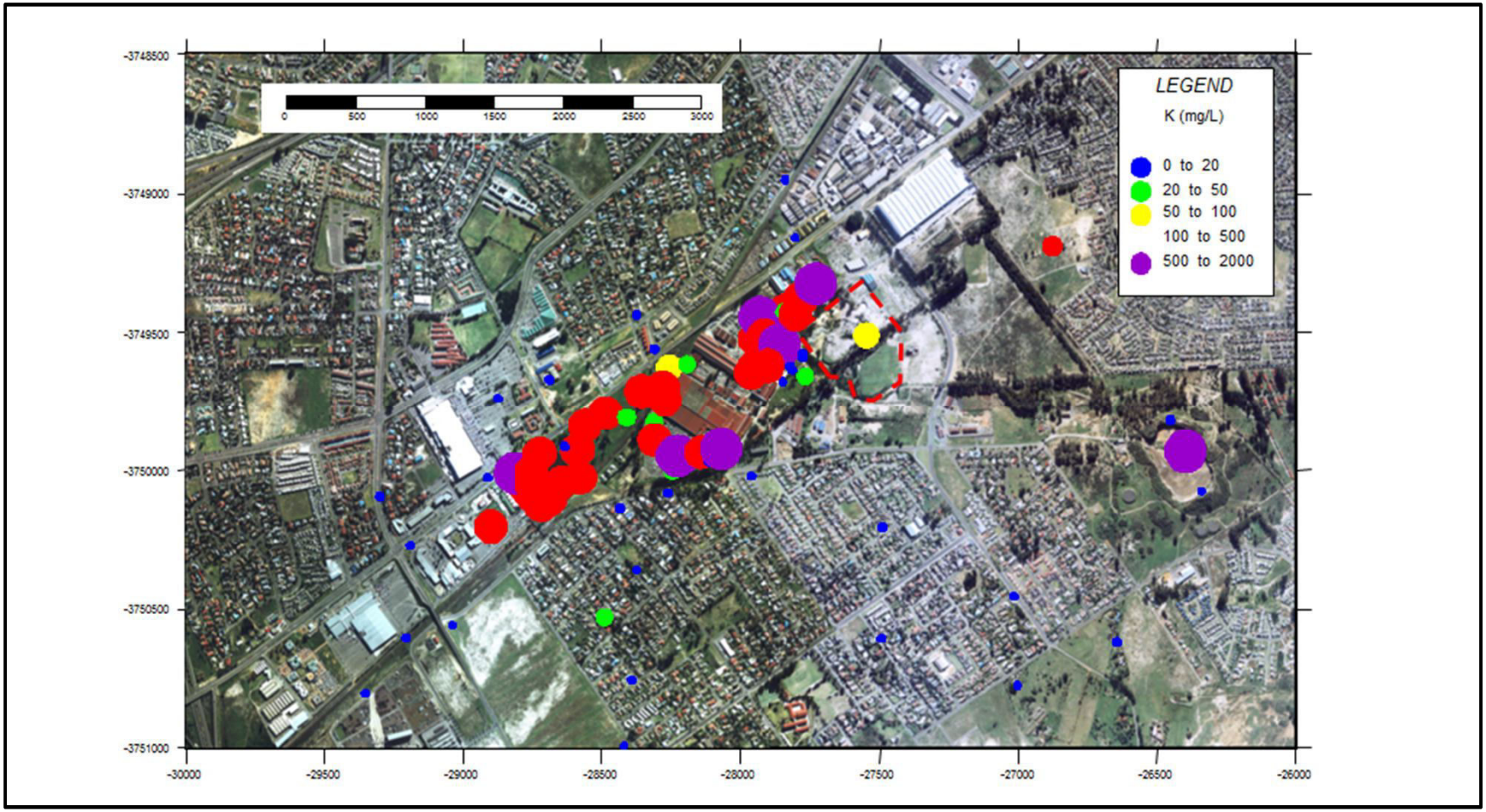


Figure 9: Distribution of K concentrations at the Everite site

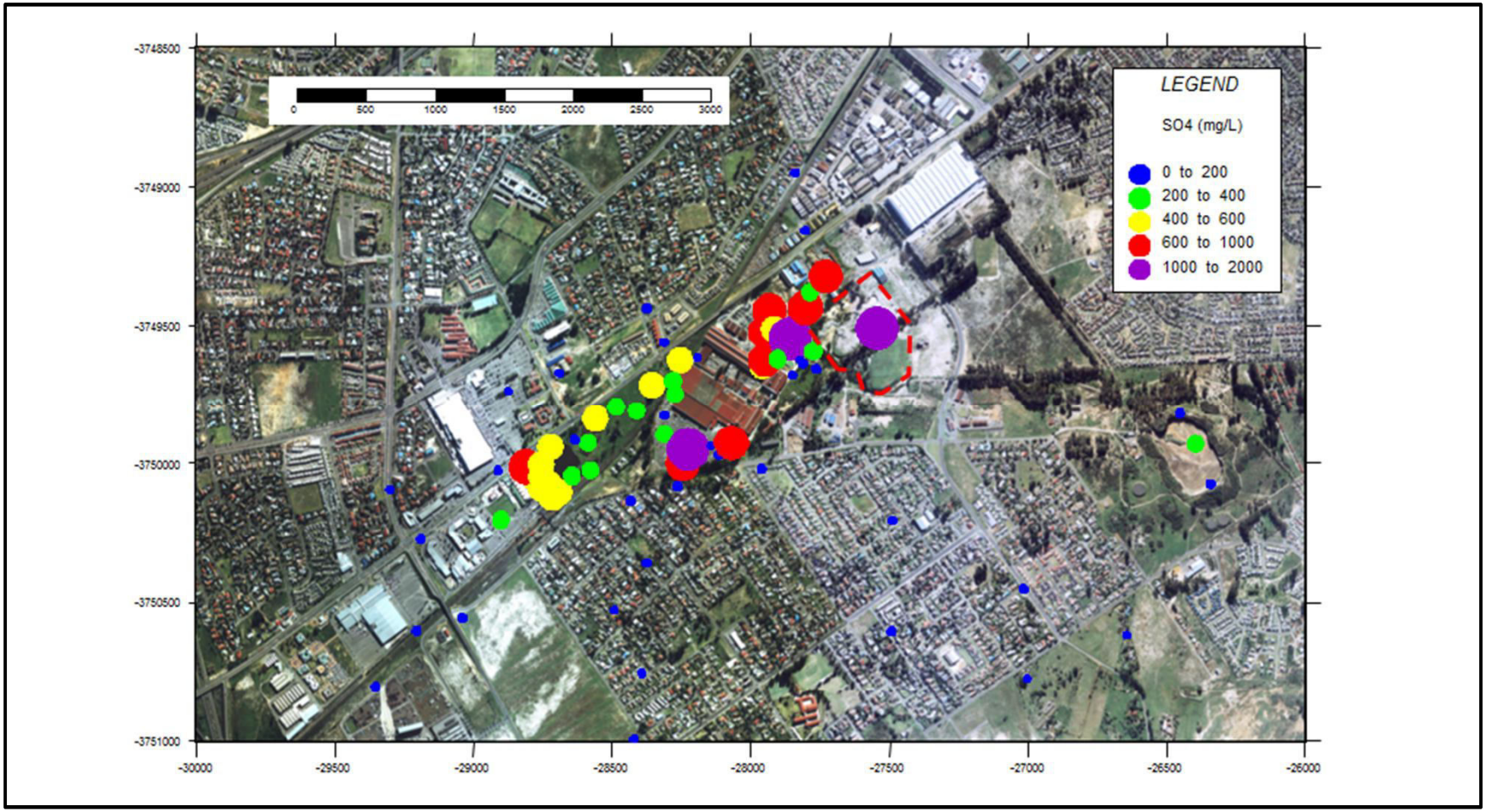


Figure 10: Distribution of SO4 concentrations at the Everite site

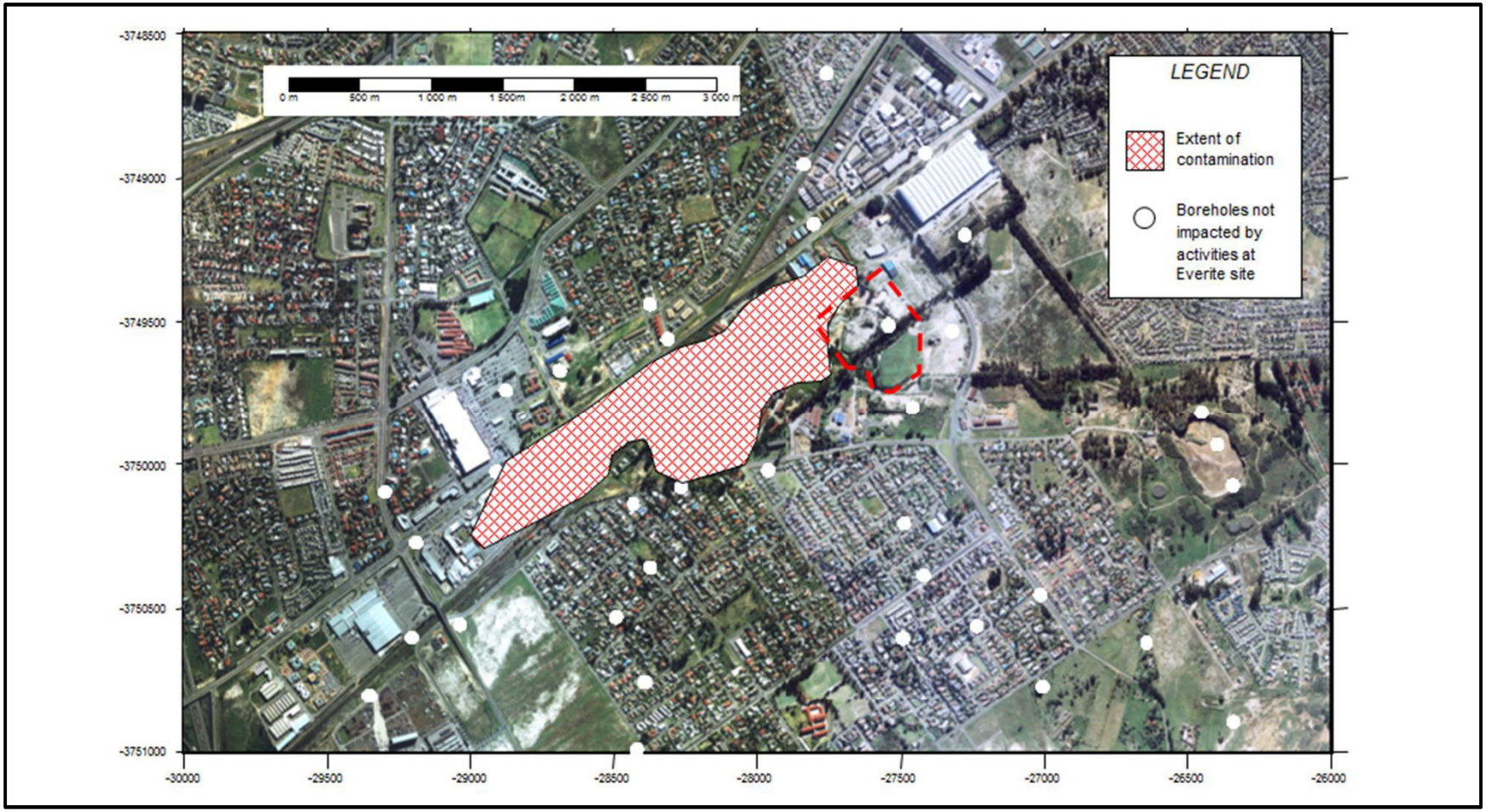


Figure 11: Extent of groundwater contamination resulting from historic activities at the Everite site

APPENDIX A

Parsons & Associates report of 2005

Parsons & Associates
specialist groundwater consultants cc
CK 96/27895/23

Report
171/EVER-D1

Everite, Brackenfell Groundwater Contamination - Status Report

report prepared for

Group Five (Pty) Ltd

Ref: 171/EVER ***October 2005***

tel (021) 855-2480 ***PO Box 2606 Somerset West 7129*** ***fax (021) 855-2363***

CONTENTS PAGE

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

The Everite factory in Brackenfell was established in the 1940s and produced asbestos-based products (Figure 1). The factory was subsequently closed in 2000 and underwent a formal decommissioning process during 2001 and 2002. Currently, the site is used as an Everite warehouse and is being redeveloped into a light industrial and commercial centre by Group Five Developments (Pty) Ltd.

Part of the decommissioning process included decontamination of the factory of asbestos and closure and capping of a small waste disposal site. Contamination elsewhere on the site also had to be investigated and assessed so effective remedial actions could be implemented. A number of potential sources of contamination were identified at the outset of these investigations, which included (Parsons and Associates, 2001):

- the effluent canal and wastewater dam
- the waste disposal site
- areas of historic disposal in the vicinity of the tarred parking area
- integration of the site into a municipal stormwater management plan

Since 1996, a number of geohydrological investigations have been undertaken in the vicinity of the Everite site, which provided useful information regarding site-specific conditions and detected impacts. Investigations by GIBB Africa (1996), CSIR (1998) and Parsons and Associates (1998) were carried out in the vicinity of the wastewater dam. Results of these studies indicated groundwater contamination had occurred from wastewater disposal practises at the site. The findings of these investigations are summarised in Parsons and Associates (2001).

Parsons and Associates (2001) investigated possible contamination over the extent of the Everite property. Widespread groundwater contamination was detected and interpreted to be the result of historic activities on the site. Off-site investigations by Parsons and Associates (2002) showed most contamination had remained on site, with a narrow groundwater contamination plume having migrated about 1 km west of the wastewater dam. No identified groundwater users had been impacted by the contamination (Parsons and Associates, 2002).

As the contamination plume posed little health or environmental risk and the western part of the plume had migrated into an area used for commercial purposes, groundwater-specific remedial actions were considered unnecessary (Parsons and Associates, 2002). Parsons and Associates (2002) recommended monitored natural attenuation as an appropriate remedial action on the site, and considered regular groundwater monitoring (which would include measurement of groundwater levels and collection of samples for chemical analysis) to be sufficient for this purpose. Interpretation of results of monitored data would allow migration of the contamination plume to be tracked.

2 TERMS OF REFERENCE

Prior to the current investigation, the last monitoring run was conducted in December 2002. For this reason, Mr Attie Greyling of Group Five (Pty) Ltd requested Parsons and Associates during March 2005 to provide a proposal for groundwater monitoring at the site.

Following a site visit by Messrs Roger Parsons and Attie Greyling on 8 July 2005, it was agreed Parsons and Associates would initially undertake one sampling run of all existing monitoring wellpoints at the site. The purpose of the proposed investigation was:

- to check the status of monitoring wellpoints on the property,
- assess the contamination status of groundwater (in relation to previous results),
- prepare a monitoring plan around the waste disposal site, that can be presented to DWAF, and
- prepare a status report.

It was further agreed the extent of monitoring of future monitoring would be reviewed once the construction of the area east of the AC Pipes factory was nearing completion.

3 WORK UNDERTAKEN

3.1 Status of Monitoring Stations

Since July 1998, a total of 51 wellpoints and 3 boreholes, hereafter referred to as 'monitoring stations', have been installed at and around the Everite site (Figure 2 and Table 1).

Table 1. Summary of monitoring stations installed at the Everite site since 1998

Investigation By	Total Number of Monitoring Stations	Monitoring Station IDs
Parsons and Associates (1998)	15 wellpoints	WP1 to WP15
Parsons and Associates (2001)	23 wellpoints and 3 boreholes	WP101 to WP125 and BH126 to BH128
Parsons and Associates (2002)	13 wellpoints	WP201 to WP214

On 25 July 2005, Mr Noorodien Solomon of Parsons and Associates undertook a field survey to determine the current status of the monitoring stations. A total of 30 wellpoints and the 3 boreholes were located (Figure 2). Monitoring station depths and groundwater levels were measured. Wellpoint WP206 was dry and a groundwater level could not be measured. All other monitoring stations were in good condition and measurements could be made. However, 6 monitoring stations did not have a protective cover and could easily be damaged, while casing in WP119 may be cracked due to occurrence of roots in the wellpoint (Table 2). The remaining 21 wellpoints could either not be located or have been destroyed.

Table 2. Summary of monitoring stations located during July 2005

Monitoring Station	Depth (mbc)	Comment	Monitoring Station	Depth (mbc)	Comment
BH126	21.5	good condition	WP118	6.4	good condition
BH127	7.6	good condition	WP119	4.8	roots in wellpoint
BH128	9.5	good condition	WP121	1.7	good condition
WP101	5.2	no protective cover	WP123	11.9	good condition
WP102	6.6	good condition	WP124	7.0	good condition
WP104	6.3	good condition	WP125	7.6	good condition
WP105	7.9	good condition	WP201	4.0	good condition
WP106	5.4	good condition	WP203	5.8	good condition
WP107	6.6	white greasy flakes in water	WP204	5.9	good condition
WP108	4.7	no protective cover	WP205	4.7	no protective cover
WP109	5.0	no protective cover	WP206	2.9	dry
WP110	6.7	good condition	WP207	5.8	good condition
WP111	6.7	no protective cover	WP209	5.9	good condition
WP112	5.9	no protective cover	WP211	4.1	good condition
WP114	5.9	good condition	WP212	5.7	good condition
WP116	6.3	good condition	WP214	5.9	good condition
WP117	6.9	good condition			

3.2 Groundwater Sampling and Analysis

A key component of the investigation was to assess groundwater quality and contamination status. Noorodien Solomon undertook a sampling run on 4 and 5 August 2005. This included measurement of groundwater levels and collection of groundwater samples. All monitoring stations were purged for at least 10 mins prior to taking a sample. Electrical conductivity (EC) and pH were measured in the field. Sample bottles were rinsed three times before being filled and stored in a cooler box with ice bricks until delivery to Bemlab Laboratories in Somerset West on 5 August 2005. A list of constituents that were analysed for are given in Table 3. All data collected during the sampling run was added to the project database.

Table 3. List of constituents analysed for in August 2005

Field Parameters	Laboratory Analysis
EC	K
pH	SO_4
	Cl
	NO_3
	NH_4
	DOC

4 ASSESSMENT OF GROUNDWATER CONTAMINATION

4.1 Previous Investigations

According to Parsons and Associates (2001), groundwater quality measured in June 2001 was similar to that measured in August 1998. This indicated little change in the contamination status of the subsurface. Parsons and Associates (2001; 2002) were unable to clearly define ambient groundwater quality, as widespread contamination on the site made proper interpretation difficult. However, ambient concentrations of K and SO_4 were believed to be less than 20 and 200 mg/L, respectively.

Previous investigations indicated K, SO_4 and pH to be good indicators of contamination at the site. Hence, groundwater with a K - SO_4 character was accepted as being indicative of groundwater contamination. Parsons and Associates (2001; 2002) confirmed significant contamination had occurred in the vicinity of the wastewater dam, in the Moulded Goods Yard, in the AC Pipes Area and north and south of the Current Dump. Groundwater around the wastewater dam displayed chemical concentrations similar to the effluent. It was concluded the waste disposal site had little negative impact on the quality of groundwater (Parsons and Associates, 2001).

The severity of contamination was previously indicated by class intervals that were based on DWAF (1998) guidelines for drinking. The guidelines indicated K and SO_4 concentrations in groundwater underlying the site were generally in excess of 100 and 600 mg/L, respectively (Parsons and Associates, 2001). It was clear from the data widespread groundwater contamination had occurred.

According to Parsons and Associates (2002), groundwater contamination appeared to have remained confined to the boundaries of the site. However, the contamination plume had migrated about 1 km west of the wastewater dam. Groundwater beyond the extent of contamination appeared to reflect ambient conditions, where K and SO_4 concentrations were below their respective ideal water quality limits of 25 and 200 mg/L set by DWAF (1998). No identified groundwater users were impacted.

4.2 Current Status

4.2.1 Groundwater Levels

Parsons and Associates (2001; 2002) previously reported depth to groundwater at the site to be shallow. Measurements taken during August 2005 confirm this, and groundwater levels range between 0.2 and 3.9 m below ground level (Figure 3). Groundwater levels are very shallow around the AC Pipe Area and Current Dump, ranging between 0.2 and 1.8 mbgl.

Based on August 2005 data, groundwater east of the Everite site flows in a westerly direction (Figure 4). West of the factory, direction of flow changes towards a south-westerly direction. This confirms earlier interpretation made by Parsons and Associates (2001; 2002).

4.2.2 Groundwater Contamination

Although previous investigations at the Everite site suggested K and SO_4 concentrations to be good indicators of groundwater contamination, EC measurements during August 2005 have proved useful in understanding the level of contamination and the extent thereof. Parsons and Associates (2002) presented a map showing the extent of contamination. Groundwater sampled beyond the expected extent of contamination has EC levels of between 35 and 70 mS/m, which are considered to represent ambient conditions (Figure 5). The figure also shows the contamination plume has not migrated further south-westward towards monitoring stations WP204, WP207 and WP212. Parsons and Associates (2002) reported there was no northern or southern lateral expansion of the plume. This is supported by the low EC level measured in groundwater at WP211 (36 mS/m).

At the Moulded Goods Yard, EC levels ranged between 80 and 100 mS/m, with groundwater at WP105 having an EC of over 260 mS/m. Also, towards the AC Pipe area, EC levels range between 130 and 330 mS/m. EC levels representing ambient conditions were measured in groundwater at WP116, BH128 and BH126 (20 to 60 mS/m), located west of the Current Dump. Interpretation of the Durov diagram (Figure 6) confirms earlier conclusions that levels of contamination are greatest around the wastewater dam and AC Pipes Area. The quality of groundwater measured in the Moulded Goods Yard has an inconsistent nature, but high EC levels has also been measured in this area.

In terms of K and SO_4, the high concentrations at the site confirm the impact of the wastewater dam and previous activities around the AC Pipe Area on the surrounding groundwater bodies (Figure 7 and Figure 8). As seen in Figure 7, ambient K concentrations may be between 5 and 15 mg/L, while contaminated groundwater has K concentrations as high as 485 mg/L (measured in groundwater at WP105). Also, interpretation of Figure 8 shows ambient SO_4 concentrations may be between 30 and 110 mg/L, while contaminated groundwater has SO_4 concentrations over 500 mg/L.

Interestingly, groundwater sampled at monitoring station BH127 has a K concentration of 20 mg/L, but EC was measured to be almost 400 mS/m. Further, the K concentration at WP116 was 230 mg/L, while EC was only 20 mS/m. Although there is no direct relationship between K concentrations and EC levels, observed patterns at BH127 and WP116 cannot be explained, and may be related to incorrect chemical analysis.

Parsons and Associates (2002) considered monitored natural attenuation appropriate for the Everite site. Using K and SO_4 concentrations as ideal indicators of groundwater contamination, a comparison of their concentrations in groundwater during June 2001 / December 2002 [1] and August 2005 was made to assess whether the adopted remedial action positively affected the environment. Monitored data for the monitoring stations located during August 2005 were plotted against that measured in June 2001 / December 2002 (Figure 9 and Figure 10). Since both these monitoring runs were undertaken during the winter period, influence of seasonal variation on groundwater quality was considered insignificant.

[1] Some monitoring stations were only installed during November 2002, and hence sampled for the first time during that period (see Table 1)

An analysis of data presented in Figure 9 showed a general improvement in groundwater quality at the Everite site. Variation in K concentrations from June 2001 / December 2002 to August 2005 is presented in Figure 11. Interpretation of the figure shows 50% of samples from the monitoring stations show improved quality, 38% reflected almost no change (improved or deteriorated), while 12% showed a deterioration of groundwater quality. The latter was evident in groundwater sampled at WP104, WP116, WP125 and WP214. Based on available data and an assessment of overall groundwater quality at the site, this occurrence cannot be explained. Similar patterns are observed when interpreting variation in SO_4 concentrations from June 2001 / December 2002 to August 2005 (Figure 12).

However, Figure 11 does show that monitored natural attenuation has had a positive impact on the environment and underlying groundwater bodies. K concentrations in the monitoring stations have improved by up to 500 mg/L (Table 4). It is also seen the contamination plume has not migrated further south-westward towards monitoring stations WP204, WP205, WP207 and WP209, since the last monitoring run in June 2001. Improved groundwater quality may be attributed to improved water quality at Dam 5 and Dam 6 since September 1998 (Figure 13).

Table 4. Comparison of monitored K concentration data from June 2001 / December 2002 to August 2005

Monitoring Station	June 2001 (mg/L)	August 2005 (mg/L)	Diff (mg/L)	% Diff	Monitoring Station	June 2001 (mg/L)	August 2005 (mg/L)	Diff (mg/L)	% Diff
BH126	4.7	4.3	-0.4	-9.4	WP118	702.9	357.7	-345.1	-49.1
BH127	31.0	19.6	-11.4	-36.6	WP119	10.3	11.1	+0.8	+7.8
BH128	415.6	3.8	-411.8	-99.1	WP121	10.9	7.5	-3.4	-31.6
WP101	12.0	9.5	-2.5	-20.9	WP123	57.1	14.7	-42.4	-74.2
WP102	40.0	30.2	-9.8	-24.6	WP124	90.0	43.7	-46.3	-51.4
WP104	45.0	61.5	+16.5	+36.8	WP125	36.0	62.9	+26.9	+74.7
WP105	719.0	485.3	-233.7	-32.5	WP201	10.0	9.2	-0.8	-8.5
WP106	672.0	29.3	-642.7	-95.6	WP203	11.0	11.1	+0.1	+0.9
WP107	281.0	63.8	-217.2	-77.3	WP204	2.9	5.0	+2.1	+71.5
WP108	197.0	131.5	-65.5	-33.2	WP205	3.9	5.0	+1.1	+28.2
WP109	333.3	144.5	-188.9	-56.7	WP206	1.3	Dry		
WP110	573.2	309.2	-264.0	-46.1	WP207	13.0	12.4	-0.6	-4.5
WP111	284.1	268.3	-15.8	-5.5	WP209	14.0	8.9	-5.1	-36.7
WP112	284.1	234.5	-49.6	-17.5	WP211	9.3	5.8	-3.5	-37.8
WP114	700.8	262.8	-437.9	-62.5	WP212	1.2	7.4	+6.2	+514.7
WP116	45.4	227.7	+182.3	+401.3	WP214	3.4	132.2	+128.8	+3 789.1
WP117	327.4	285.7	-41.7	-12.7					

5 CONCLUSIONS AND RECOMMENDATIONS

Parsons and Associates were requested by Mr Attie Greyling of Group Five (Pty) Ltd to assess the status of monitoring stations at and around the Everite site, which could be used for future monitoring of groundwater levels and groundwater quality. Based on a field survey undertaken in July 2005, 33 monitoring stations may be used for regular groundwater monitoring to track migration of the contamination plume. However, 6 monitoring stations require protection covers to ensure their future use. It is recommended lockable caps be installed at WP101, WP108, WP109, WP111, WP112 and WP205.

Since 2001, the affects of monitored natural attenuation seem to be positive, with a general improvement in groundwater quality at the site. Although groundwater contamination still exist at the site, concentrations levels of K and SO_4 have been reduced. However, it is uncertain whether the improved quality may also be related to seasonal variations. It is therefore recommended quarterly sampling be undertaken for 2 years to define seasonal variation. Thereafter, it is recommended 6 monthly sampling runs be undertaken to monitor the migration of the contamination plume.

REFERENCES

CSIR (1998) Everite-Dam Watergehalte. Report prepared for Andre van der Merwe and Associates, Report No. JW598. Groundwater Group, CSIR.

Department of Water Affairs and Forestry (1998) Quality of Domestic Water Supplies, Volume 1 – Assessment Guide. Second edition. Water Research Commission No.: TT 101/98.

Gibb Africa (1996) Everite Brackenfell – Preliminary Environmental Contamination Report. Report prepared for Group Five Properties (Pty) Ltd, Report No. J19391B.

Parsons and Associates (1998) Everite, Brackenfell – Assessment of Soil and Water Contamination Status at Adjacent Dam Property. Report prepared for Group Five Properties, Report No. 029/EVER-1, September 1998. Parsons and Associates Specialist Groundwater Consultants ^{cc}, Somerset West.

Parsons and Associates (2001) Everite, Brackenfell – Preliminary Results of Investigation of Groundwater Contamination. Report prepared for Jones and Wagener Consulting Engineers, Report No. 092/EVER-F1, July 2001. Parsons and Associates Specialist Groundwater Consultants ^{cc}, Somerset West.

Parsons and Associates (2002) Everite, Brackenfell – Investigation of the Extent of Groundwater Contamination. Report prepared for Group Five Developments (Pty) Ltd, Report No. 102/EVER-F1, December 2002. Parsons and Associates Specialist Groundwater Consultants ^{cc}, Somerset West.

FIGURES

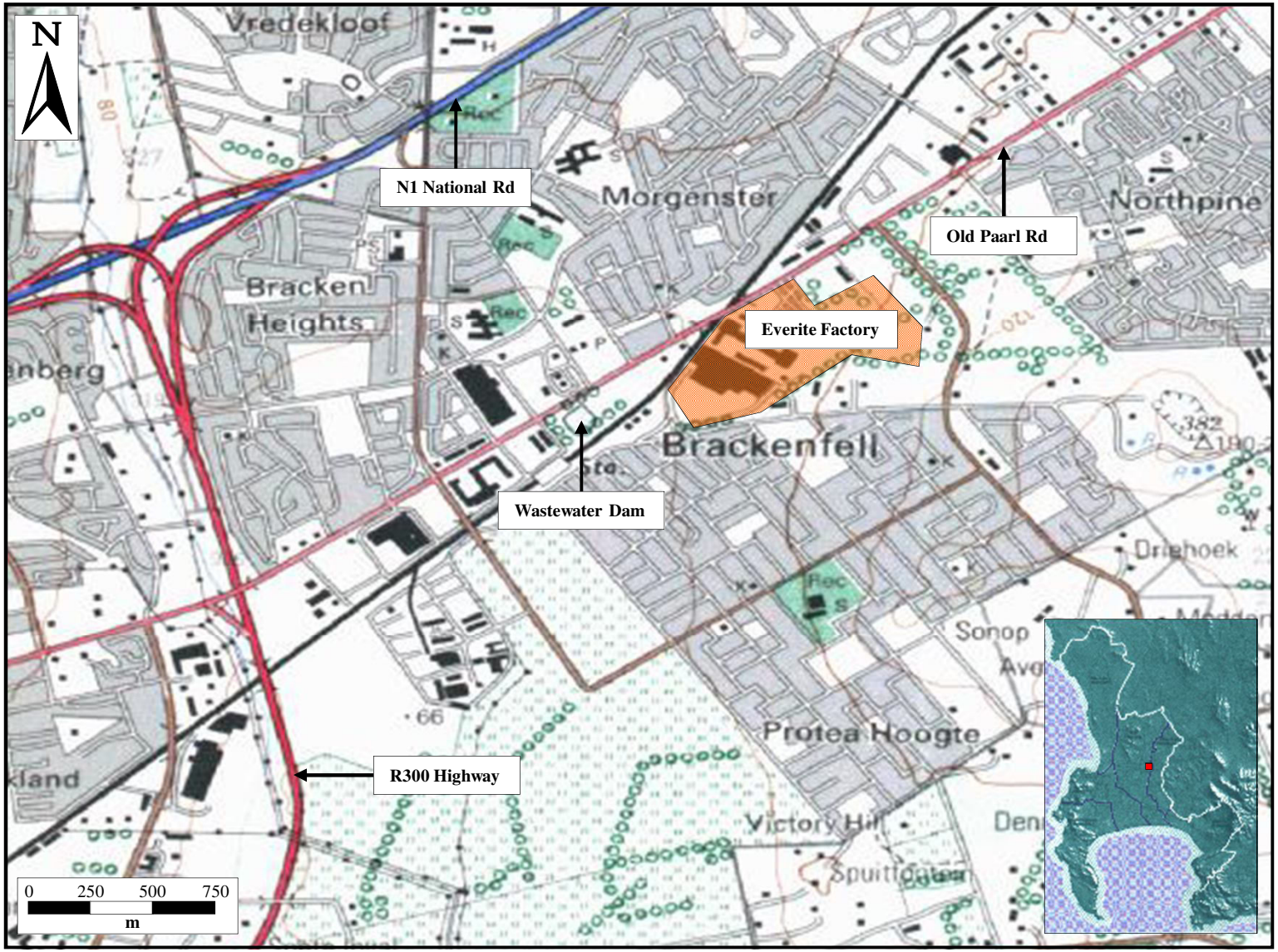


Figure 1. Locality map of the Everite factory in Brackenfell

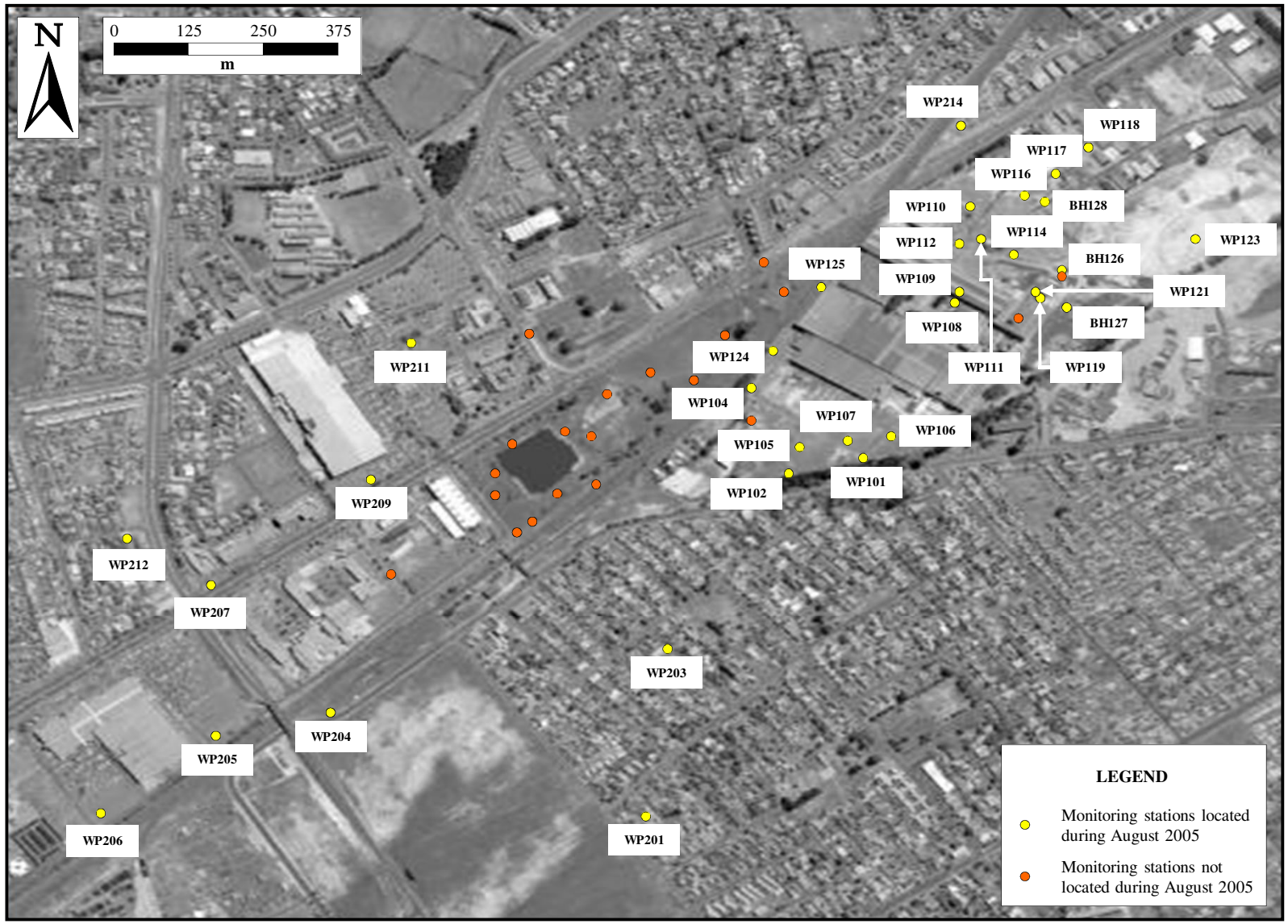


Figure 2. Positions of monitoring stations located during August 2005, as well those previously installed at the Everite site, but could not be located

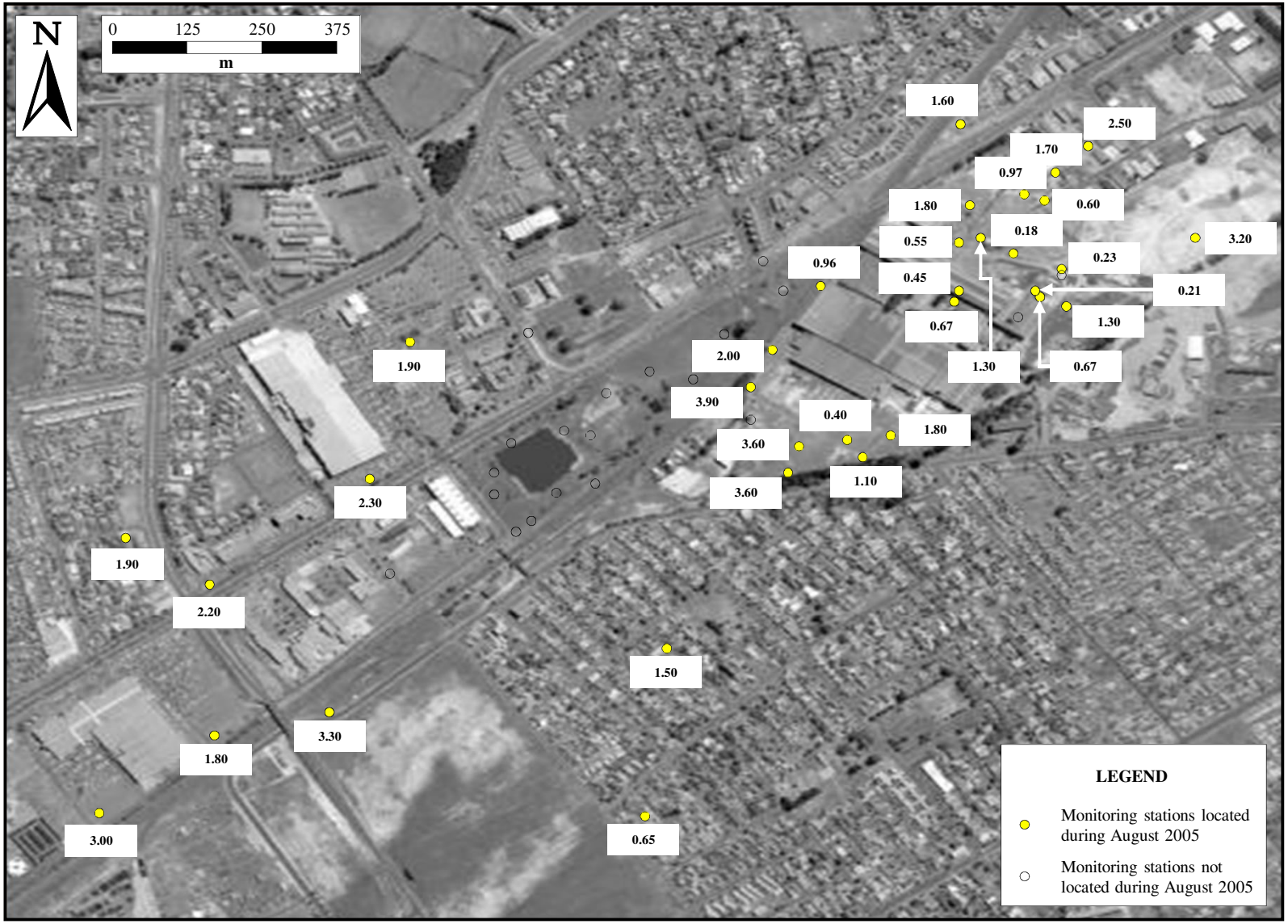


Figure 3. Depth to groundwater map, with groundwater levels measured in mbgl

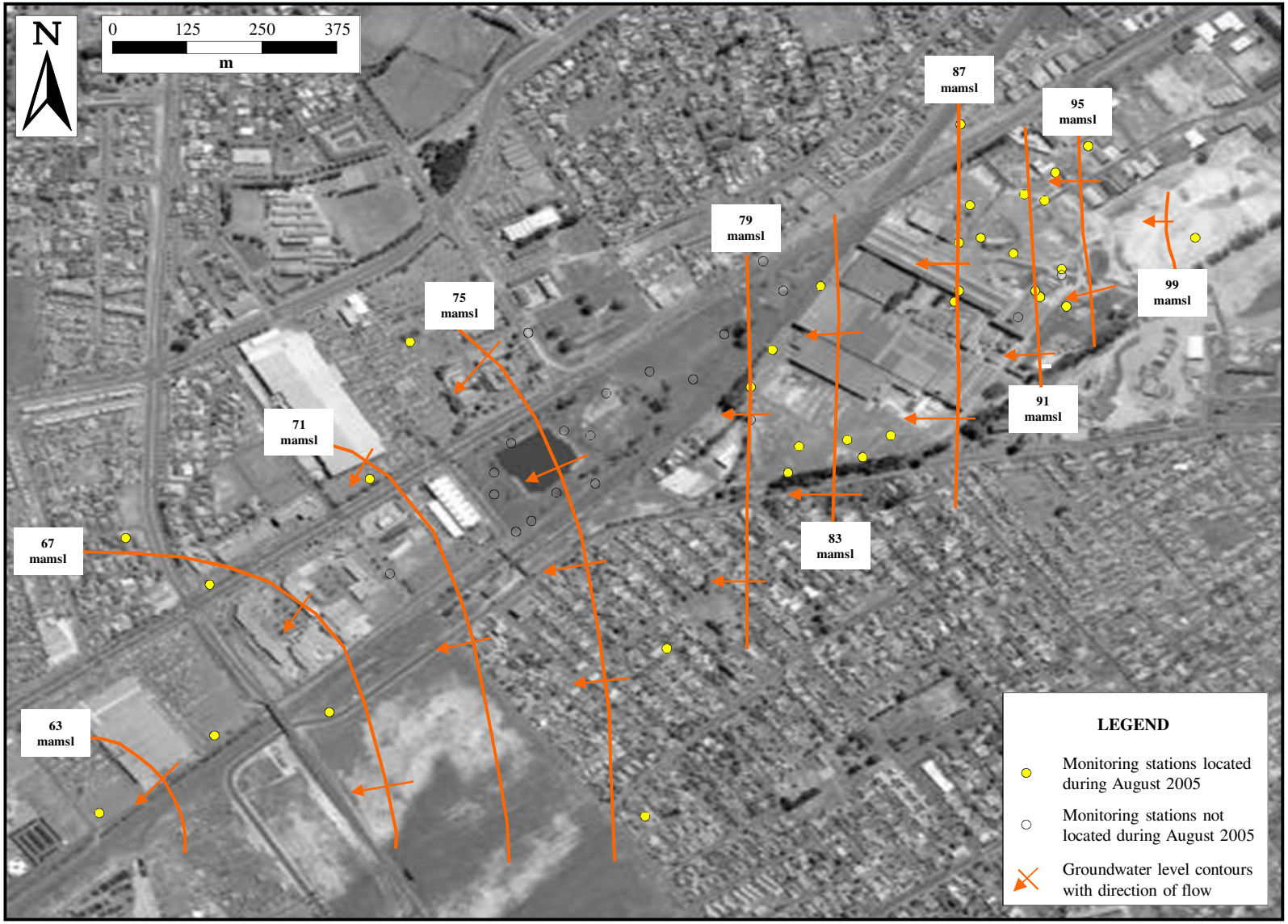


Figure 4. Groundwater level contour map showing direction of groundwater flow

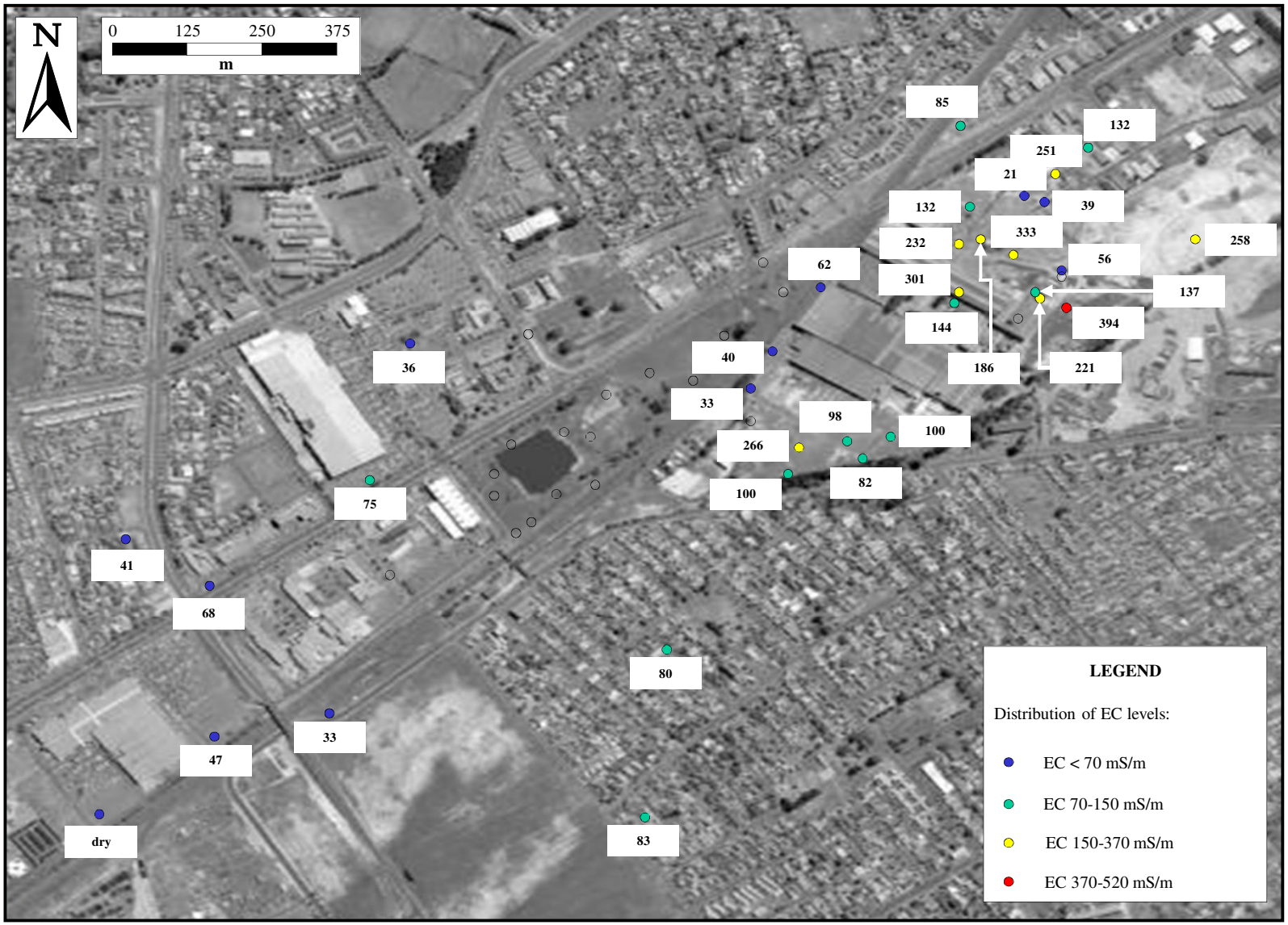


Figure 5. Electrical conductivity (EC) levels measured in groundwater during August 2005, measured in mS/m

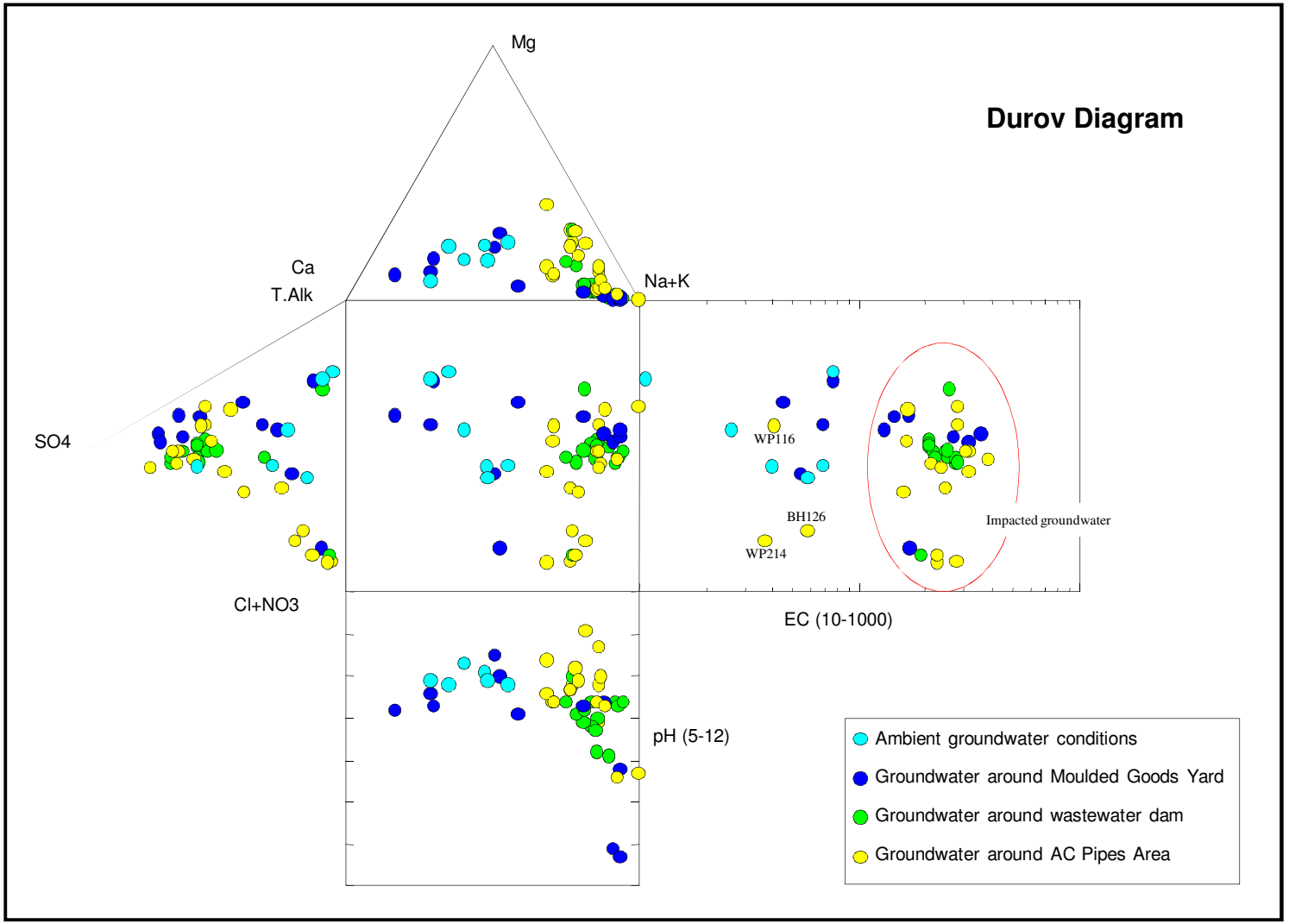


Figure 6. Hydrochemical character of groundwater sampled at the Everite site

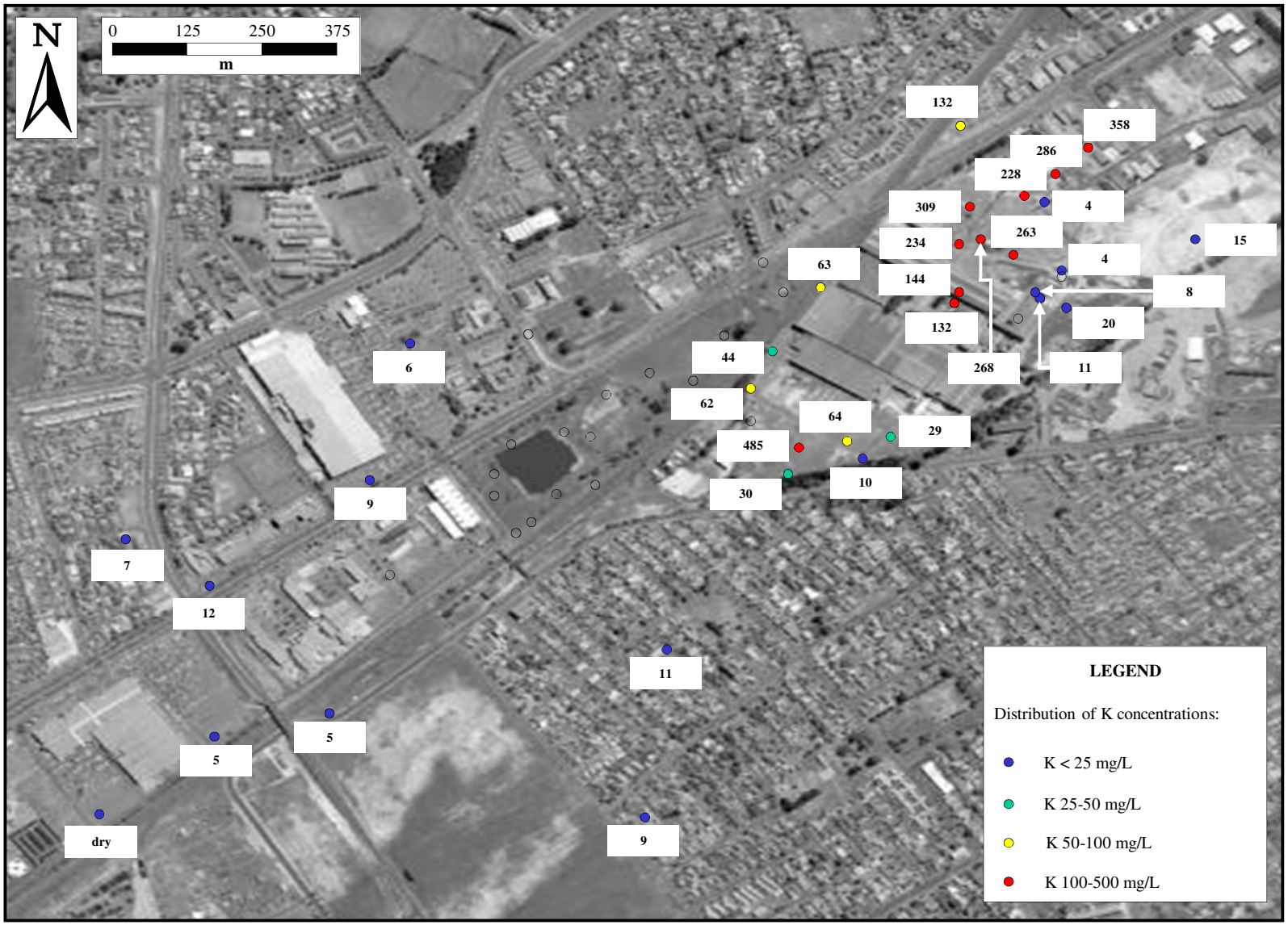


Figure 7. Potassium concentrations (K) measured in groundwater during August 2005, measured in mg/L

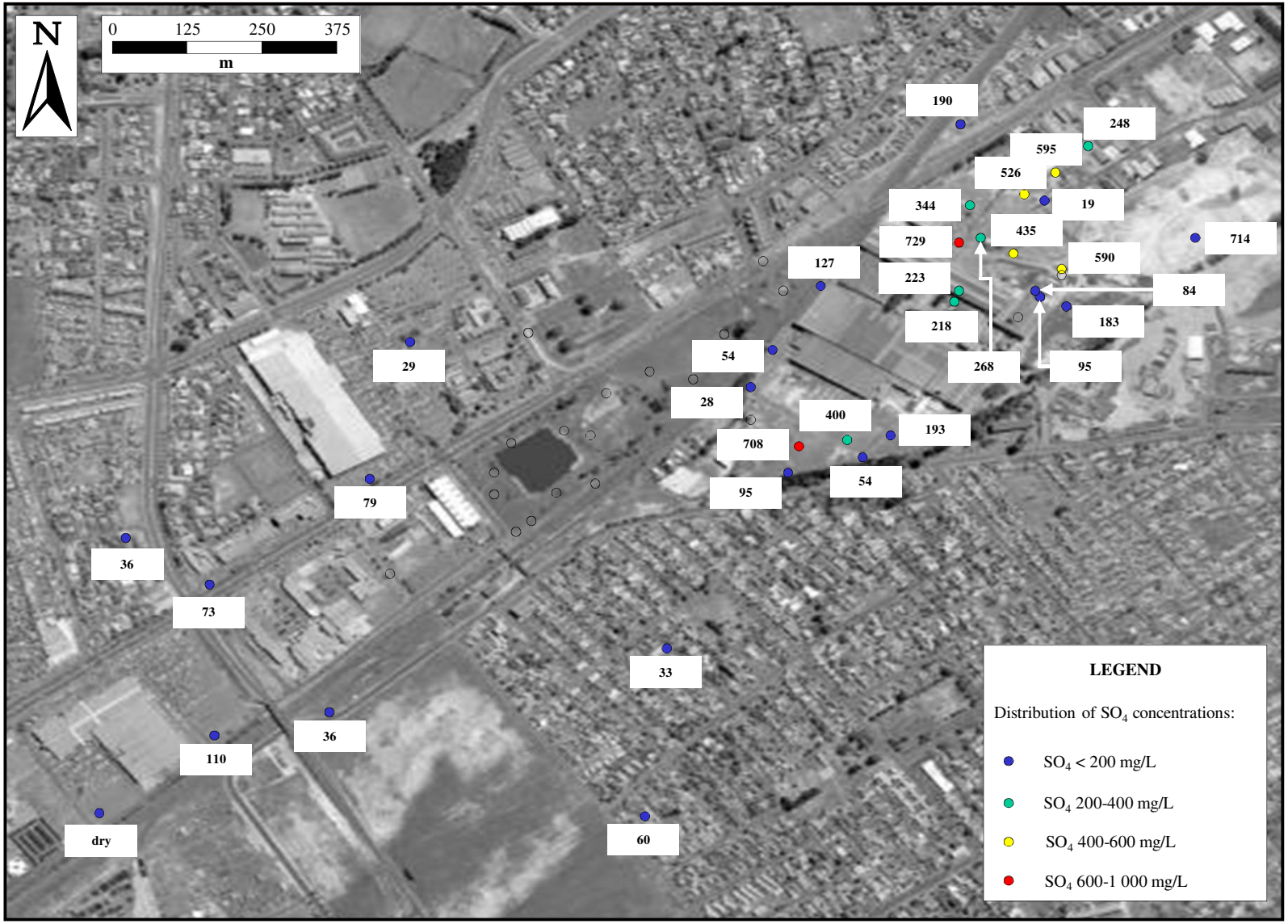


Figure 8. Sulphate concentrations (SO_4) measured in groundwater during August 2005, measured in mg/L

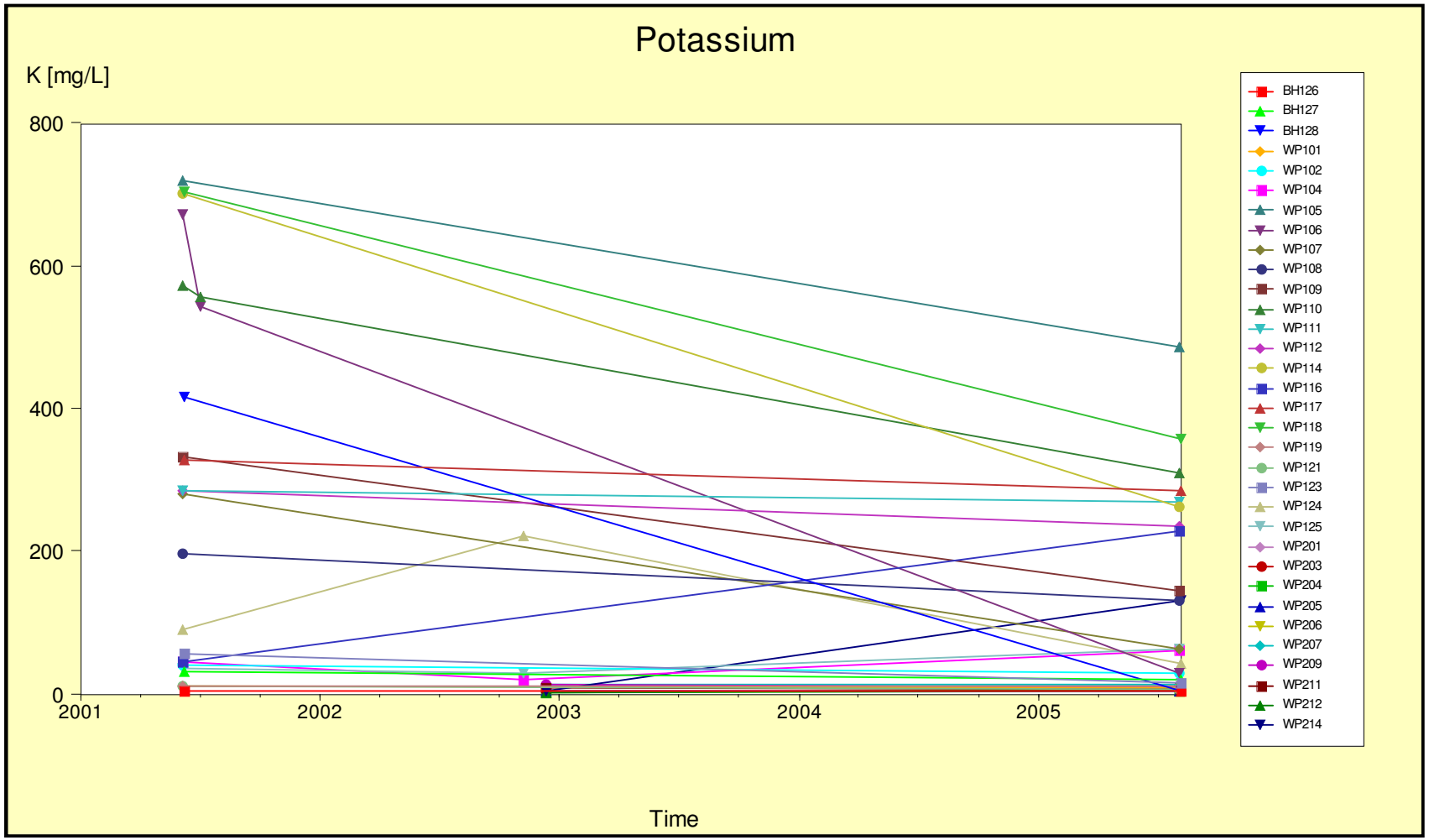


Figure 9. Comparison of K concentrations measured in groundwater during June 2001 with that measured during August 2005

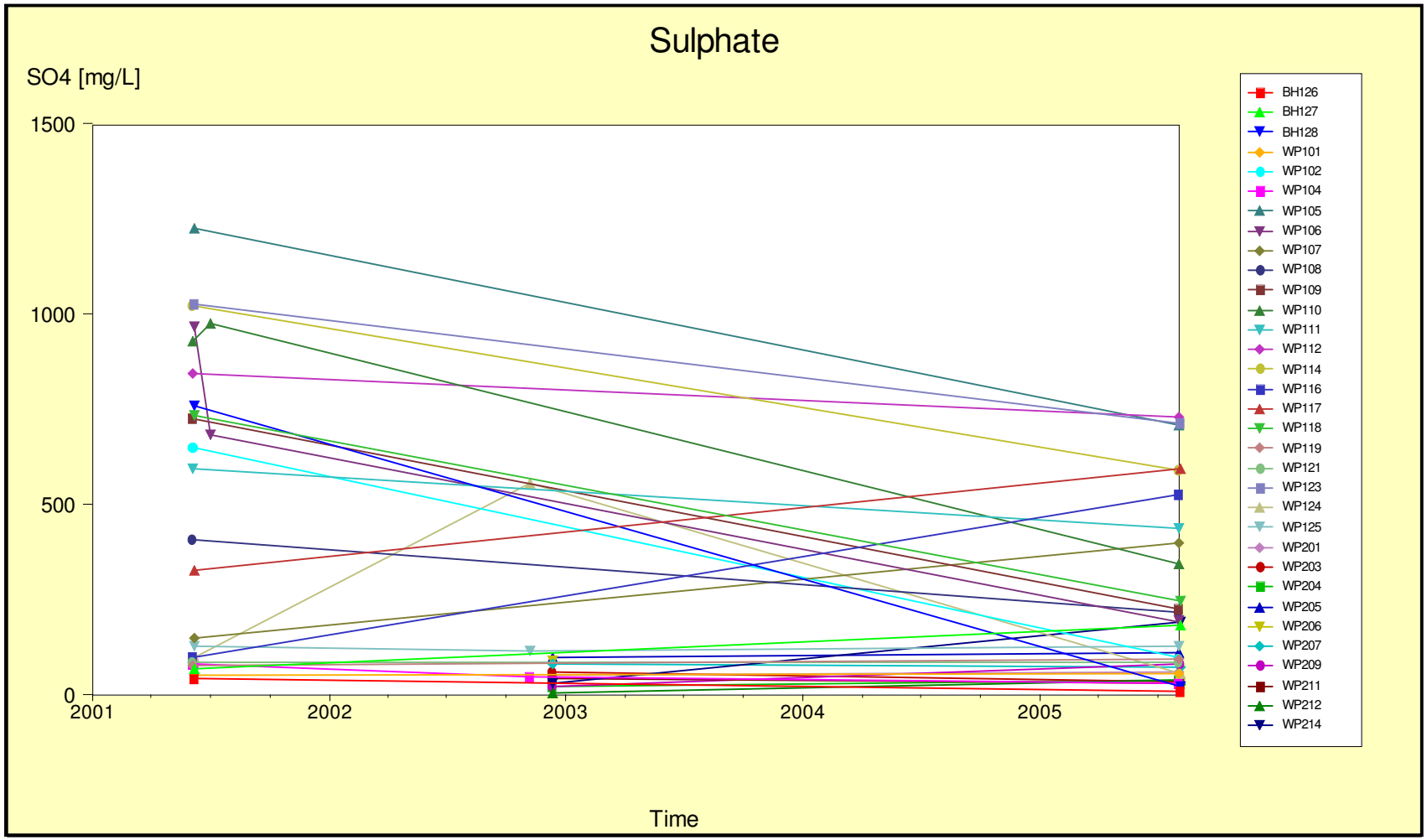


Figure 10. Comparison of SO_4 concentrations measured in groundwater during June 2001 with that measured during August 2005

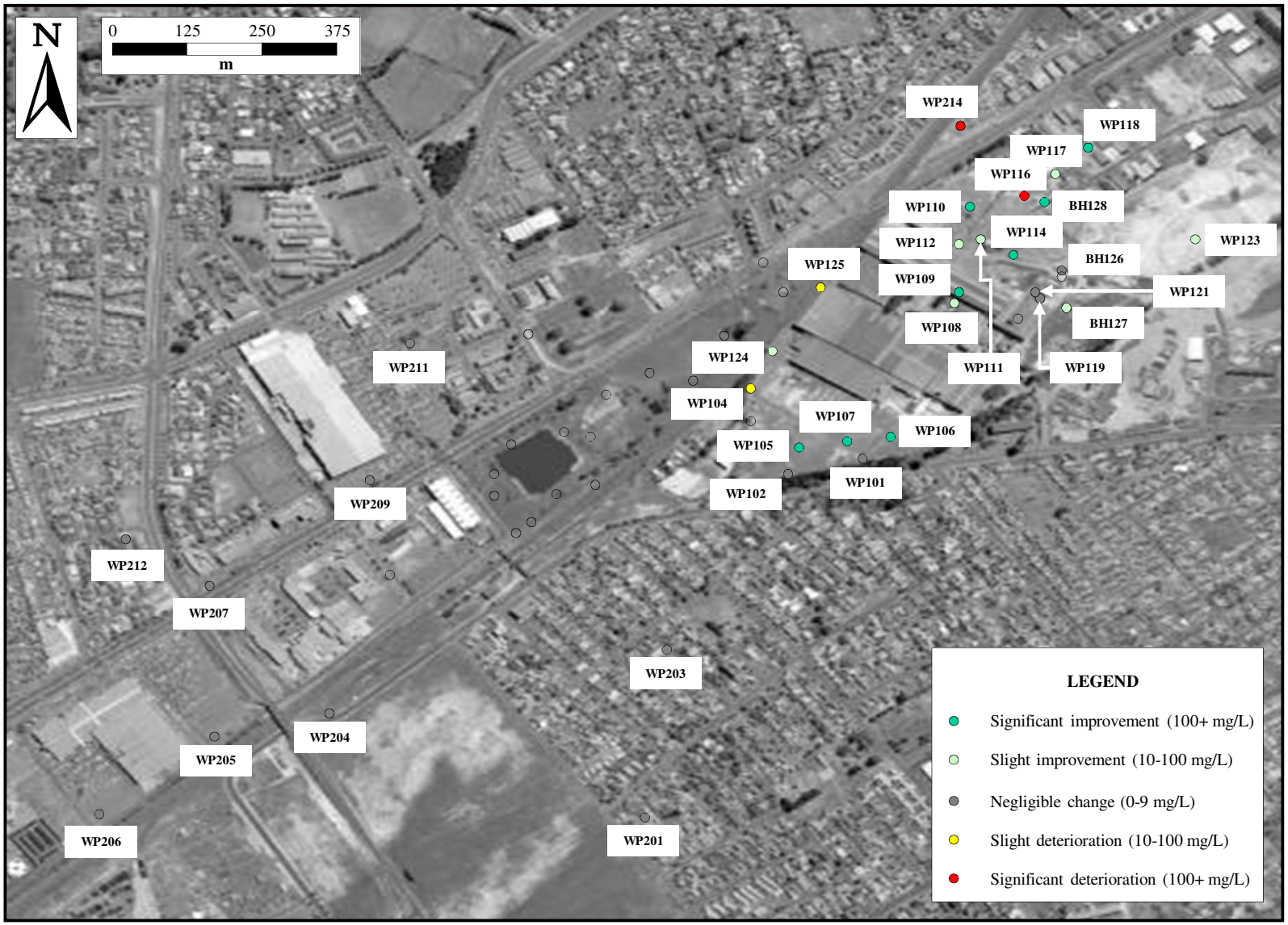


Figure 11. Affects of monitored natural attenuation / seasonal variation on groundwater bodies underlying the Everite site, using K concentration variations from June 2001 to August 2005

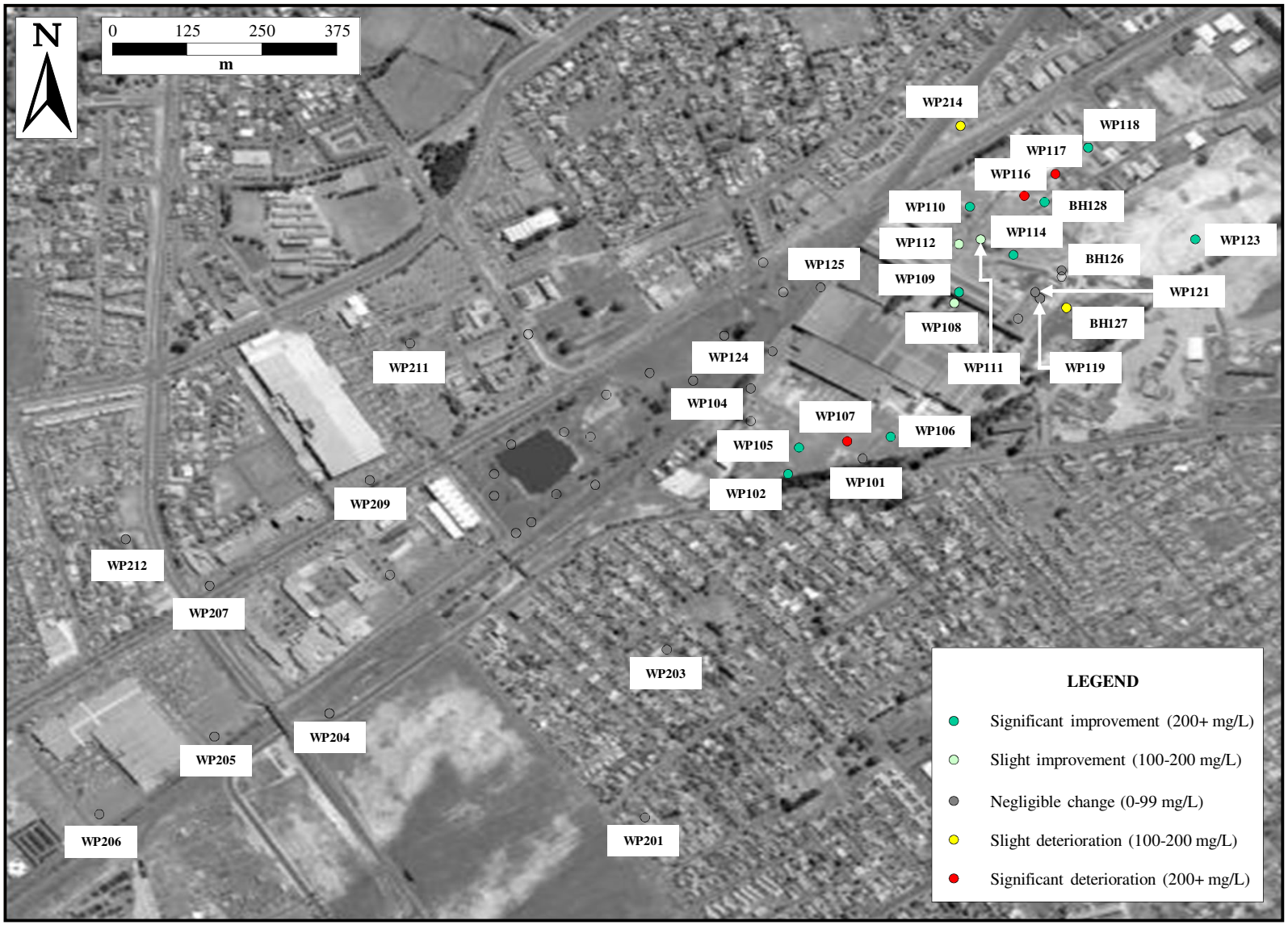


Figure 12. Affects of monitored natural attenuation / seasonal variation on groundwater bodies underlying the Everite site, using SO_4 concentration variations from June 2001 to August 2005

Figure 13. Monitored water quality at Dam 5 and Dam 6

Appendix A

Chemical Analysis – August 2005

BemLab (Pty) LTD
CK2002/017933/07

Director: Dr. W.A.G. Kotzé

AECI Building W21
De Beers Road
Somerset West

P O Box 12457
Die Boord,
Stellenbosch, 7613

Tel. (021) 851-6401
Fax (021) 851-4379
Sel. 082-804-7499
E-mail akotze@bemlab.co.za

Vat Reg. Nr. 4160185577

Report No.: **NR10152/2005**

ANALYSES REPORT

Mr. Parsons
Parsons & Associates
P.O. Box 2606
Somerst West
7129

Date received: 05/08/2005
Date tested: 08/08/2005

Reference No.	Lab. No.	K mg/l	Cl mg/l	NH4-N mg/l	NO3-N mg/l	DOC Mg/l	S mg/l
BH 126	10160	4.259	151.66	0.37	0.29	21	9.904
BH 127	10177	19.646	1137.40	1.18	0.03	31	183.366
BH 128	10152	3.799	94.78	0.17	0.27	1	19.051
DAM 5	10179	114.118	299.86	0.21	4.09	82	160.771
DAM 6	10175	52.730	338.64	1.16	8.39	72	118.066
WP 101	10181	9.493	132.70	0.03	1.17	47	54.316
WP 102	10170	30.156	93.06	0.09	4.34	37	95.194
WP 104	10183	61.541	17.23	0.03	2.66	46	28.126
WP 105	10172	485.342	106.85	1.54	16.56	125	708.292
WP 106	10171	29.327	126.67	0.36	0.67	30	193.041
WP 107	10161	63.779	105.99	1.20	0.02	44	399.866
WP 108	10166	131.509	262.81	0.10	0.45	58	217.688
WP 109	10165	144.455	638.50	0.15	0.09	57	223.245
WP 110	10163	309.206	99.09	7.29	0.42	112	344.307
WP 111	10178	268.331	207.66	1.29	0.01	105	435.437
WP 112	10176	234.496	163.71	0.13	1.43	86	729.433
WP 114	10164	262.843	611.79	1.01	0.08	96	590.151
WP 116	10162	227.690	125.80	1.53	0.05	83	525.738
WP 117	10159	285.721	228.34	0.18	2.25	128	595.072
WP 118	10157	357.720	68.93	0.22	1.32	116	248.032
WP 119	10168	11.136	741.04	0.77	1.27	23	94.939
WP 121	10167	7.465	399.81	0.09	0.62	18	83.562
WP 123	10158	14.745	285.21	0.51	0.23	32	714.135
WP 124	10174	43.699	22.40	1.27	1.47	34	54.463

Reference No.	Lab. No.	K mg/l	Cl mg/l	NH4-N mg/l	NO3-N mg/l	DOC Mg/l	S mg/l
WP 125	10173	62.891	38.78	0.29	2.49	30	126.653
WP 201	10185	9.151	177.51	0.04	0.26	85	59.517
WP 203	10182	11.102	159.41	0.03	1.34	60	33.255
WP 204	10180	4.973	44.81	0.05	7.36	46	36.028
WP 205	10184	4.999	59.46	0.03	1.78	44	109.675
WP 207	10156	12.420	149.93	0.54	8.84	31	72.881
WP 209	10155	8.859	117.19	0.19	2.40	30	78.534
WP 211	10153	5.788	101.70	0.17	4.46	41	28.550
WP 212	10154	7.376	107.71	0.17	5.50	22	36.154
WP 214	10169	132.231	88.75	0.17	0.25	97	189.988

Analyses for Project: 171/EVER

Sample conditions

Samples in good condition.

Statement

The reported results may be applied only to samples recieved. Any recommendations included with this report are based on the assumption that the samples were representative of the bulk from which they were taken.

Dr. W.A.G. Kotzé (Director)
.....
for BemLab

11-08-2005
.....
Date

Enquiries: Dr. W.A.G. Kotzé
Arrie van Deventer

DECLARATION OF INDEPENDENCE, QUALIFICATION AND EXPERIENCE

Project:	Everite Asbestos Waste Site: Hydrogeological Assessment
Client:	Group Five Properties
EIA Consultant:	Chand Environmental Consultants

DECLARATION OF INDEPENDENCE

I, Roger Paul Parsons, hereby declare that:

- I acted as an independent groundwater specialist in this assessment;
- I regard the information contained in this report as it relates to my specialist input to be true and correct;
- I do not have and will not have any financial interest or vested interest in the undertaking of the activity, other than remuneration for work performed;
- I have disclosed to the client, environmental consultant and competent authority any material information that has or may have the potential to influence decisions relating to this matter; and
- I am aware false declaration is an offence.

QUALIFICATIONS AND EXPERIENCE

I have a Ph.D degree in Geohydrology from the University of the Free State and have practised as a Hydrogeologist since 1984. Prior to establishing Parsons & Associates Specialist Groundwater Consultants^{cc} in 1996, I worked for the Department of Water Affairs: Directorate of Geohydrology (1984 – 1990) and the CSIR: Groundwater Programme (1990 – 1996). I am a registered Professional Natural Scientist (400163/88) and a Fellow of both the Institute of Waste Management of Southern Africa (IWMSA) and the Water Institute of South Africa (WISA). I belong to a number of learned societies related to my profession (Ground Water Division, International Associations of Hydrogeologists, National Ground Water Association, International Association of Hydrological Sciences) and regularly attend conferences, lectures and training courses to remain abreast of developments in my field.

Dr Roger Parsons
Ph.D (U.F.S.) Pr.Sci.Nat.
29 May 2015