Address :
08 Moldau Complex, 416 Emily Hobhouse Street
Pretoria North
0182
P.O. Box 60545, Karenpark, 0118
Mobile: 071 307 2675
Fax no: 086 514 7468
Email : simphiwe@magalelas.co.za
Web : www.magalelas.co.za
CK Reg No: 2007/061739/23

NEWCASTLE MUSLIM CEMETERY GEOHYDROLOGICAL REPORT

Submitted to:

Udidi Peoject Development Company (Pty) Ltd
P. O. Box 11302
Dorpspruit
3206

May 2012

TABLE OF CONTENTS

1 INTRODUCTION 4

2 SCOPE OF WORK 5

3 INFORMATION COLLECTED 6

3.1 Physiography and Geomorphology 6

3.2 Climate 8

3.3 Piezometry 9

3.4 Recharge 12

3.5 Water chemistry 12

3.5.1 Methodology 12

3.5.2 Discussion of chemical characteristics of groundwater 13

4 INITIAL CONCEPTUAL GEOHYDROLOGICAL MODEL 15

4.1 Geohydrological Setting 15

4.2 Sandstone and siltstone 15

4.3 Mudstone and sandstone 16

4.4 Sandstone, Mudstone and shale unit 16

4.5 Mudstones 16

4.6 Ecca shales and sandstones 17

4.7 Aquifer Vulnerability 17

5 PREDICTION OF PLUME DEVELOPMENT AND IMPACT ON GRAVE SINKING 20

6 WORK REQUIRED 20

7 CONCLUSIONS AND RECOMMENDATIONS 21

8 REFERENCES 23

9 APPENDIX 24

LIST OF FIGURES

Figure 1.1 NN Muslim flow chart to predict shaft inflows 6

Figure 3.1 Location of Newcastle....................7

Figure 3.2 Location of Muslim cemetery....................8

Figure 3.3 Newcastle Precipitation....................9

Figure 3.3.2 Occurrence of water strike and blow yield in Kwazulu Natal 10

Figure 3.3.3 Kwazulu Natal Piezometric surface....................11

Figure 3.5.1 Newcastle groundwater piper diagram 14

LIST OF TABLES

Table 3.5.1 Newcastle Hydrochemistry 13

Table 4.3.1 Kwazulu Natal Geohydrological parameters....................19

1 Introduction

Magalela & Associates were appointed by Udidi Project Development Company to carry out a desk Geohydrological investigation at the Newcastle Muslim Cemetery (also referred in this report as the NN Muslim Cemetery) site to predict vulnerability of aquifers to pollution. The study focused on the evaluation of the Geohydrological conditions and characterization of the lithologies (aquifers, aquitards and aquicludes) and quantification of groundwater close to the proposed cemetery site. The main objective was to predict pollution plume development into the groundwater system and recommend groundwater management and assess the impact of grave sinking to the groundwater.

A 'georequest' was made and most of the Geohydrological information for the area and its surroundings was obtained from the National Groundwater Archive (NGA). Hydrocensus, water levels, geology and hydrochemistry data was analysed. This information shall act as framework and guide the Geohydrological investigation.

The initial approach to estimate and manage groundwater inflow at any site is to find the most probable groundwater flow mode. Geohydrological data was collected and used to construct an initial conceptual Geohydrological model. A conceptual Geohydrological model requires values for hydraulic conductivity/permeability (K), transmissivity (T) and Storage coefficient (S). These aquifer parameters are best calculated from aquifer tests which create water level drawdowns followed by subsequent recovery monitoring. Diagnostic plots of drawdown and recovery help identify preferred groundwater flow paths and no-flow boundaries which then aid in understanding the existing groundwater regime.

A steady state analytical model or numerical groundwater flow model would then be established. Contaminant plume transport is aided by diffusion, sorption and advective transport by groundwater. So the groundwater flow model feeds into the contaminant transport model that outlines the mode and rate of pollution plume development at any given site. This report lists the required data required to improve the level of confidence in the predicted rates and risk of pollution plume development at the Muslim Cemetery.

The study could be carried out in three stages:

1. Desk study and site visit
2. Field investigation
3. Use all data to assess Geohydrological conditions at Muslim Cemetery

2 Scope of work

The description of the stages is as follows (*Task 2 and 3 are recommendations to improve the level of confidence*):

Task 1 Desk study

Objectives Review and analyse all available and sourced data

Deliverables Design of site investigation to determine Geohydrological regime for Muslim Cemetery site (K, T, S, and b)

Report and recommendations

Task 2 Site investigation

Objectives Drilling of 2 shallow boreholes and perform hydraulic tests.

Collect of Geohydrological site data and report on Geohydrology of the sit

Deliverables Progress reporting on findings

Task 3 Geohydrological analysis and reporting

Objectives Use all data to assess Geohydrological condition at Muslim Cemetery

Deliverables Progress reporting on findings which include:

- Predicted pollution plume development
- Conclusions and recommendations
- Presentation

This report focuses on the first task, which is the desk study and data analysis.

A correct approach to the Geohydrological investigation is illustrated in flow chart, figure 1.1.

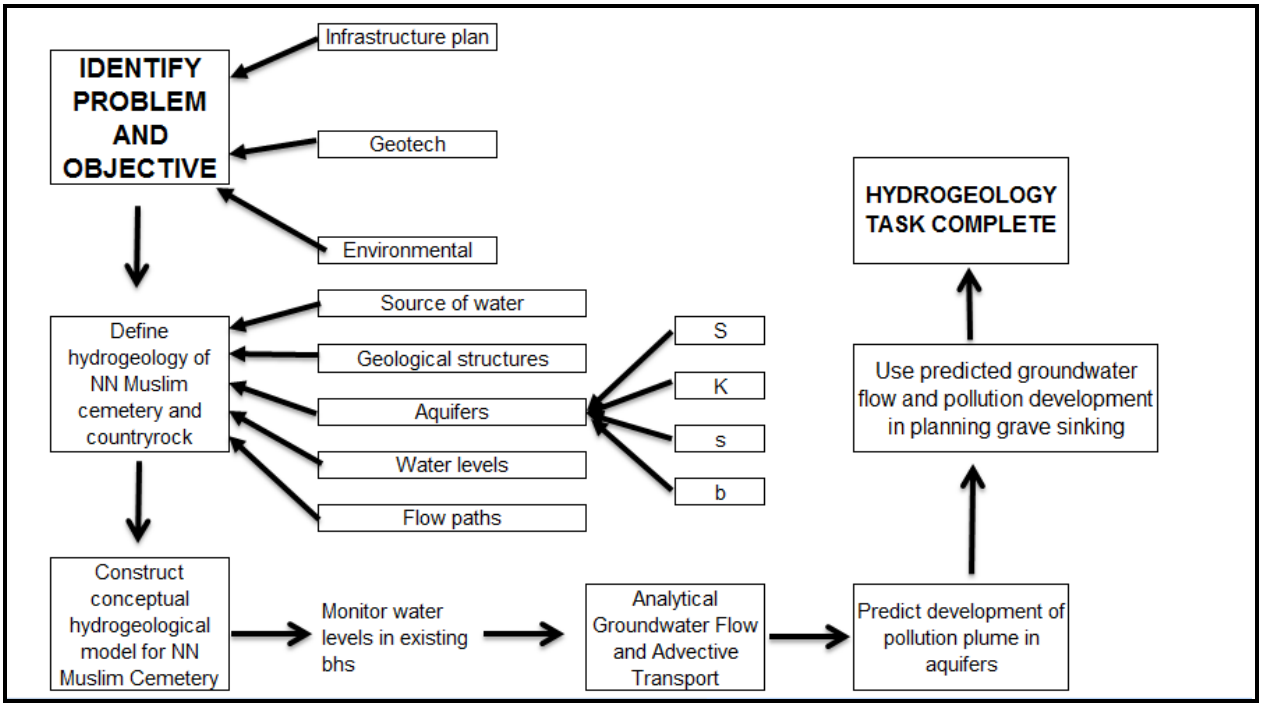

Figure 1.1: Newcastle Muslim Cemetery flow chart to predict pollution plume development

3 Information Collected

3.1 Physiography and Geomorphology

The NN Muslim Cemetery is located in the Newcastle Municipality which falls within Amajuba District (DC 25).The Amajuba District forms part of the Northwest part of KwaZulu Natal Province. The municipality areal extent is 1855 km^2, most of it lying on the spur, escarpment and foothills of Drakensburg Mountains.

The Low Drakensburg is part of the Great Escarpment formed by the Drakensburg Mountain Chain that stretches from the Southern Cape up into Mpumalanga. Above this lies the high-lying hinterland, or Highveld.

It is important to understand the regional geomorphology as this in turn leads to a clearer understating of regional groundwater flow patterns. The regional low lying areas are typical plateau-and-scarp scenario, a product of differential weathering of rocks of different competency. Hard rocks usually are found as a hard cap overlying much weaker rocks. Escarpment slopes comprise deeply dissected topography, into which the eroding rivers have incised. The plateau areas above the escarpments are characterized in places by impeded drainage, and heavy shrink-swell clays. In contrast, the soils of the escarpment are shallow, and extremely vulnerable to disturbance, which usually results in erosion, by virtue of the steep slopes that characterize the entire escarpment area.

Escarpments also contain numerous hanging wetlands covering wide areas exceeding 20 hectares. The wetlands play a vital role in the hydrological cycle, and in maintaining the water production efficiency of this important catchment area, though their capacity to receive, filter, store and gradually release water into the river systems.

Locality maps of the area are shown in Figures 3.1 and 3.2.

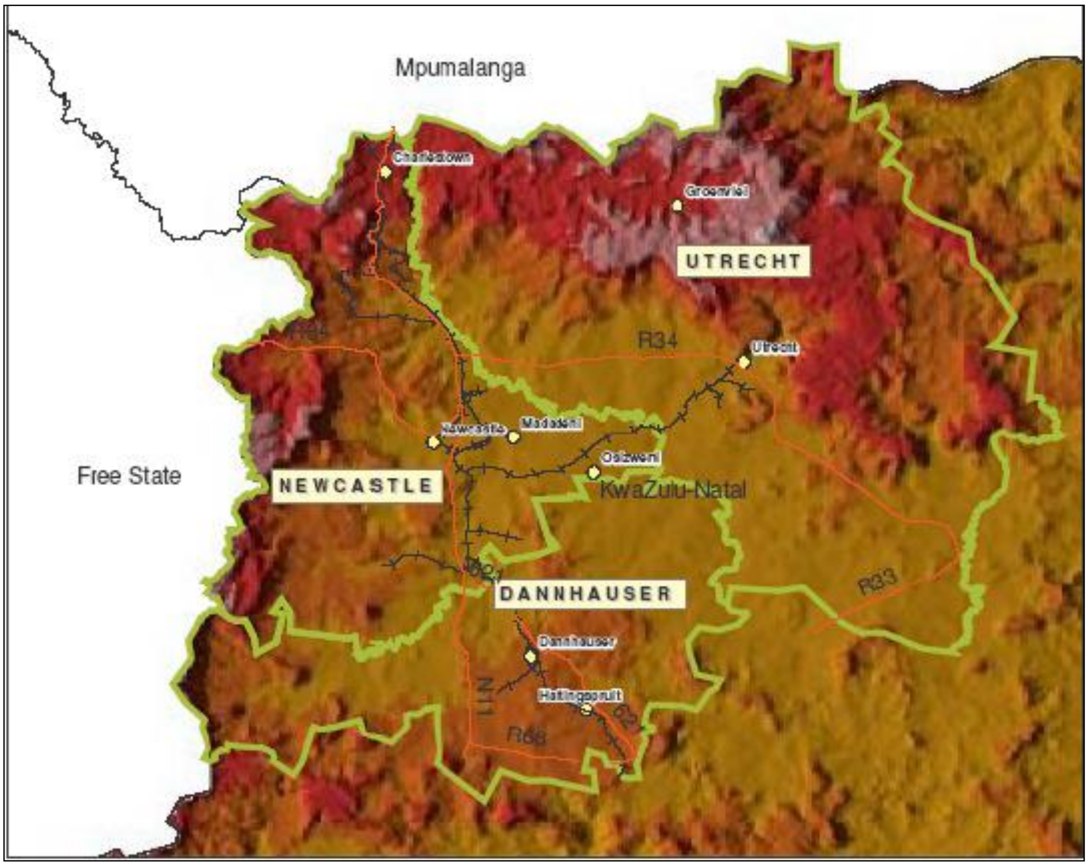

Figure 3.1: Location of Newcastle

Figure 3.2: Location of Muslim Cemetery

3.2Climate

Newcastle lies in the summer rainfall of the country. It enjoys a mild and equable climate. No direct weather observations have been made in the study area itself, but broad weather patterns may be inferred from measurements taken from adjacent areas. Subsidence inversions usually rise above escarpment, resulting in an influx of humid air from the warm Mozambique current of the Indian Ocean, in the form of south easterly winds.

The average rainfall approximately ranges between 410mm to 500mm per annum. Evapotranspiration is extremely high, for instance Bloemfontein pan evaporation ranges between 1 600 – 1 800 mm/annum, due to the existence of semi – arid conditions (*www.weathersa.co.za*). The catchment has an average vegetation index of 40, and is dominated by Nama Karoo and Grassland vegetation occupying close to 90 % of the catchment. Generally flat to shallow terrain associated with very little runoff dominates the study area. Dentritic drainage pattern dominates the study area. Figure 3.2 shows monthly rainfall for Amajuba district.

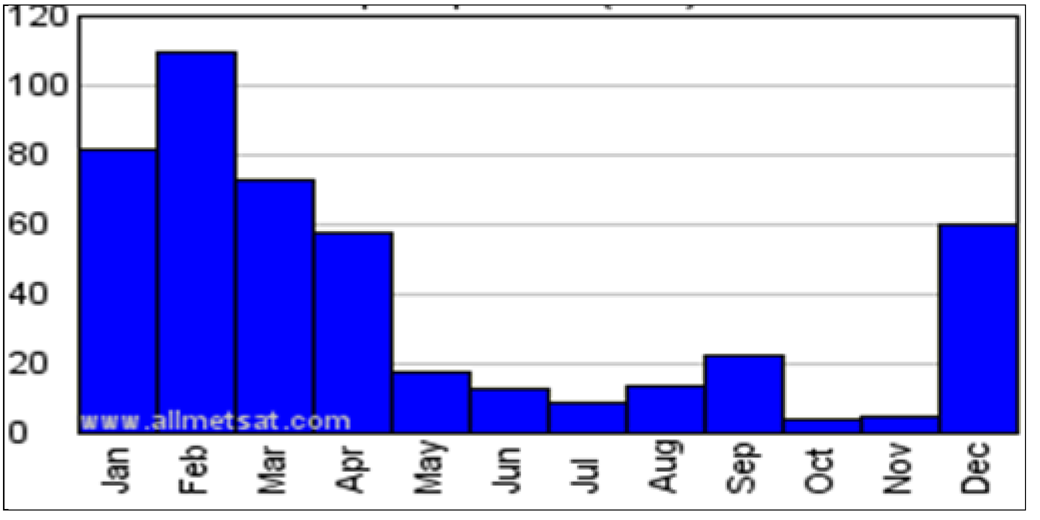

Figure 3.3 Newcastle Precipitation (www.allmetsat.com)

Newcastle also enjoys an average temperature of 16°C, although the temperature ranges from lows of 9°C in winter and highs of 30°C in summer. Rainfall occurs mostly in the summer. It is unpredictable and unreliable and is mostly influenced by moist air moving in from the Indian Ocean in the east and south east.

3.3 Piezometry

Water levels are important in delineating the cemetery catchment area and regular groundwater monitoring gives an insight into the impact of anthropogenic activities on groundwater. The water levels are also useful in determining the area water budget and reflect the input of parameters such as rainfall, surface runoff, and evapotranspiration and infiltration rates.

A piezometric surface was generated from data acquired from National Groundwater Archive. Figure 3.3.3 shows a piezometric surface constructed using the water level records obtained from the National Groundwater Archive. The map shows a regional groundwater level gradient towards the south and also some areas that show that the flow has been disrupted by local pumping. Strategic groundwater monitoring points are required to improve the piezometry understanding and to determine accurate groundwater flow gradients around the cemetery area.

The concentric water level contours at the south western part of Newcastle indicate a local steep gradient towards pumping boreholes. It should be noted that the water levels in the south western part are hydraulic heads due to pumping and do not reflect rest water levels. Rest water levels are expected to be in the range of 5-20 meters below ground level (mbgl). Outside pumping areas, the water levels mimic topographic elevation, indicating that the aquifers in the area are unconfined. The topography-groundwater level relationship can be used to estimate expected groundwater levels for selected elevations.

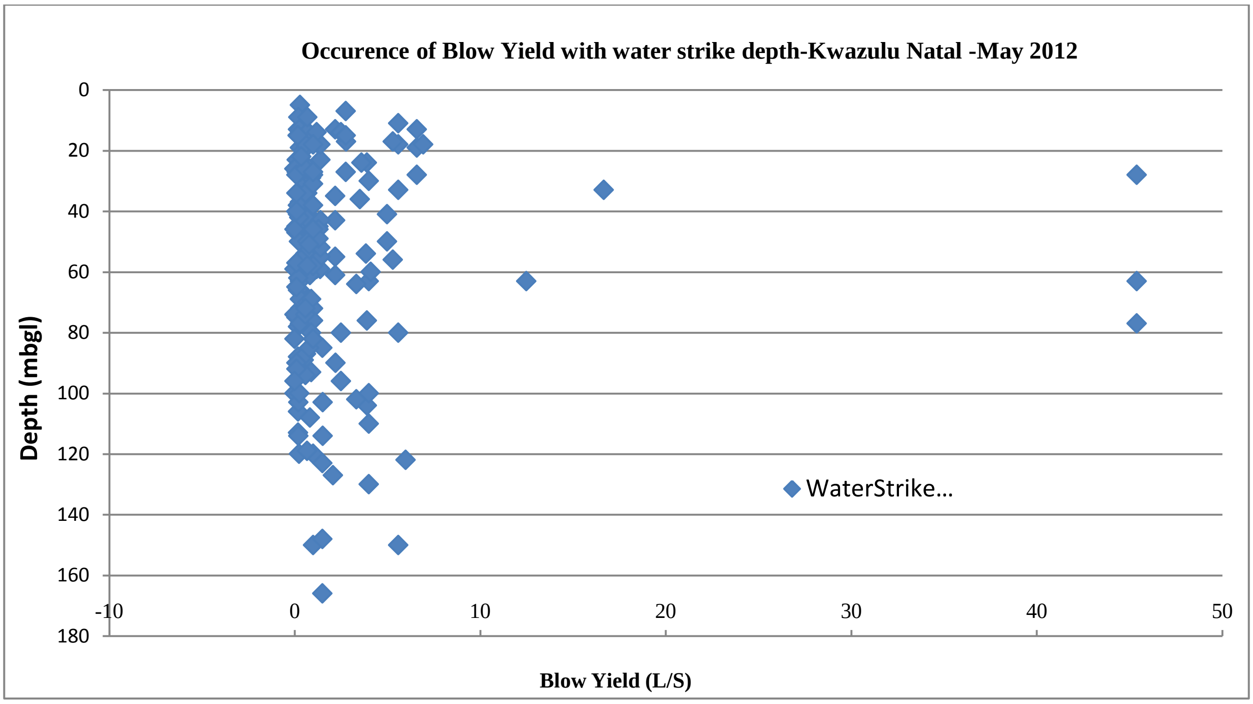

Figure 3.3.2: Occurrence of water strikes and blow yields in Kwazulu Natal.

The frequency distribution of water strike depths is depicted in figure 3.3.2 and clearly show a greater frequency of shallow water strikes coinciding with weathering and associating shallow fracturing. The deep aquifer show a water strike frequency spread throughout the depth range confirming the anisotropic character of the aquifer. Figure 3.3.2 also shows that shallow groundwater levels (<10m deep) exist in the area.

The deep water bearing horizon is controlled by the lateral and vertical distribution of the deeper fractures and weathering within the shales and contact zones between the shales and sandstones. The clay in the Elliot formation could be an aquitard and mostly seepage and very low yields is expected in the clays.

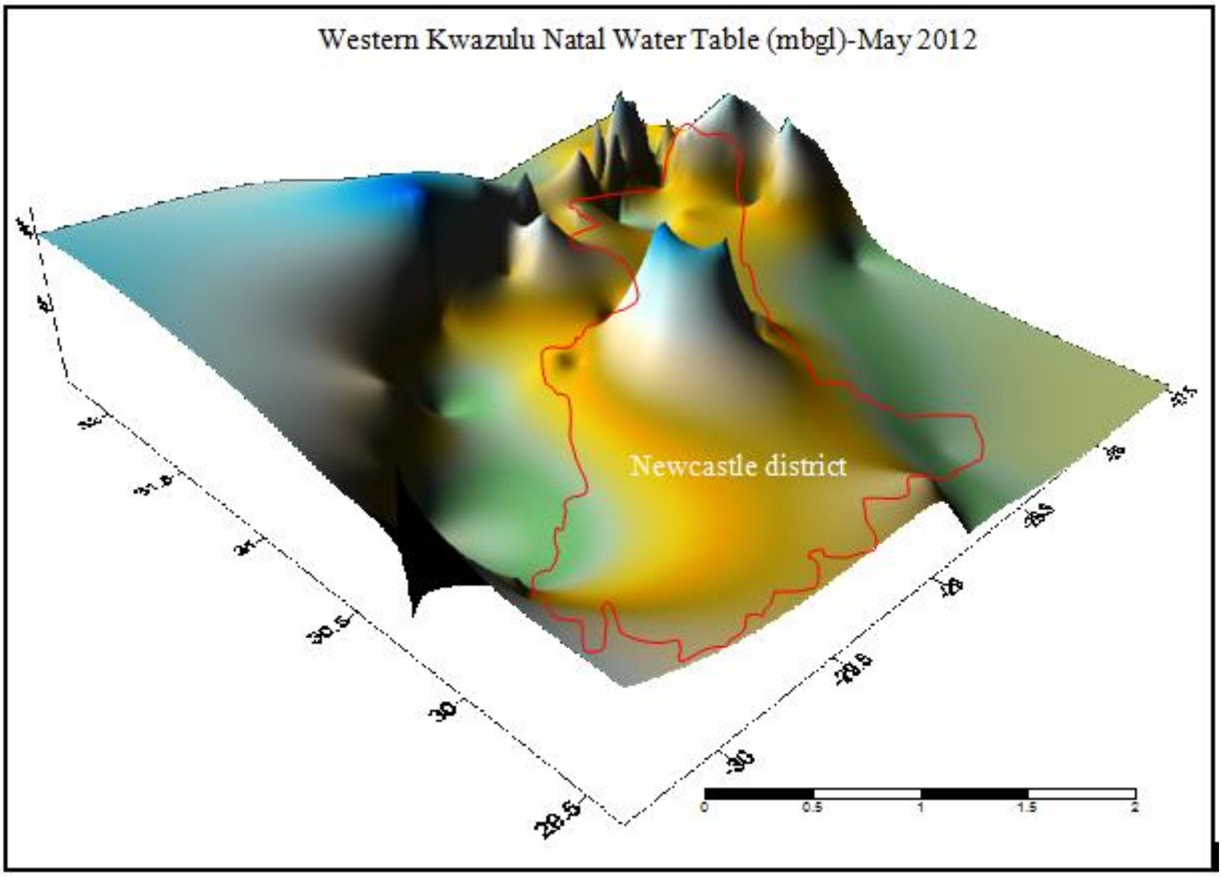

Figure 3.3.3: KwaZulu Natal piezometric surface

Groundwater gradients determined from the water strikes data in the area indicate that groundwater in both the shallow and deep aquifers flows from the elevated areas towards the rivers following the topography closely. The general groundwater flow direction is from north east to south west. The vallies and associated floodplains are relatively flat and groundwater gradients are gentle at 0.005 (1:200) to the extreme east of Newcastle. The area around the south west part of Newcastle proves much steeper groundwater gradients at 0.03 (1:30). The steep gradients could be attributed to current groundwater pumping.

3.4 Recharge

The chloride mass balance method of estimating recharge can be used because of its low cost and reasonable precision. If a steady state is attained between the chloride flux at the surface and the chloride flux beneath the evapotranspiration and the mixing zone, the following mass balance can be defined:

Kafri, H., Phlandt, C. (1984) outlined a method to estimate the recharge to ground water from rainfall using chloride measurements for rainwater and ground water. Chloride is a conservative ion, when water is concentrated by evaporation chlorinity increases.

Knowing the initial chlorinity of rain water in the immediate flushed zone intake area one can calculate the percentage of recharge out of rainfall as follows:

$$\text{Recharge} = \text{P (mm)} * \frac{C1_r \text{ (mg/1)} * 100\%}{C1_{gw} \text{ (mg/L)} - \text{ground water mg/1}}$$

Where P= annual precipitation; Cl_r=chloride in rainfall; Cl_{gw}=chloride in groundwater

The same method was used to estimate recharge in Newcastle area. A value of 9.7 % for recharge from rainfall was calculated using samples from four boreholes. The average rainfall chlorinity for the area was estimated at 1,6 mg/1. The value 1,6 mg/1 is taken as representative of the chloride concentration of the local rainfall. The average ground water chloride content was taken as 16,4 mg/1.

3.5 Water chemistry

3.5.1 Methodology

A total of four groundwater sample analysis data that was obtained from the NGA. Results of water quality data were imported into WISH (Windows Interpretation System for Geohydrologists) and PhreeqC Geochemical Modeling software. WISH and PhreeqC assess the electro neutrality of the data by calculating the charge balance for each sample. The Laboratory analysis percentage error in electro-neutrality of 4.6 % was deemed accurate.

3.5.2 Discussion of chemical characteristics of groundwater

The laboratory groundwater chemical analysis results were plotted on a Piper diagram (Figure 3.5.1). The dominant groundwater type is Calcium – Magnesium-Bicarbonate (Ca-Mg-HCO_3). The water type is typical of recently recharged groundwater from rainfall .The presence of Ca and HCO3 indicates recharge from fresher groundwater from a shallower aquifer, receiving intermittent recharge, enabling flushing of the groundwater system. The hydrochemical analysis results are listed in Table 3.5.1.

Table 3.5.1 Newcastle hydrochemistry (Source: National Groundwater Archive, May 2012)

Site Name/ Analyte	C11_168659	C11_169109	C12_100000369	C11_169107
pH	5.8	7.92	7.20	7.93
EC(mS/m)	43.3	51.6	41.6	32.1
TDS (mg/l)	177.7	241.8	105.3	107.8
Ca (mg/l)	38.7	49.7	35.4	27.5
Mg (mg/l)	10.6	20	11	12
Na (mg/l)	35.6	31.1	26.6	18.0
K (mg/l)	2.74	0.9	6.3	3.3
MALK (mg/l)	334	423	282	243
Cl (mg/l)	19.6	6	23	17
SO4 (mg/l)	9.9	16.1	38.8	10.8
NO3-N (mg/l)	0.02	0.96	2.3	5
F (mg/l)	0.15	0.49	0.10	0.15
Si (mg/l)	14.3	16.86	18.7	15.9

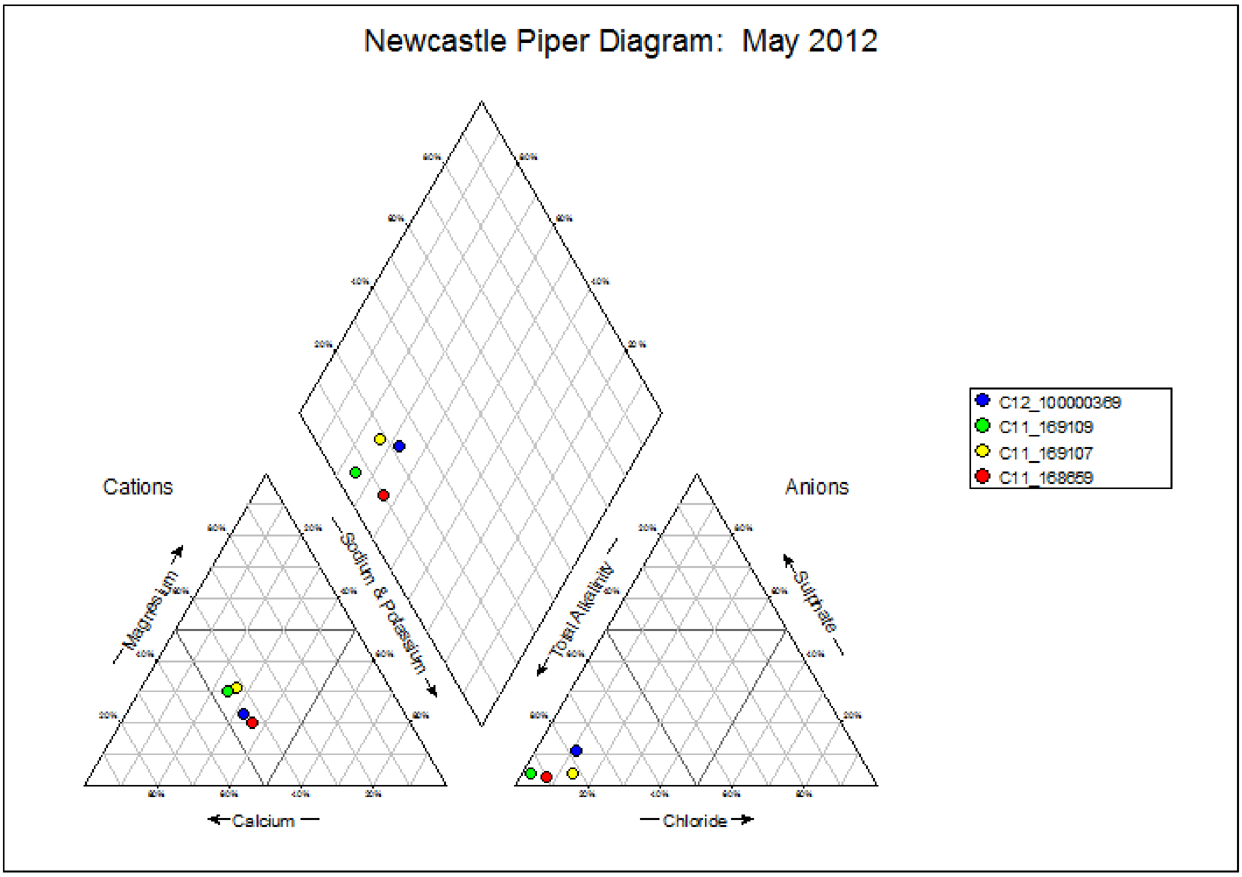

Figure 3.5.1: Newcastle groundwater piper diagram

The sulphate levels in the four borehole samples indicate minimum intrusion of groundwater from a polluted source. The sources of nitrates and sulphates could be fertilizers and cattle dung usually associated with agriculture and livestock farming areas. Evidence of groundwater pollution from sources like industrial or from cattle dung as interpreted from Piper diagram is further confirmed by levels of EC. Solute transport is usually associated with well developed fractured networks and aquifers with highly transmissive matrix.

4 Initial Conceptual Geohydrological model

The conceptual model forms the basis for understanding groundwater occurrence and flow mechanisms. The conceptual model aids in determining the modeling approach and choice of analytical/numerical and solute transport model. The conceptual Geohydrological model uses groundwater monitoring data and Geohydrological interpretation from drilling and test pumping work.

The geological history, hydrostratigraphy, structure and influence on surface drainage pattern, reveals potential groundwater flow channels, likely sources of recharge, and helps delineate Geohydrological boundaries. Geohydrological boundaries constrain the effective groundwater catchment and estimation of quantities of water that flow through rock units.

The conceptual model is discussed below.

4.1 Geohydrological Setting

The Low Drakensburg escarpment, that forms the north-western and northern boundaries of Newcastle, has in some parts been stripped by erosion. The upper part of the escarpment is underlain by dolerite dykes and sills, which are remnants of the feeder pipes through which the magma that formed basalts layers were flowed. Below the dolerite flows are successive layers of sedimentary rocks of the Stromberg, Beaufort and Ecca groups. The rock units have been discussed below.

4.2 Sandstone and siltstone

The shallow depths are characterized by the Clarens Formation containing pale –cloured fine grained sandstone and siltstone. Dinosaur and fish fossils are found in places .The sandstones are porous and highly transmissive hence any water that is recharged is expected to infiltrate into the underlying lithologies.

4.3 Mudstone and sandstone

Below the Clarens Formation are layers of red – maroon to green mudstones, with interbedded sandstones. This 30m thick lithology is slightly weathered, with sub-horizontal fracturing. In some places the formation is vuggy but the spatial distribution of the vugs could increase storativity but low effective porosity. Low effective porosity reduces permeability, therefore where it is unfractured, the clay extremely retard groundwater flow.

Clay layers are in some places found between the mudstone and sandstone layers. The clay layer consists of silty and stiff polished slickensides. The clay could be a product of deep chemical weathering of lackustrine sediments. Clays are naturally porous but of low transmmisivity, this clay layer is expected to be an aquitard.

4.4 Sandstone, Mudstone and shale unit

This unit contains alternating sandstone, mudstone and shale, and minor coal beds, as well as abundant plant and insect and early dinosaur fossil traces; in addition to minor coal seams. A more permeable caps this unit. It is a medium to coarse-grained sandstone primarily of Aeolian origin. The main zone of groundwater movement is through the less permeable matrix, the coarse grained horizons and the sandstone shale contact. The hydraulic conductivity of the sandstone has been estimated to be in the ranges between 0.05m/day and 0.5 m/day.

4.5 Mudstones

The unit comprises mainly gray-green to reddish mudstones, some thick river-channel sandstones, as well as abundant vertebrate fossils. The Permian/Triassic extinction boundary is contained in the Upper Beaufort.The mudstone is moderately fractured at oblique angles to layering with some secondary dissolution cavities. Most of the joints in the mudstone layer are closed and infilled with mainly vein quartz, clay and secondary minerals.

4.6 Ecca shales and sandstones

The unit is dominated by dark shale, sandstone and minor coal layers. Contains remains of Glossopteris flora, and thick coal beds to the north, together with some of the earliest reptile fossils. The shale is moderately fractured at oblique angles to layering with fine secondary dissolution cavities. The cavities/vugs show some degree of interconnectivity, which would enhance groundwater flow.

The major joints trend observed in shale are oblique to bedding plains. These joints represent typical tension joints. The majority of the joints are mainly open providing excellent channels for water transfer between formations. Where closed they are infilled with mainly vein quartz, clay and secondary minerals. Porosity is estimated at less than 5%. Bedding planes and lithological contacts often have permeabilities higher than adjacent lithologies; hence the Sandstone-Shale contact can be more transmissive than the two lithologies.

4.7 Aquifer Vulnerability

Previous drilling work in the area was included noting temperature differences in different lithologies. Very little temperature differences were noted between the shallow and deep aquifers. This could be an indication that groundwater from the top shallow aquifers moves so rapidly into the bottom units hence very limited mixing and temperature equilibration time. This phenomenon is suggestive of a drainage zone where shallow aquifer water upwells from deep levels and vice-versa depending on which zone is colder and warmer.

The water level behavior during drilling show that as we go down from ground level, we go through zones which allow water to be lost from the borehole and therefore fairly permeable. These zones are interspaced with others where groundwater levels rises in a borehole, indicating that they are separated from the draining zones by relatively impermeable thickness of the shallow siltstones and they themselves contain water under great pressure head than the overlying aquifer.

The dominant zones are those where no substantial changes of pressure heads occur with depth, indicating either no flow of groundwater or equipotential surfaces which are essentially vertical, as would occur with horizontal flow. The presence of underflow demostrates that one is dealing with a water level situation controlled by drainage at depth and is not hydrostatic.

The shallow sandstone and siltstones that constitute the shallow aquifers have no barrier from surface water infiltration and pollutant transportation; and therefore could be at risk of being polluted. Elevated levels of sulphates confirm small scale yet active pollution transport. The deep shale and sandstone aquifers are less vulnerable to possible pollutant plume intrusion where the clay restricts hydraulic continuity between the shallow and deep aquifers. Zones of higher permeability associated with the faults, fractures and bedding planes may indicate the presence of potential pathways for the movements of contaminants and provide a localized link between the shallow and deeper aquifers.

Unit No.	Hydrostratigraphic Unit	Formation	Blow out yield (l/s)	Hydraulic conductivity (K) m/d	Transmissivity (T) m^2/d	Storativity (S)	Data source	Comments
1	Sandstone and siltstone	Clarens	12	0.5	-	-	NGA	Effective porosity (n_e) not estimated. More accurate data to be obtained through drilling of pumping boreholes and subsequent aquifer hydraulic testing
2	Mudstone and Sandstones	Elliot	0.5	0.26	-	-	NGA	
3	Sandstone, Mudstone, Shale	Molteno	3	0.42		-	NGA	
4	Mudstones	Beaufort	2	0.1	-	-	NGA	
5	Shale and Sandstones	Ecca	0.3	0.2	-	-	NGA	

Table 4.3.1: Kwazulu Natal Geohydrological parameters(initial conceptualization)

5 Prediction of Plume Development and Impact on Grave Sinking

Despite the fact that the graves are expected to be shallower than 4m deep, ponding of water at the bottom of the excavation is a common consequence of excavating in saturated rocks or soils. Preliminary indication from water level data is that shallow water levels are not exclusive. If shallow water levels are expected then pollution of groundwater from surface or graves is expected.

The upper sandstone layer has been noted to be highly permeable therefore localized grouting to reduce the ultimate flow through the grave will be required. Groundwater elevation recorded as shallow as 10mbgl should be expected at same levels if the areas are not pre-dewatered.

The shale and mudstone have been noted to be fine grained and wide joint spaced; with low groundwater flow rates and is least likely to provide grouting difficulties in grave construction. The siltstone, where recharged, is most likely to be the most problematic due to higher than expected average inflow rates and the anticipated intersection of unconsolidated sandy formations. The red clay layer could also present grouting problems due to its hygroscopic nature.

Dewatering boreholes may be useful:

a. Where weak rock near the face of the grave would be subject to collapse under the action of groundwater pressure

b. Where a grave lining would be subject to excessive hydrostatic loading during back wall grouting.

6 Work Required

The desk study has identified gaps in the initial conceptual Geohydrological model. The data gaps shall be filled with Geohydrological parameters obtained from the site investigation.

The site investigation will comprise

- Drilling of two shallow boreholes
- Test pumping/ slug testing or perform point dilution tests to get aquifer parameters
- Numerical Analytical groundwater flow and contaminant transport model
- Predict pollution plume development

7 Conclusions and Recommendations

The Geohydrological units for the site are summarized as:

Probable aquifers – high groundwater potential

Upper sandstone, shale

Probable aquitards – low to medium groundwater potential

Siltstone

Probable aquicludes – poor groundwater potential/non aquifers

Clay, mudstone

The report is based on regional and provincial Geohydrological data; hence the level of confidence decreases on the risk of pollution plume development. The regional water level is deeper than 5 meters below ground level and basing on this, the pollution risk is reduced if graves are properly plugged/grouted by cement.

During the site visit it was observed that there are graves that have been there for many years, some over a century, but due to limited data in the area the exact impact on water quality could not be determined.

To increase the level of confidence Magalela and Associates would recommend:

- Complete site investigation
- Update of the conceptual model for cemetery site
- If required construct numerical groundwater flow model
- Predict development of pollution plume

Most of the data was obtained from the National Groundwater Archive. An initial conceptual model has been drawn up to guide the site investigation. Hydrochemical data analysis shows an intermediate type of water which is typical of interconnected shallow and deep aquifers. This promotes quick groundwater transfer between aquifers hence quick solute transport.

During the site investigation the site Geohydrologist will collect relevant data from the site for input into the Geohydrological conceptual model. When all information is available from the site investigation, Magalela and Associates will update the initial conceptual Geohydrological model, report on the risks of pollution plume development.

If significant risk or uncertainty is anticipated then Magalela and Associates will recommend a water balance is drawn up then used in an accurate numerical groundwater flow model. The model can then be used to simulate contaminant transport and water management.

Magalela & Associates would like to thank Udidi Project Development Company for the opportunity to present this work. Please use this document as a basis for discussion and we would be pleased to answer any queries.

Yours sincerely

Magalela & Associates.

8 References

1. KZN Groundwater Plan 2008-01-09
2. Amajuba AWSD water quality 2010.04

9 Appendix

BH Name	X	Y	WaterStrike (mbgl)	Blow Yield (L/S)
KZN060885	-30.3639	30.23265	120	1
KZN060885	-30.3639	30.23265	150	1
KZN060884	-30.3437	30.2779	63	4
KZN060884	-30.3437	30.2779	110	4
KZN060884	-30.3437	30.2779	130	4
KZN060886	-30.3434	30.2499	11	5.6
KZN060886	-30.3434	30.2499	18	5.6
KZN060886	-30.3434	30.2499	33	5.6
KZN060886	-30.3434	30.2499	80	5.6
KZN060886	-30.3434	30.2499	150	5.6
KZN070001	-30.1873	29.94315	49	0.8
KZN070002	-30.1871	29.94871	60	0.6
KZN040137	-30.0456	30.62943	41	0.2
KZN040137	-30.0456	30.62943	78	0.2
KZN040152	-30.045	30.62888	5	0.3002
KZN040152	-30.045	30.62888	19	0.3002
KZN040152	-30.045	30.62888	37	0.3002
KZN040152	-30.045	30.62888	66	0.3002
KZN040114	-30.0091	30.06568	24	3.9
KZN040114	-30.0091	30.06568	76	3.9
KZN040114	-30.0091	30.06568	104	3.9
KZN070031	-29.8601	30.96555	63	0.3
KZN040133	-29.81	30.82828	39	0.3
KZN040133	-29.81	30.82828	56	0.3
KZN070030	-29.5815	31.05641	13	6.6001
KZN070030	-29.5815	31.05641	19	6.6001
KZN070030	-29.5815	31.05641	28	6.6001
KZN060007	-29.3357	31.36336	50	5
KZN060008	-29.3323	31.37553	122	6
KZN040136	-29.2296	30.83	47	0.1001
KZN040136	-29.2296	30.83	75	0.1001
KZN040135	-29.229	30.88583	38	0.2001
KZN040135	-29.229	30.88583	88	0.2001
KZN040134	-29.1768	30.76916	38	0.2002
KZN040134	-29.1768	30.76916	66	0.2002
KZN040134	-29.1768	30.76916	92	0.2002
KZN040134	-29.1768	30.76916	113	0.2002
KZN060731	-28.9921	31.34913	46	0.11

KZN060726	-28.9815	31.48996	102	3.33
KZN070048	-28.9693	29.4361	59	1.2
KZN070047	-28.9682	29.43999	57	1.1
KZN060735	-28.9402	31.24838	69	0.38
40129	-28.8902	30.92835	40	0.2
KZN060723	-28.8516	31.30144	90	2.22
KZN040096	-28.8486	30.69172	120	0.25
KZN040132	-28.8453	30.85224	26	0.8
KZN040132	-28.8453	30.85224	42	0.8
KZN040132	-28.8453	30.85224	54	0.8
40132	-28.8453	30.85224	26	0.8
40132	-28.8453	30.85224	42	0.8
40132	-28.8453	30.85224	54	0.8
40130	-28.8349	30.89807	18	1
40130	-28.8349	30.89807	72	1
40130	-28.8349	30.89807	76	1
40131	-28.8141	30.89224	50	0.25
KZN070178	-28.8134	29.36096	13	0.38
40133	-28.8101	30.82829	39	0.3
40133	-28.8101	30.82829	56	0.3
KZN060725	-28.7382	31.47091	33	16.67
KZN040064	-28.7168	30.50558	114	1.52
KZN060721	-28.7106	31.52071	103	1.53
KZN040087	-28.6829	30.53593	36	3.52
KZN040066	-28.6598	30.40293	42	0.61
KZN040079	-28.6513	30.46529	72	0.32
KZN060717	-28.6381	31.53033	29	0.55
KZN060715	-28.6302	31.52205	38	0.42
KZN070067	-28.6088	29.40999	13	0.2
KZN040071	-28.5957	30.41413	60	4.11
KZN040072	-28.5739	30.42588	54	3.85
KZN060727	-28.5626	32.30999	17	2.78
KZN060728	-28.547	32.30083	27	0.13
KZN040075	-28.5454	30.46468	48	1.04
KZN060729	-28.539	32.28808	23	0.13
KZN060719	-28.5042	31.47602	63	12.5
KZN070066	-28.4654	29.70193	9	0.22
KZN060737	-28.4623	32.13697	24	3.61
KZN060832	-28.1964	31.76885	80	2.5
KZN060832	-28.1964	31.76885	96	2.5
KZN070144	-28.1792	31.39402	30	0.5
KZN070144	-28.1792	31.39402	72	0.5
KZN060830	-28.1598	31.78921	27	0.3

KZN060830	-28.1598	31.78921	69	0.3
KZN060829	-28.1295	31.7641	34	0.7
KZN060829	-28.1295	31.7641	70	0.7
KZN070149	-28.1276	31.63441	17	0.67
KZN070145	-28.1258	31.36402	20	0.47
KZN060828	-28.1249	31.74966	42	0.9
KZN060828	-28.1249	31.74966	93	0.9
KZN070117	-28.1157	31.70694	13	2.2
KZN070117	-28.1157	31.70694	61	2.2
KZN070154	-28.1107	31.67183	127	2.08
KZN040146	-28.1063	31.86755	15	0.5
KZN040146	-28.1063	31.86755	89	0.5
KZN070152	-28.088	31.6933	59	1.38
KZN070150	-28.085	31.76905	61	0.83
KZN070146	-28.0704	31.30691	43	0.86
KZN070113	-28.0662	31.79033	114	0.22
KZN070112	-28.0571	31.70602	35	2.2001
KZN070112	-28.0571	31.70602	43	2.2001
KZN070112	-28.0571	31.70602	55	2.2001
KZN070107	-28.0552	31.78144	59	0.0002
KZN070107	-28.0552	31.78144	74	0.0002
KZN060762	-28.0031	31.80544	29	0.9001
KZN060762	-28.0031	31.80544	69	0.9001
KZN060762	-28.0031	31.80544	80	0.9001
KZN060747	-27.9969	31.75989	119	0.67
KZN040145	-27.8819	31.61728	28	45.4
KZN040145	-27.8819	31.61728	63	45.4
KZN040145	-27.8819	31.61728	77	45.4
KZN060792	-27.875	31.85136	106	0.2
KZN070103	-27.8714	31.67069	45	0.11
KZN040141	-27.8647	31.63284	18	1.3
KZN040141	-27.8647	31.63284	45	1.3
KZN040143	-27.8647	31.64284	13	0.3
KZN040144	-27.8641	31.642	13	0.6
KZN040144	-27.8641	31.642	54	0.6
KZN060833	-27.8638	31.95025	34	0.6
KZN060833	-27.8638	31.95025	42	0.6
2731DC00124	-27.8577	31.63339	14	2.5
KZN060789	-27.8479	31.9725	56	0.36
KZN060826	-27.8447	31.78947	85	1.5001
KZN060826	-27.8447	31.78947	123	1.5001
KZN060826	-27.8447	31.78947	148	1.5001
KZN060826	-27.8447	31.78947	166	1.5001

KZN040158	-27.8434	31.79311	23	1.4
KZN040158	-27.8434	31.79311	55	1.4
KZN040156	-27.8405	31.78339	87	0.62
KZN060827	-27.8383	31.78228	40	0.1
KZN070098	-27.8359	31.67311	42	0.27
KZN060798	-27.8355	31.93447	18	1.4
KZN060798	-27.8355	31.93447	43	1.4
KZN060798	-27.8355	31.93447	52	1.4
KZN060794	-27.8338	31.89681	13	0.27
KZN060756	-27.8329	31.76506	62	0.22
KZN060799	-27.8329	31.95256	14	0.7
KZN060799	-27.8329	31.95256	50	0.7
KZN060796	-27.8155	31.90345	26	0.0002
KZN060796	-27.8155	31.90345	100	0.0002
KZN070100	-27.8037	31.60472	26	0.0002
KZN070100	-27.8037	31.60472	82	0.0002
KZN070099	-27.7961	31.59589	77	0.3001
KZN070099	-27.7961	31.59589	92	0.3001
KZN060803	-27.7959	31.97378	18	6.94
KZN070102	-27.791	31.58864	74	0.6
KZN070102	-27.791	31.58864	94	0.6
KZN060802	-27.79	31.97178	28	0.1001
KZN060802	-27.79	31.97178	65	0.1001
KZN060743	-27.7856	31.87045	15	0.17
KZN060810	-27.7356	31.84734	90	0.1
KZN060814	-27.7246	31.77714	18	0.6
KZN060814	-27.7246	31.77714	26	0.6
KZN060814	-27.7246	31.77714	72	0.6
KZN060815	-27.7179	31.78389	7	2.76
KZN060815	-27.7179	31.78389	15	2.76
KZN060815	-27.7179	31.78389	27	2.76
KZN060808	-27.7046	31.85253	22	0.36
KZN060817	-27.7029	31.78756	46	1.3
KZN060817	-27.7029	31.78756	49	1.3
KZN060818	-27.69	31.77256	41	5
KZN060805	-27.668	31.86806	40	0.1
KZN060804	-27.6659	31.86936	51	0.8
KZN060804	-27.6659	31.86936	85	0.8
KZN070093	-27.6609	31.41153	64	3.33
KZN060822	-27.66	31.80795	15	0.17
KZN060819	-27.6586	31.78678	108	0.83
KZN070091	-27.6577	31.17617	28	1
KZN070091	-27.6577	31.17617	38	1

KZN060820	-27.6409	31.78984	14	1.2
KZN060806	-27.6361	31.86745	31	1
KZN060806	-27.6361	31.86745	58	1
KZN060806	-27.6361	31.86745	82	1
KZN060807	-27.6329	31.87803	17	5.3
KZN060807	-27.6329	31.87803	56	5.3
KZN070090	-27.6284	31.1367	103	0.22
KZN070092	-27.626	31.22195	30	4
KZN070092	-27.626	31.22195	100	4
KZN060824	-27.612	31.79742	18	1
KZN060824	-27.612	31.79742	27	1
KZN060824	-27.612	31.79742	46	1
KZN070094	-27.5948	31.45845	100	0.27
KZN060825	-27.5926	31.82189	34	0.1002
KZN060825	-27.5926	31.82189	57	0.1002
KZN060825	-27.5926	31.82189	92	0.1002
KZN070088	-27.586	30.73653	9	0.7
KZN070088	-27.586	30.73653	58	0.7
KZN070095	-27.4712	31.92761	46	0.0002
KZN070095	-27.4712	31.92761	96	0.0002