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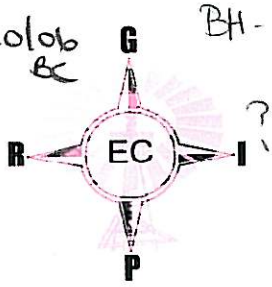

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SOURCE REF NR:	AD 018	Own Archive		Copy attached	X
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A: SOURCE DESCRIPTION

District Municipality:	Amatole	X	Chris Hani		O.R Tambo	
	Ukhahlamba		Cacadu		Alfred Nzo	
Local Municipality:	GREAT KEI					
Institution where Information is held:	AD GEO CONSULTANTS					
Branch of Institution:						
Contact details: Contact person:	A. VAN ROOYEN					
Contact Tel:	043 7268868					
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B: TYPE OF INFORMATION

Information format:	Hard copy	X	Data Summary		Electronic Report	
	Specify Other:					
Report / Info Title:	KHAMANGA BAY RESIDETIAL DEVELOPMENT - BULK WATER SUPPLY STUDY					
Report Nr:	AD/012/03		Date:	31-Jul-03		
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Author's Qualification:	Hydrogeologist		Govt Dept		Project Manager	
	Engineer		Technician	X	Other	
	Specify Other:					
Captured by:	R MAMPURU	Date:	13/02/2004	Signed:		

C: GEOHYDROLOGICAL CATEGORIZATION

Project Type	Source development	X	Feasibility Study		Sanitation Study:	
	Specify Other: Waste Disposal					

Reference Co-ordinate:	Latitude	Longitude
	32.85041667	28.11641667

	Yes	No	Complete	Incomplete
Lithological & Construction Logs	X		X	
Hydrocensus Data	X		X	
Pump Testing Data	X		X	
Chemical Water Analysis Data	X		X	
Geohydrological Data	X		X	
Spring Data		X		
Remote Sensing Data		X		
Map Data	X		X	

Comments: ONE VOLUME ONLY

Reviewed by: A VAN ROOYEN Date: 13/02/2004 Signed:

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KHAMANGA BAY RESIDENTIAL DEVELOMENT BULK WATER SUPPLY STUDY REPORT FOR THE PROPOSAL CALL FOR THE FEASIBILITY STUDY AND PILOT PROJECT ON THE GROUNDWATER POTENTIAL

AMATOLE DISTRICT MUNICIPALITY (DC13)

GREAT KEI LOCAL MUNICIPALITY

EAST LONDON MAGISTERIAL DISTRICT

Attention: Mr. Tony Kriel
Port Ferry 71 (PTY) LTD

Author: A.J. van Rooyen
Date: 31 July 2003
Technical Report No: AD/012/03
Project No: AD/006/03

KHAMANGA BAY RESIDENTIAL DEVELOPMENT

BULK WATER SUPPLY STUDY

REPORT FOR THE PROPOSAL CALL
FOR THE FEASIBILITY STUDY AND PILOT PROJECT
ON
THE GROUDWATER POTENTIAL

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ABBREVIATIONS

° C	Degrees Celsius
CMAs	Catchment Management Agencies
DECAS	Department of Environmental and Cultural Affairs and Sport
DEM	Digital Elevation Model
DWAF	Department of Water Affairs and Forestry
EC	Electrical conductivity
EIA	Environmental Impact Assessment
ESE	East south-east
EVT	Evapotranspiration
GIS	Geographic Information System
IGS	Institute for Groundwater Studies
k	permeability
km	kilometer
m	metre
m^2	square meter
MAI	Mean Annual Infiltration
MAP	Mean Annual Precipitation
MAR	Mean Annual Run-off
mg/l	milligram per litre
Mm^3	Million cubic metres
mS/m	millisiemens per metre
n	porosity
NW	North West
NWA	National Water Act
S	storativity
SE	South East
S_s	specific storage
WNW	West north-west
WRC	Water Research Commission
WRYM	Water Resources Yield Model
WSDP	Water Services Development Plan
WUA	Water User Associations

GLOSSARY

Unconfined aquifer : An aquifer in which the water table (i.e. the top of the saturated zone at which pore water pressure is at atmospheric pressure) is free to fluctuate.

Confined aquifer : An aquifer which is overlain by a confining layer of significantly lower permeability which restricts vertical movement of water and contains the groundwater under pressure greater than atmospheric pressure. If the aquifer is penetrated, the water level may rise above the top of the aquifer, and even above the ground surface, to reach its potentiometric level on an imaginary surface representing pressure or hydraulic head in the artesian aquifer, analogous to the water table of an unconfined aquifer.

Aquifer : A consolidated or unconsolidated geologic unit (material, stratum, or formation) or set of connected units that yield a significant quantity of water of suitable quality to wells or springs in economically usable amounts.

Aquitard : a geologic material, stratum, or formation of low permeability (a confining unit) that transmits significant amounts of water on a regional scale or over geologic time.

Aquiclude : a geologic material, stratum, or formation that contains water (i.e. has porosity) but does not transmit it (i.e. has zero or negligible permeability).

Specific storage : The volume of water that a unit volume releases from or takes into storage when the pressure head in the unit volume changes a unit amount.

Storativity : The volume of water an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of pressure head normal to that surface.

REPORT TITLE: The Potential for Exploiting Groundwater

KHAMANGA BAY RESIDENTIAL DEVELOPMENT

WATER SUPPLY STUDY

REPORT FOR THE PROPOSAL CALL
FOR THE FEASIBILITY STUDY AND PILOT PROJECT
ON
THE POTENTIAL FOR EXPLOITING GROUND WATER

EXECUTIVE SUMMARY

The Amatole District Municipality is responsible for water demand management in the Amatole District of the Eastern Cape.

Khamanga Bay is a private residential country estate being developed at Moonshine Bay near Cintsa West. One of the keystones to the development is a sustainable water supply of good quality. A total of 241 plots are to be developed with an estimate water need of 1200 l/d per plot (289 m^3 /day or 3.35 l/s on a 24 hour pump cycle).

The undesirable levels of water supply risk in terms of quantity and especially quality at all the existing developments, in this region, along the coast are a critical restraint that threatens the viability of the development. The development agency thus initiated this study to investigate the following options to ensure an adequate supply of water:

- Ground water (borehole) development
- Bulk water supply from Amatole District Municipality
- Desalination

The purpose of this study was to investigate the above three options at a pre-feasibility level as a first phase, and to ensure that all major issues relating to them are identified, so that they may be addressed in a subsequent phase. The results from this study should enable recommendations to be made on the phasing of the development of future raw water supply sources.

The important aspects concerning the groundwater (borehole) option, and contained in this report, are summarized below:

- To produce water from a large subterranean reservoir (aquifer);
- To obtain fundamental information about hydrogeological properties and parameters in the aquifer, and its interaction with related systems, in preparation for possible future expansion;
- To set up a coordinated management and monitoring system to address the medium- to long-term uncertainties about sustainability, impact on the environment and existing usage, either surface or groundwater;

Hydrogeology of the investigated area

- The area designated for further groundwater-directed investigation forms part of the R30B quaternary sub-catchment.
- The project area is located in hilly terrain along the coast, where mean annual precipitation (MAP) was calculated to be ~900 mm/a.
- The Beaufort Group is the geologically dominant unit in the catchment, and is divided into two subgroups, namely,
    - Tarkastad Subgroup

o Adelaide Subgroup
Sand, dune sand and dune rock borders the sea.

- Two areas of existing abstraction with acceptable water qualities were identified. The first area (Existing 1) is located directly east of the development and supplies the existing three houses on the development. The second area (Existing 2) is located in the Inkwenkwezi Game Reserve.
- Two target areas were identified for exploration. Target area 1 is located south of the development in a ravine and has a southeast-northwest orientation. Target area 2 is and elongated area just inland from the coastal dunes to the north of the development (See the project map).

Critical Data

- Several methods from the Recharge Program written by the IGS were used to estimate the recharge in the area. An infiltration proportion of 4.3% of MAP was derived.
- There is one existing borehole of good quality in Existing Area 1. The recommended abstraction for this borehole is 17.28 m^3/d. The recharge area was calculated to be ~ 0.2982 km^2 resulting in potential annual recharge of 0.0115 Mm^3/a or 31.6 m^3/d.
- Two boreholes of good water quality are available in Existing Area 2. The recommended abstraction form these boreholes BH9 and BH11 are 25.92 and 30.24 m^3/d respectively. Borehole BH9 is currently in use by the reservation at a rate of 10.8 m^3/d. There is thus spare capacity and further exploration is possible in this area. This area is however far from the proposed development.
- The water quality of the boreholes drilled in Target Area 1 proved to be unsuitable for human consumption over an extended period. Treatment of this water is an option. The equipment of borehole Kham2 is however recommended. This water can be utilized in the construction of the roads, houses etc. This would help to alleviate stress on the fresh water source in Target Area 2.
- The water quality in Target Area 2 is acceptable and a single borehole (Kham 6) is available for abstraction. The recommended abstraction rate for this borehole is 64.8 m^3/d.
- The catchment for Target Area 2 was calculated to be ~1.916 km^2 resulting in potential annual recharge of 0.074 Mm^3/a or 203.26 m^3/d.
- Local confined aquifer drawdowns much larger than 10 m are possible at well sites, without impacting in any way on the aquifer's saturated thickness. However to protect the freshwater aquifer and to ensure that the surrounding cone of depression do not adversely affect base flow we restricted the recommended abstraction rate to ensure a maximum drawdown of less than 10 m. Subsequently only borehole Kham 6 is recommended for abstraction at a rate of 0.75 l/s for a 24 hour pumping period. This ensures an adequate supply for 54 plots.
- This leaves a shortage for the development as a whole but provides enough water for the initial development. See the table below for an example of the typical developmental pace (water need) for this kind of development.

Table 1: Expected developmental progress

Period:	No. of registered plots for the period	No of houses built for the period	Total no of houses built up to end of the period	Estimated water need (m^3/d)*
01/12/2003 to 01/12/2004	90 Plots	5 Houses	5 Houses	6.0
01/12/2005	120 Plots	7 Houses	12 Houses	14.4
01/12/2006	150 Plots	11 Houses	23 Houses	27.6
01/12/2007	180 Plots	13 Houses	36 Houses	43.2
01/12/2008	210 Plots	14 Houses	50 Houses	60
01/12/2009	240 Plots	15 Houses	65 Houses	78

* This estimation do not take into account the water needed for the building of the houses, roads etc.

The Water Services Development Plan (WSDP) of Amatole District Municipality plan to provide bulk water to Cintsa West by the year 2007.

Failure to supply bulk water by this date will mean that the supply from Target Area 2 will have to be augmented by:

- Introducing a water treatment plant. A more than adequate supply of water is available from Target Area 1 for this purpose or,
- Exploration in Existing Area 2 and the laying of a pipeline to the development.
- Increased abstraction from Existing Area 1 is not recommended since the recharge to the aquifer system is limited.
- Increased abstraction from Target Area 2 might be feasible at this stage if the rainfall, abstraction and water level monitoring data indicate potential to do so.

Technical Constraints

- There are no drilling or pumping technology limitations to the exploration
- Borehole design considerations dictate that the boreholes be effectively and permanently cased, to the depth of solid rock. Pvc casing and screens was installed in the production boreholes.
- The potential for easy and relatively inexpensive connections to existing water-supply infrastructure was an important consideration in the selection of the most appropriate sites.

Environmental Constraints

- Efforts and resources should be spent on a monitoring programme. Monitoring boreholes were drilled in Target Area 1 and 2 for this purpose.
- The impact on the environment is likely to be as much a function of appropriate management as of the numerous relevant variables other than the actual groundwater abstraction. A little-discussed risk is the decision-making process and the ecosystem knowledge base required to switch pumps off timeously, if the impact resulting from groundwater abstraction is considered unacceptable.
- Possible water-quality considerations could include: Impacts on the freshwater ecosystem waters related to either abnormally-high or abnormally-low concentrations of key constituents.
- Disruption to the nutrient contribution to the ocean via the aquifer (unlikely).

Legal and Societal Aspects

- The National Water Act (No. 36 of 1998) and the Water Services Act (No. 108 of 1997) now govern the use of water. The latter imposes certain responsibilities upon (new) local authorities for the town of Cintsa-West. Enquiries should be made about the current status of their planning and how these might be impacted upon by the proposed development.
- An Environmental Impact Assessment (EIA) would be required in order to inform the authorities as to the likely environmental implications of the proposed development. Involvement of interested and affected parties is integral to the EIA process. The competent authority would be the provincial Department of Environmental and Cultural Affairs and Sport, if the applicant were a private company or local authority, and the national Department of Environmental Affairs and Tourism, should the applicant be a provincial or national government department.

1. INTRODUCTION

1.1 TERMS OF REFERENCE

AD Geo Consultants was appointed to investigate the supply of water to the Khamanga Bay development from groundwater sources.

The aims of the study were as follows:

- To document all relevant geohydrological data
- To evaluate and comment on the current groundwater sources
- To evaluate and recommend alternative groundwater supply sources

1.2 SCOPE OF THE INVESTIGATION

The following actions were undertaken in order to reach these aims:

- A hydro census in and around the Khamanga Bay development.
- Data collection, and the evaluation of historical data
- Evaluation of structural geology
- The evaluation of the results of yield tests conducted at existing boreholes located in the vicinity of the development
- The identification and evaluation of areas exhibiting groundwater potential
- The drilling of exploration boreholes in these areas for the supply of groundwater to the development
- To evaluate the yield characteristics of the highest yielding exploration borehole(s)
- To evaluate the groundwater quality at the highest yielding borehole(s) with regards to drinking water
- Supervision with regards to the development of new groundwater sources
- To compile a comprehensive geohydrological report that details all methodology, results and utilisation recommendations

1.3 LOCATION OF THE STUDY AREA

The development of Khamanga Bay is located at Moonshine Bay near Cintsa-West in the Great Kei Local Municipality of the Amatole District Municipality.

The natural vegetation cover in and around the development has generally been removed. The study area is indicated by the locality map.

2.0 DESK STUDY

2.1 INFORMATION SOURCES

The following sources of information were referenced:

Geology map

- Geological map of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland, 1997; scale 1: 1 000 000.
- 3228 KEI MOUTH, 1979; scale 1 : 250 000.

Topographical map

- 2328 CC GONUBIE, Fifth Edition, 1996; scale 1 : 50 000.

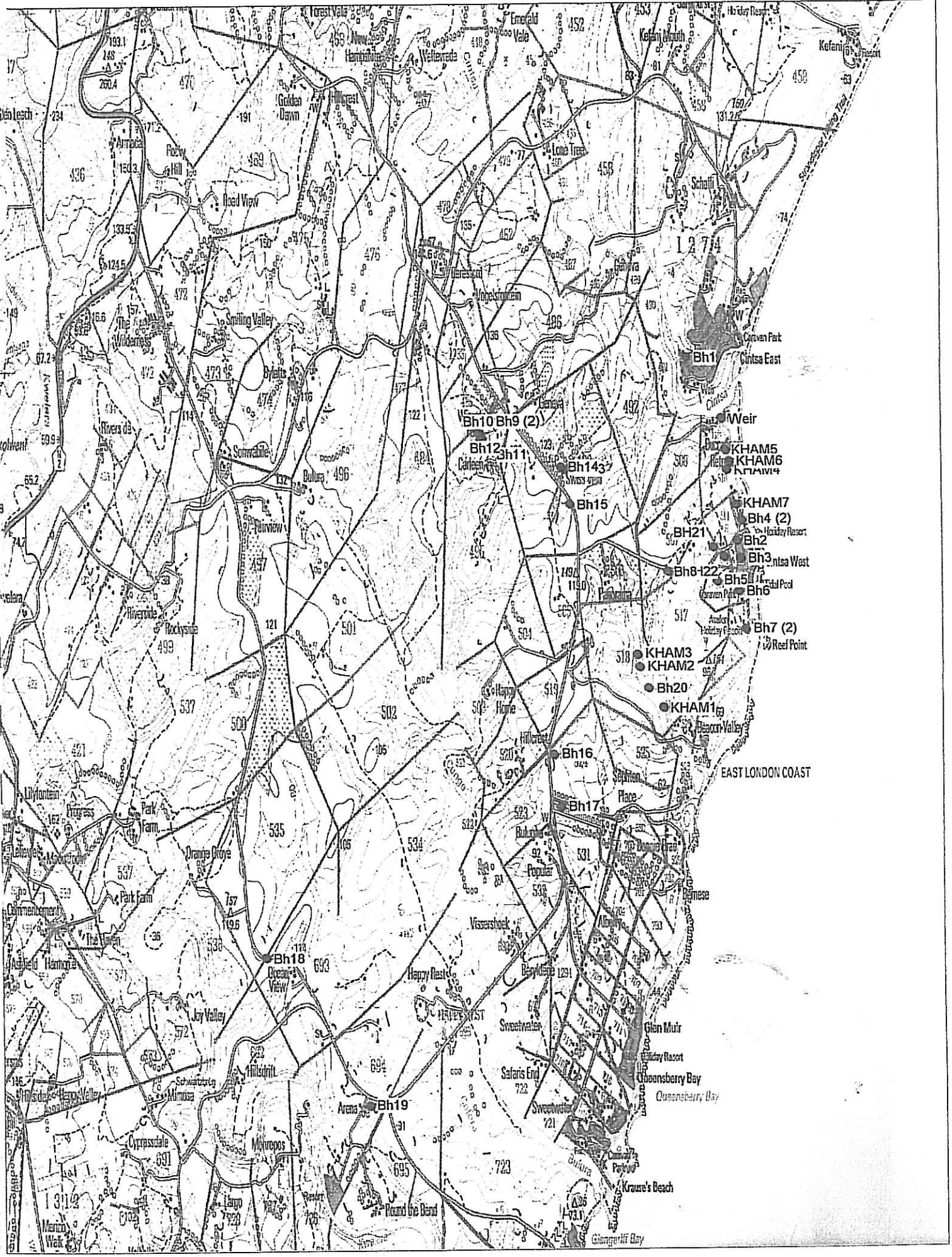
2.2 DESK STUDY RESULTS

A generalized impression of the geological setting of the study area was obtained from the available geological maps, with more detailed information obtained from topographical maps and regional mapping during a site visit.

A localised hydrocensus revealed the presence of twenty existing boreholes in the immediate vicinity of the study area (Figure 2). Of these thirteen boreholes is motorised (5 with Mono pumps and 8 with submersibles), Four are unequipped and three are deemed destroyed/dry. See Appendix A.

Two target areas were identified in the study area. One is located to the north of the development and one to the west of the development. These target areas were further investigated by means of geophysical surveys.

FIGURE 1: KHAMANGA BAY DEVELOPMENT - LOCATION MAP



3. EXISTING INFORMATION

3.1 SURFACE WATER SOURCES

The development is ~2 km south of the Cintsa River. There are no perennial steams or other significant surface water sources in the vicinity of the development. Several small west-east trending non perennial streams sustained by small earth dams divide the investigated area.

Surface water is therefore not deemed to be freely available for domestic or industrial use.

3.2 GROUNDWATER SOURCES

A detailed borehole survey was undertaken in the area as indicated by Figure 2.

Details regarding the results of the hydro census are given in Appendix A, while the detailed results of pump- and chemical tests are given by Appendices B and C respectively.

Two areas of existing abstraction with acceptable water qualities were identified. The first area (Existing 1) is located directly east of the development and supplies the existing three houses on the development. The second area (Existing 2) is located in the Inkwenkwezi Game Reserve.

The following existing production boreholes were identified within these areas:

- **Borehole Bh7 (Existing Area 1)**

  Yield characteristics

  The yield characteristics of this borehole were tested by means of a stepped discharge- and recovery test conducted in the period between June, 25 and 26, 2003.

  The static groundwater level was located at a depth of 7.08 m below the datum level[1] at the time of testing. The test pump was placed at a depth of 67.0 m below the datum level, with a total borehole depth of 104.0 m being recorded.

  - Stepped discharge test
    This test comprised two 60-minute steps conducted at yields of 0.25 and 0.5 L/s respectively. A maximum drawdown of 59.92 m was achieved during the test.

  - Recovery test
    The groundwater level recovered to 93.12% of its original level after a period of 2 hours (120 minutes).

  Groundwater quality

  A groundwater sample was taken and submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

  The groundwater classifies as:

  - Domestic use: Class 2 Water of marginal quality

[1] Taken as a distance of 0.37 m above the ground surface.

The borehole is currently in use and equipped with a submersible pump.

❑ **Borehole Bh9 (Existing Area 2)**

Yield characteristics

The yield characteristics of this borehole were tested by means of a stepped discharge-, constant discharge- and recovery test conducted in the period between June, 30 and July, 5 2003.

The static groundwater level was located at a depth of 32.49 m below the datum level[2] at the time of testing. The test pump was placed at a depth of 89.8 m below the datum level, with a total borehole depth of 115.0 m being recorded.

- Stepped discharge test
  This test comprised of three 60-minute steps conducted at yields of 0.39, 0.54 and 1.02 L/s respectively. A maximum drawdown of 57.31 m was achieved during the test.

- Constant discharge test
  This test was conducted at an average yield of 0.5 L/s for a period of 72 hours (4320 minutes). A maximum drawdown of 23.25 m was achieved during the test, which translates to approximately 41 percent of the available drawdown.

- Recovery test
  The groundwater level recovered to 94.19% of its original level after a period of 35 hours (2100 minutes).

Groundwater quality

A groundwater sample was taken and was submitted to Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 2 Water of marginal quality

The borehole is currently in use and equipped with a submersible pump.

❑ **Borehole Bh11 (Existing Area 2)**

Yield characteristics

The yield characteristics of this borehole were tested by means of a stepped discharge-, constant discharge- and recovery test conducted in the period between July, 14 and 19, 2003.

The static groundwater level was located at a depth of 13.14 m below the datum level[3] at the time of testing. The test pump was placed at a depth of 53.0 m below the datum level, with a total borehole depth of 64.9 m being recorded.

2 Taken as a distance of 0.61 m above the ground surface.

3 Taken as a distance of 0.28 m above the ground surface.

- Stepped discharge test
  This test comprised two 120-minute steps conducted at yields of 0.52 and 1.83 L/s respectively. A maximum drawdown of 39.86 m was achieved during the test.

- Constant discharge test
  This test was conducted at an average yield of 0.58 L/s for a period of 72 hours (4320 minutes). A maximum drawdown of 23.15 m was achieved during the test, which translates to approximately 58 percent of the available drawdown.

- Recovery test
  The groundwater level recovered to 99.8% of its original level after a period of 36 hours (2160 minutes).

Groundwater quality

A groundwater sample was taken and was submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 2 Water of marginal quality

The borehole is currently unused and equipped with an old mono pump. It used to supply water to a tomato packaging plant.

4. GENERAL GEOLOGY AND GEOHYDROLOGY

4.1 REGIONAL GEOLOGICAL SETTING

The Beaufort Group is the geologically dominant unit in the catchment, and is divided into two subgroups, namely,

- Tarkastad Subgroup
- Adelaide Subgroup

Sand, dune sand and dune rock borders the sea.

The Tarkastad Subgroup consists of the Burgersdorp and Katberg Formations. The Burgersdorp Formation consists mainly (70-80%) of brownish-red and grey mudstone. Sandstone layers are typically 2 to 3 m thick. The Katberg Formation consists of mainly (~90%) sandstone. The sandstone is fine-grained to medium-grained, horizontally laminated, cross-bedded or massive.

The Adelaide Subgroup consists of grayish-green and brownish-red mudstone interspersed with multi-layered river channel stones. The sandstone to mudstone ratio is of the order of 1:2.

Dolerite sheets occurring in the area are superficial and related to dyke intrusions.

4.1.1 Structure of the area

Faulting:	Two major east-west striking hinge faults occur to the north of the development. Their downthrows are the south along the coast but diminishes inland and dies out within 20 km.
Folding:	Variations in dip steepness and direction occur locally next to some intrusions. Dips increase in the faulted areas at the coast and are mainly eastward.
Fracturing:	Localized fracturing associated with dolerite intrusions occur within the dolerite and the host rock. Fractures also form as a result of weathering, tectonic forces and stress release on unloading by denudation. Lithological boundaries often represent opportunity when there is local flexure and rock competence contrasts.
Weathering:	Climate conditions and rock type influence the intensity and mode of weathering. Decomposition due to chemical weathering prevails in the area. The weathered zone is not expected to exceed 30 m in depth.
Stress regime:	The maximum horizontal compression is NW-SE trending in the area – Andreoli *et al*(1996). NW-SE trending structures are thus likely to be in tension (open) and those at right angles to this in compression (closed)

Gay (1975) concluded that horizontal stresses tend to be larger than vertical stress at shallow depths. At greater depths the vertical stress is nearly twice those acting horizontally. This implies that horizontal fractures are more likely to be open at shallow depths but closed deeper down due to increasing load pressure.

Given the NW-SE maximum horizontal stress The NW-SE trending (vertical) fractures are most likely to be open at depth.

4.2 HYDROGEOLOGY

Groundwater occurs mainly in the rock matrix. Principal Transmissivity is derived from large but infrequent fractures. These fractures have a relatively low storage capacity. Secondary Transmissivity occur by numerous micro fissures with higher Storativity but lower Transmissivity; hence the name "Dual Porosity Aquifers". Deeper fractures often have a higher Transmissivity but lower Storativity

than shallow fractures. Groundwater abstracted from deeper fractures via boreholes, or other means, is replenished by downward leakage.

Yields of up to 2.00 l/s are obtainable but can be as high as 12.00 l/s in exceptional cases in fractured sedimentary rock. The norm would however be in the order of 1.50 l/s. The influence of dolerite intrusions raises the average yields in fractured sedimentary rock and approximately 20% of the boreholes targeting dolerites yield more than 5.0 l/s.

Several methods from the Recharge Program written by the IGS were used to estimate the recharge in the area. An infiltration proportion of 4.3% of MAP was derived.

5. BOREHOLE SITING

5.1 METHODOLOGY

The initial procedure comprises a desk study, which incorporates a detailed ortho-photograph interpretation and the collation of existing data. This is followed by regional geological mapping during a walk-over site inspection, and ground magnetic- and electro-magnetic surveys to identify and locate the most suitable drilling targets. The geophysical traverses are conducted at right angles to structures targeted for exploration where possible.

5.1.1 Magnetic method

The different magnetic susceptibilities of the different rock types result in contrasting magnetic signatures. Thus, magnetic anomalies identified during the surveys can be interpreted to represent intrusive structures (such as dykes), geological contacts and faults which may have a bearing on the occurrence, storage and movement of ground water. These geological structures are deemed to be primary targets in the selection of drilling sites for ground water exploration.

A Geotron model G4 Proton-precession magnetometer, which measures the strength of the total magnetic field at a given locality directly, was utilized during the study. A station interval of five m was used on the traverses.

5.1.2 Frequency domain electro-magnetic method

The Fdem EM system can be used for the rapid and simple measurement of site conductivities, which facilitates the detection of steeply dipping conductive targets (for example: dykes, fracture zones and faults) by means of electro-magnetic coupling.

The Fdem is a moving-source, moving-receiver system which measures the ratio of both the vertical and horizontal in- and out-phases components of a secondary magnetic field to the free space primary magnetic field. The transmitter and receiver units are connected by a light-weight 2-conductor Teflon cable which acts as a reference to the primary magnetic field.

Different types of magnetic anomalies, often having the same order of magnitude, can be distinguished by correlating electromagnetic data with magnetic data. The electromagnetic signature of a geological contact or fault can be distinguished by a step in the magnetic background response where typical dyke-like anomalies are absent, while intrusive dykes possess distinct magnetic signatures. The presence of remnant magnetism and the lack of background definition may however, hamper the interpretation of dip direction from magnetic data. The centre of an electromagnetic anomaly may coincide with the centre or edge of the dyke, depending on the width of the dyke and the degree of weathering.

The dip direction can often be interpreted from the geometry of the electromagnetic anomaly, while the width and position of dyke contacts can be identified from negative electromagnetic anomalies.

5.2 EFFICACY OF SITING WORK

Major geological structures could readily be identified from the results of the geophysical surveys, that together with the available geological, topographical and drainage data were sufficient to identify possible drilling sites.

The siting methods utilized during this study are thus deemed to be efficacious.

NOTE: It must be kept in mind that although structures with a relatively higher groundwater potential can readily be identified by means of the above-mentioned methods, no known technique can measure the water bearing qualities of such structures.

5.3 SCOPE OF SITING WORK

Magnetic and electro-magnetic surveys were conducted in two target areas identified for exploration. Target area 1 is located south of the development in a ravine and has a southeast-northwest orientation. Target area 2 is and elongated area just inland from the coastal dunes to the north of the development (See the project map).

6.0 RESULTS

Detailed geological- and geohydrological logs are included as Appendix D, with borehole positions indicated by the project map.

6.1 NEWLY DRILLED BOREHOLES

6.1.1 Borehole KHAM 1 (Target Area 1)

Drilling results

The borehole was drilled to a depth of 78 m by Messrs. Drilling Africa Trust on 3/4 May 2003.

The borehole was drilled to a diameter of 205 mm to a depth of 14 m, after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an outside diameter of 178 mm and a sidewall thickness of 4 mm, was installed from the surface to a depth of 14 m. Perforated steel casing, with a diameter of 165 mm and a sidewall thickness of 4 mm, was installed from a 22 m up to a depth of 43 m

Groundwater seepage occurred at a depth of 52 m. A total estimated blow yield of 1.4 L/s was reported.

A sanitary seal with a concrete collar was installed and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested. The static groundwater level was located at a depth of 22.31 m below the top of the casing.

Groundwater quality

A groundwater sample was taken and submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 4 Dangerous water quality

6.1.2 Borehole Kham 2 (Target Area 1)

Drilling results

The borehole was drilled to a depth of 78 m by Messrs. Drilling Africa Trust on 6/7 May 2003.

The borehole was drilled to a diameter of 205 mm to a depth of 15 m, after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an outside diameter of 178 mm and a sidewall thickness of 4 mm, was installed from the surface to a depth of 15 m. The borehole was not developed (cased) as a production borehole due to the chemical quality of the water.

Groundwater seepage occurred at a depth of 41 m and 68 m. A total estimated blow yield of 5.0 L/s was reported.

A sanitary seal with a concrete collar was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested due to the chemical quality of the water. The static groundwater level was located at a depth of 9.38 m below the top of the casing.

Groundwater quality

A groundwater sample was taken and submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 3 Poor water quality – unsuitable for use without treatment

6.1.3 Borehole KHAM 3 (Target Area 1)

Drilling results

The borehole was drilled to a depth of 86 m by Messrs. Drilling Africa Trust on 8/9 May 2003.

The borehole was drilled to a diameter of 205 mm to a depth of 11 m, after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an outside diameter of 178 mm and a sidewall thickness of 4 mm, was installed from the surface to a depth of 11 m.
Groundwater seepage occurred at a depth of 68 m. A total estimated blow yield of 1.67 L/s was reported.

A sanitary seal with a concrete collar was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested. The static groundwater level was located at a depth of 8.07 m below the top of the casing.

Groundwater quality

A groundwater sample was taken and was submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 3 Poor water quality – unsuitable for use without treatment

6.1.4 Borehole KHAM 4 (Target Area 2)

Drilling results

The borehole was drilled to a depth of 101 m by Messrs. Drilling Africa Trust on 22/23 May 2003.

The borehole was drilled to a diameter of 205 mm to a depth of 24 m, after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an outside diameter of 178 mm and a sidewall thickness of 4 mm, was installed from the surface to a depth of 24 m.

Groundwater seepage occurred at a depth of 28 m. A total estimated blow yield of 1.4 L/s was reported.

A sanitary seal with a concrete collar was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested. The static groundwater level was located at a depth of 8.39 m below the casing.

Groundwater quality

A groundwater sample was taken and was submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 3 Poor water quality – unsuitable for use without treatment

6.1.5 Borehole KHAM 5 (Target Area 2)

Drilling results

The borehole was drilled to a depth of 78 m by Messrs. Drilling Africa Trust on 23/24 May 2003.

The borehole was drilled to a diameter of 256 mm to a depth of 6 m, 205 mm to a depth of 18 m after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an outside diameter of 178 mm and a sidewall thickness of 4 mm, was installed from the surface to a depth of 18 m.

Groundwater seepage occurred at a depth of 58 m. A total estimated blow yield of 0.28 L/s was reported.

A sanitary seal with a concrete collar was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested. The static groundwater level was located at a depth of 4.57 m below the casing.

Groundwater quality

A groundwater sample was taken and was submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 4 Dangerous water quality

6.1.6 Borehole KHAM 6 (Target Area 2)

Drilling results

The borehole was completed to a depth of 58 m by Messrs. Drilling Africa Trust on 7/8 July 2003.

The borehole was drilled to a diameter of 256 mm to a depth of 6 m, after which the borehole was drilled to a diameter of 205 mm. Solid steel casing, with an inner diameter of 205 mm and a sidewall thickness of 6 mm, was installed from the surface to a depth of 6 m. Solid Upvc casing, with an inner diameter of 144 mm and a sidewall thickness of 8 mm, was installed from the surface to a depth of 43 m. Perforated Upvc casing, with an inner diameter of 144 mm and a sidewall thickness of 8 mm, was installed from a 43 m up to a depth of 58 m.

Groundwater seepage occurred at a depth of 48 m. A total estimated blow yield of 3.3 L/s was reported.

A sanitary seal with a concrete collar, as well as a gravel pack, was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were tested by means of a stepped discharge-, constant discharge- and recovery test conducted in the period between 21 and 26 July 2003.

The static groundwater level was located at a depth of 5.48 m below the datum level[4] at the time of testing. The test pump was placed at a depth of 52.5 m below the datum level, with a total borehole depth of 60.0 m being recorded.

- Stepped discharge test

This test comprised two 60-minute steps conducted at yields of 1.03 and 1.83 L/s respectively. A maximum drawdown of 27.4 m was achieved during the test.

- Constant discharge test

This test was conducted at an average yield of 1.4 L/s for a period of 72 hours (4320 minutes). A maximum drawdown of 25.22 m was achieved during the test, which translates to approximately 55.6 percent of the available drawdown.

- Recovery test

The groundwater level recovered to 99.6 % of its original level after a period of 30 hours (1 800 minutes).

Groundwater quality

A groundwater sample was taken and was submitted to Messrs. Pollution Control Technologies for the determination of the macro-chemical composition of the water for domestic purposes.

The groundwater classifies as:

- Domestic use: Class 2 Water of marginal quality

[4] Taken as a distance of 0.40 m above the ground surface.

6.1.7 Borehole KHAM 7 (Target Area 2)

Drilling results

The borehole was drilled to a depth of 78 m by Messrs. Drilling Africa Trust on 9/10 July 2003.

The borehole was drilled to a diameter of 205 mm to a depth of 6 m, after which the borehole was drilled to a diameter of 165 mm. Solid steel casing, with an inside diameter of 205 mm and a sidewall thickness of 6 mm, was installed from the surface to a depth of 6 m. Solid Upvc casing, with an inside diameter of 144 mm and a sidewall thickness of 2 mm, was installed from the surface to a depth of 50 m. Perforated Upvc casing, with a diameter of 144 mm and a sidewall thickness of 3 mm, was installed from a 50 m up to a depth of 62 m

Groundwater seepage occurred at a depth of 58 m. A total estimated blow yield of 3.3 L/s was reported.

A sanitary seal with a concrete collar, as well as a gravel pack, was installed, and the borehole capped with a steel lid.

Yield characteristics

The yield characteristics of this borehole were not tested. The static groundwater level was located at a depth of 8.47 m.

Groundwater quality

No groundwater sample was taken.

7. CONCLUSIONS AND RECOMMENDATIONS

In the light of the results of the hydrogeological study that was conducted in the vicinity of the development, the following recommendations can be made:

The recharge in the area is estimated to be 4.3% of MAP.

Existing boreholes Bh7, Bh9 and Bh11 have good quality water (Class 2). The recommended abstraction for these boreholes is 17.28, 25.92 and 30.24 m^3/d respectively. Borehole Bh7 supplies the three existing houses on the development. There is no scope for additional abstraction in the area surrounding this borehole. Borehole BH9 is currently in use by the reservation at a rate of 10.8 m^3/d. There is thus spare capacity and further exploration is possible in the general area of boreholes Bh9 and Bh11. This area is however far from the proposed development.

The study has shown that approximately 64.8 m^3/d of groundwater can be safely abstracted from the newly drilled borehole (Kham 6) in Target Area 2 which is deemed to be adequate to supply in the initial needs of the development. The catchment for Target Area 2 was calculated to be ~1.916 km^2 resulting in potential annual recharge of 0.074 Mm^3/a or 203.26 m^3/d. Kham 6 is recommended for abstraction at a rate of 0.75 l/s for a 24 hour pumping period. This ensures an adequate supply for 54 plots.

The water quality of the boreholes drilled in Target Area 1 proved to be unsuitable for human consumption over an extended period. Treatment of this water is an option. The equipment of borehole Kham2 is however recommended. This water can be utilized in the construction of the roads, houses etc. This would help to alleviate stress on the fresh water source in Target Area 2.

Sodium and chloride ions dominate the composition of the waters with other ions generally at low to very low concentrations.

The pH is usually in the neutral range (6.7 – 8.0).

The water is characterized by a median electrical conductivity in the 390 – 420 mS/m range. The conductivity for the recommended boreholes lie within the maximum acceptable limit for town supply (300 mS/m).

Either of the following two options is recommended for implementation during the establishment of a monitoring programme to evaluate groundwater levels and abstraction rates at borehole Kham 6:

Option A: Installation of an automatic (permanent) water level recorder, with data being collected on a six monthly basis by Ad Geo Consultants

Option B: Manual measurement of the groundwater levels to be conducted on a weekly basis

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APPENDIX A

Detailed hydrocensus results

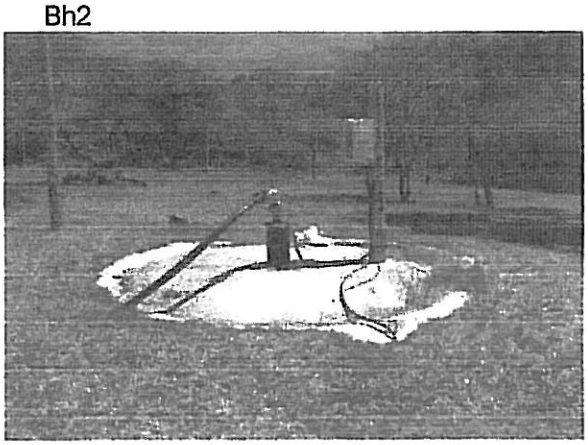
HYDRO CENSUS RESULTS

Installation no	Comment	Photo no	Latitude Dec	Min	Sec	Longitude Dec	Min	Sec	Elevation	Equipment	Yield	Quality Class	EC	Ph	Temp	Bh depth	Comment
Bh1	Existing Bh	355	32	49	52.74	28	6	26.82	17	Submersible pump							Pump located in small room behind house. Supply water to holiday resort
Bh2	Existing Bh	356	32	50	38.94	28	6	54.54	38	Mono pump						60	Borehole located in open area. Supply water to holiday resort
Bh3	Existing Bh	357	32	50	43.32	28	6	56.64	47	Submersible pump			214	8.12		100	Pump located next to house (drain cover over). Supply water to holiday resort
Bh4 (2)	Existing Bh	358	32	50	33.66	28	6	57.12	47	Submersible pump		2	84	8.84		40	George's Property
Bh5	Existing Bh	359	32	50	49.38	28	6	43.5	47	Open	0.42		165	8.25		40	Kent's place - Caravan park
Bh6	Existing Bh	360	32	50	51.72	28	6	55.56	36	Borehole collapsed	0.22					110	Kent place - Caravan park
Bh7 (2)	Existing Bh	361	32	51	1.5	28	6	59.1	33	Submersible pump	0.19	2	122	8.24		100	Allan Mosh
Bh8	Existing Bh		32	50	46.86	28	6	16.14	99	Dry bh	0.00					110	Allan Mosh
Bh9 (2)	Existing Bh		32	50	12.66	28	4	34.44	96	Submersible pump		2	133	8.21		110	Game reserve
Bh10	Existing Bh		32	50	12.06	28	4	33.12	93	Borehole blocked with stones							Game reserve
Bh11	Existing Bh	363	32	50	13.74	28	4	34.74	89	Old mono pump							Game reserve - Borehole not in use
Bh12	Existing Bh	364	32	50	13.74	28	4	34.56	88	Open borehole - old pumphouse							Game reserve - Borehole not in use
Bh13	Existing Bh	365	32	50	20.94	28	5	22.26	86	Submersible pump						100	V/d Bank
Bh14	Existing Bh	366	32	50	20.58	28	5	18.24	86	Open borehole							V/d Bank
Bh15	Existing Bh	367	32	50	29.82	28	5	23.04	95	Mono pump 3' pipe			161	8.19		100	V/d Bank
Bh16	Existing Bh	368	32	51	33.18	28	5	13.8	95	Submersible pump							Next to soil dam
Bh17	Existing Bh	369	32	51	46.38	28	5	17.46	100	Mono pump							Graham
Bh18	Existing Bh	370	32	52	24.84	28	2	35.7	118	Submersible pump	4.44		558	8.31		118	New borehole (water strike at 50, 65 and 85-90m)
Bh19	Existing Bh	371	32	53	2.22	28	3	31.8	87	Mono			453	7.99		120	Strong borehole
Bh20	Existing Bh	372	32	51	16.38	28	6	5.64	37	Open borehole						80	
BH21	Existing Bh		32	50	40.6	28	6	41.3		Submersible pump	0.25		510	6.9		100	Old windmill north of Trevors place
BH22	Existing Bh		32	50	43.1	28	6	47.5		Submersible pump	0.13		142	7.37		80	Near Trevor's house. Just above dam
Weir	Stream abstraction		32	50	8.2	28	6	46.3		Weir abstraction point			160	7.9			Backpacker camp water source
KHAM1	New Bh	395	32	51	21.3	28	6	13.6		Open	1.39	4	423	7.29		78	
KHAM2	New Bh	394	32	51	11.1	28	6	0.9		Open	5.00	3	435	7.05		78	
KHAM3	New Bh	393	32	51	8	28	5	59.6		Open	1.67	3	392	6.93		88	
KHAM4	New Bh	396	32	50	21.1	28	6	49.2		Open	1.39	2	120	7.95		101	
KHAM5	New Bh	397	32	50	16.1	28	6	48.4		Open	0.28	3	247	7.69		78	
KHAM6	New Bh	398	32	50	19	28	6	50.4		Open	3.33	1	96	7.75		60	Production borehole
KHAM7	New Bh		32	50	29.8	28	6	54.1		Open	3.33		108	7.85		62	Monitoring borehole

BH = 7

Bh1

Bh2



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Bh4

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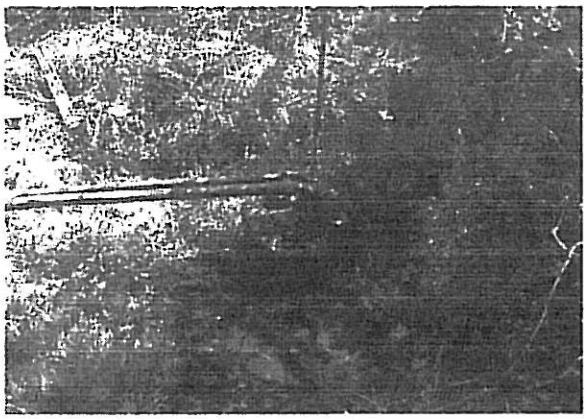

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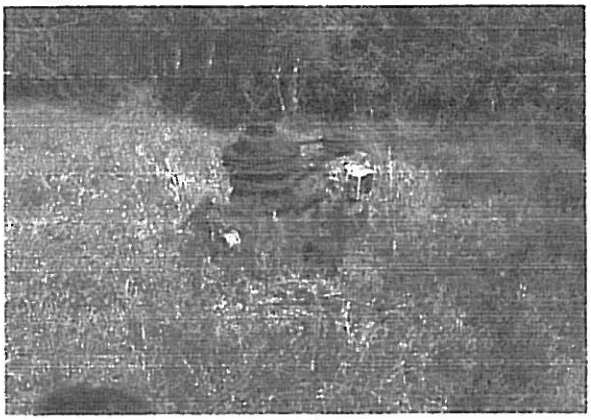
Bh9

Bh11



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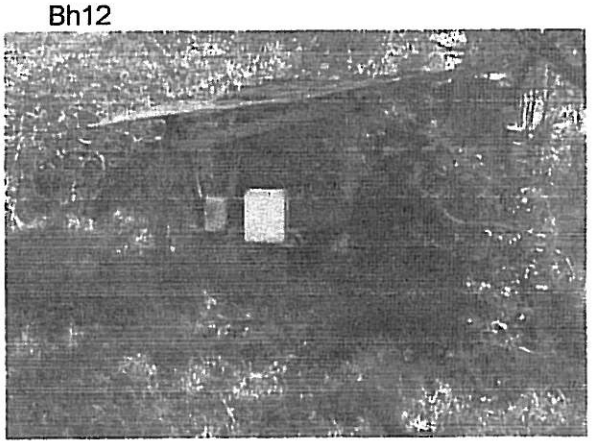

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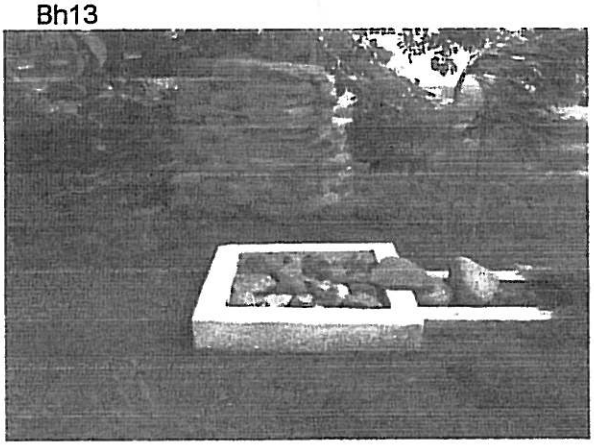

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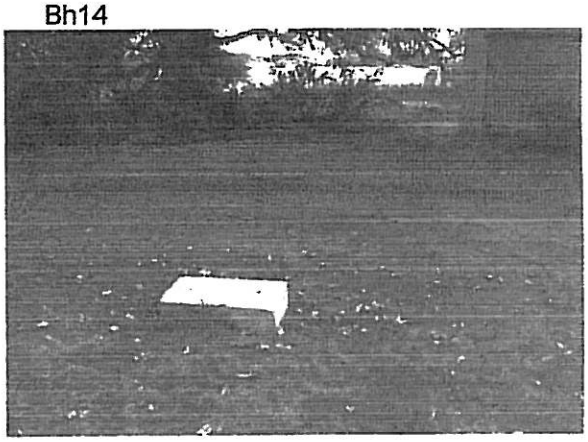

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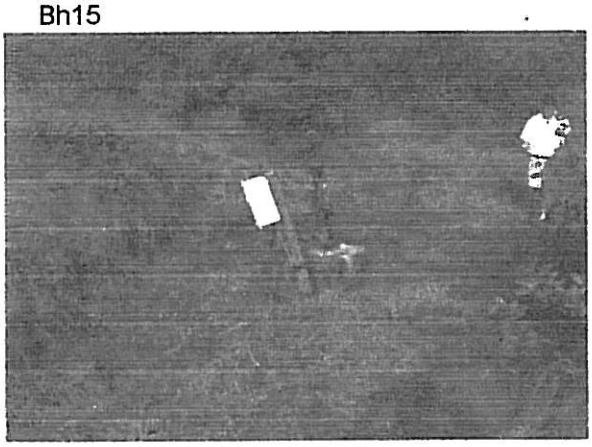

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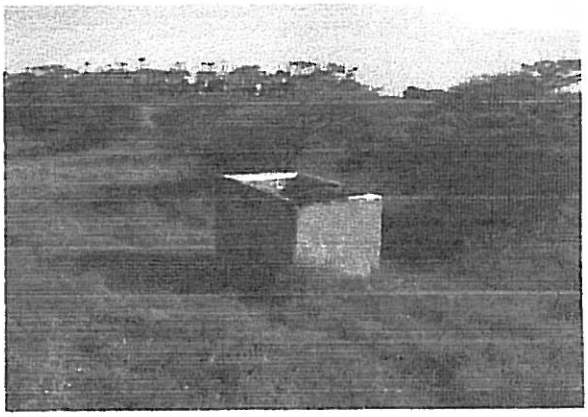

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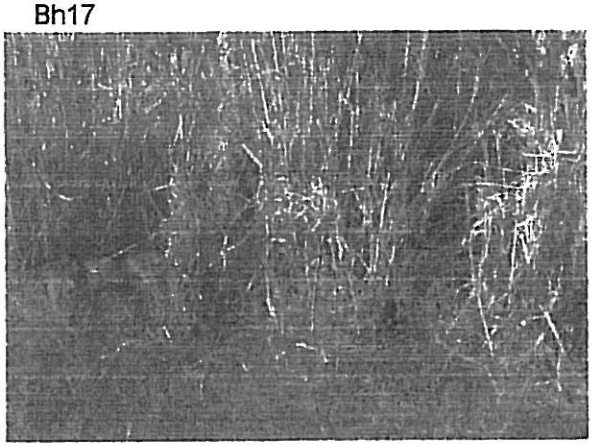

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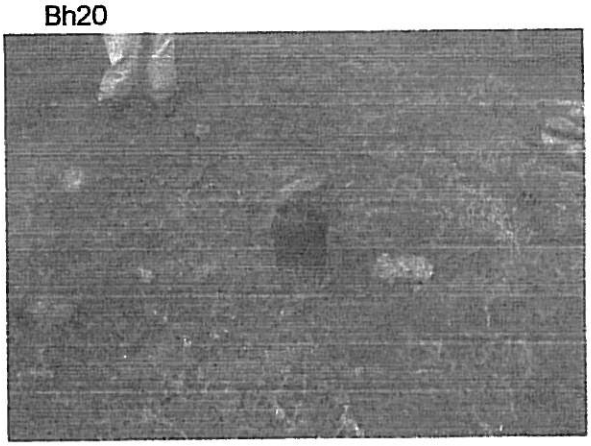

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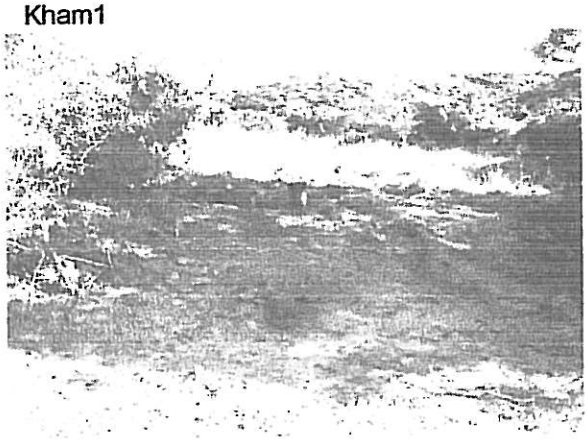

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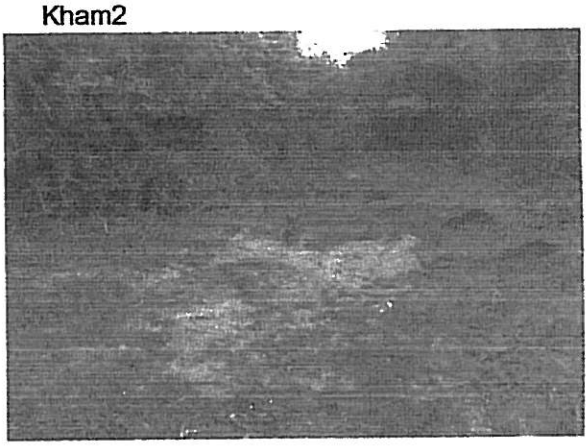

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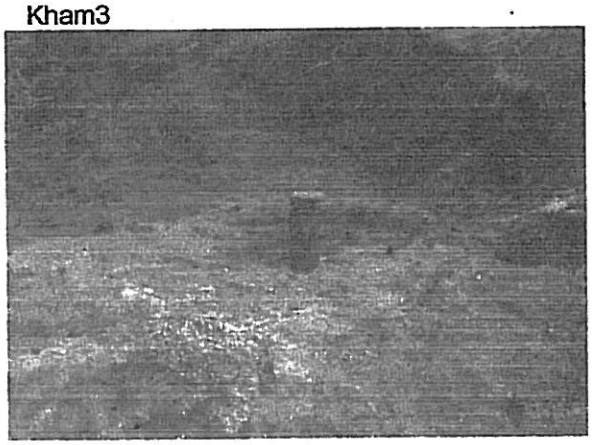

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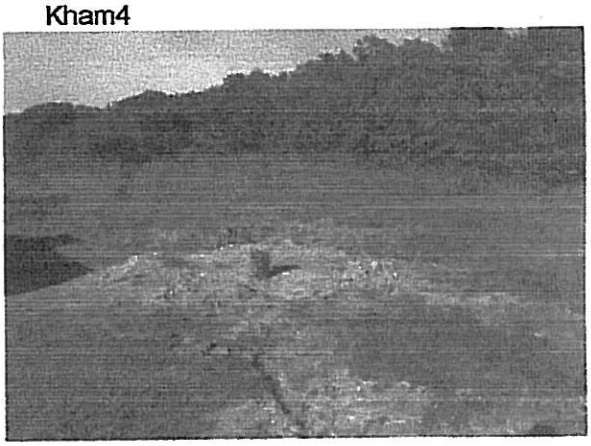

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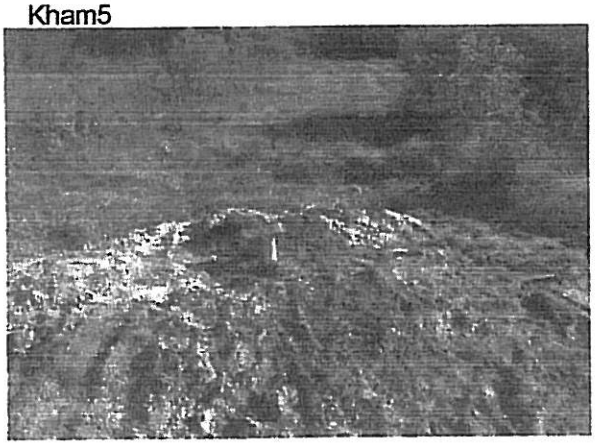

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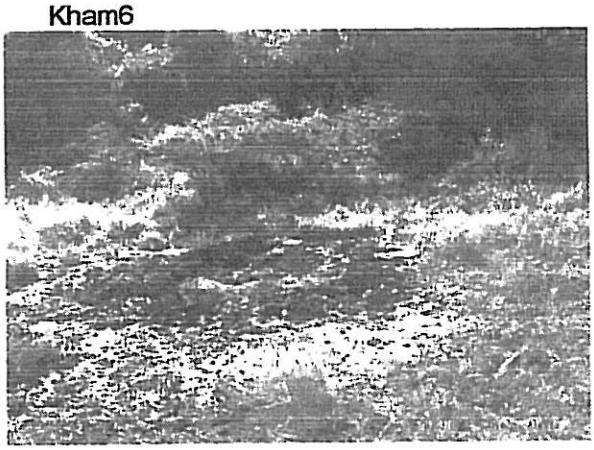
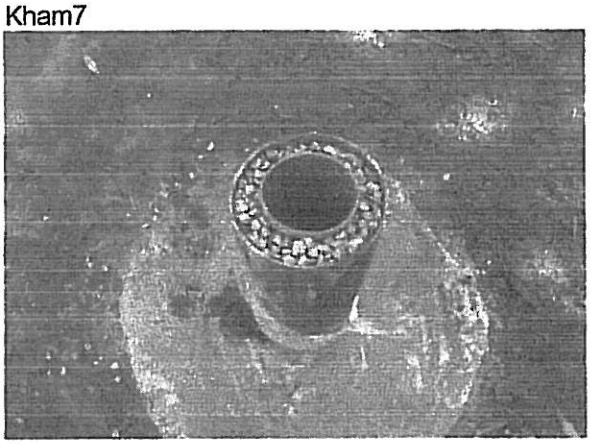
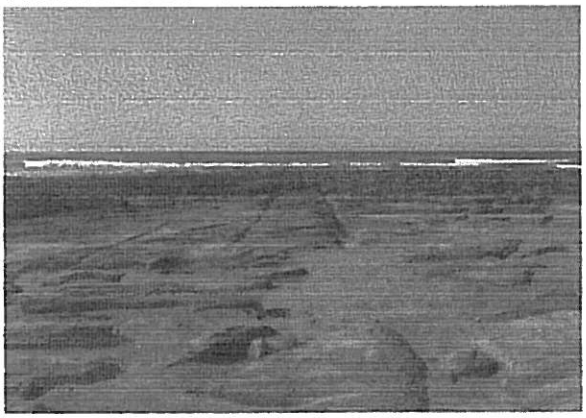


Kham7



Weir

Fractures in dune rock



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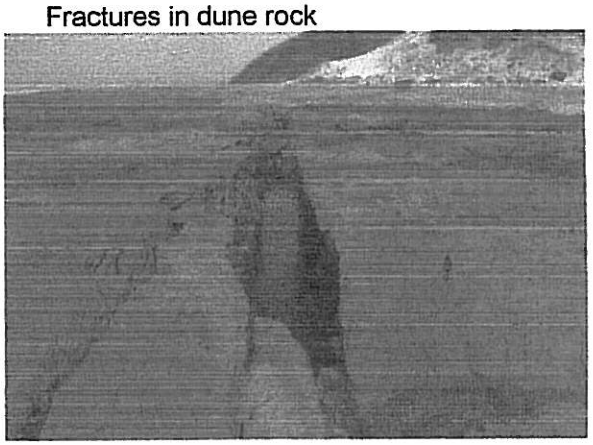


Dunes

APPENDIX B

Pump test results

Tel: (043) 748 2723; Fax (043) 748 2723
5 High Field road, Beacon Bay, 5205
E-mail: adgeoconsul@telkomsa.net

AD Geo Consultants cc

BOREHOLE TEST RECORD

CONSULTANT:	AD GEO CONSULTANTS CC
DISTRICT:	AMATOLA
PROVINCE:	EASTERN CAPE
SITE NAME:	KHAMANGA BAY DEVELOPMENT - ALLAN MOSS
PROJECT NO.	KHAMANGA BAY
DATE TESTED:	25/6/2003
MAP REFERENCE:	3228CC
CO-ORDINATES:	
LATITUDE:	32 51' 01.5"
LONGITUDE:	28 06' 59.1"
BOREHOLE NO:	Bh 7 **Monitor 1:** **Monitor 2:**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	EXIST B/H
BOREHOLE DEPTH: (mbgl)	104.00

BOREHOLE DEPTH:	104.00	**WATER LEVEL (mbgl):**	7.08	**CASING HEIGHT (magl):**	0
DATUM LEVEL ABOVE CASING (m):	0.37	**DEPTH OF PUMP(m):**	67	**Diam pump inlet (mm):**	132
EXISTING PUMPTYPE:	Submersible Pump	**CONTRACTORS:**	KHAMANGA	**TEST PUMP TYPE:**	BP??H

COMMENTS:

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	0
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	0
CASING DETECTION:	NO	0	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	0
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	0	LAYFLAT (M):	M	0

FORM 5 E

STEP DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 7	CO-ORDINATES:		DISTRICT:	AMATOLA
ALT BH NO:	0	LATITUDE	32 51' 01.5"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - ALLAN MOSS
ALT BH NO:	0	LONGITUDE:	28 06' 59.1"		

BOREHOLE DEPTH (m)	104.00	DATUM LEVEL ABOVE CASING (m):	0.37	EXISTING PUMP:	Submersible Pump
WATER LEVEL (mbgl):	7.08	CASING HEIGHT (magl):	0	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	67.00	DIAM PUMP INLET (mm):	132	TEST PUMP TYPE:	BP??H

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2					DISCHARGE RATE 3			RPM	
DATE: 25/6/2003		TIME:	10:30		DATE: -		TIME:	-		DATE: -		TIME:	-	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.28		1		1	25.60		1		1			1	53.86
2	3.44		2		2	29.84		2		2			2	46.40
3	5.84	0.25	3		3	32.80		3		3			3	39.76
5	7.20		5		5	36.64	0.50	5		5			5	24.10
7	7.76	0.25	7		7	39.36		7		7			7	15.60
10	8.24		10		10	42.08		10		10			10	10.86
15	8.88		15		15	44.80	0.49	15		15			15	9.24
20	10.16		20		20	46.32		20		20			20	8.32
30	13.28	0.25	30		30	48.72		30		30			30	7.12
40	16.64		40		40	51.28	0.48	40		40			40	6.32
50	17.84		50		50	54.00		50		50			50	4.76
60	18.56	0.25	60		60	56.88		60		60			60	3.38
70			70		70	59.92	0.41	70		70			70	2.06
80			80		75	59.92	0.33	80		80			80	1.98
90			90		80	59.92	0.31	90		90			90	1.75
100			100		90			100		100			100	1.55
120			110		95			110		110			120	1.21
AVERAGE YIELD		0.25	120		AVERAGE YIELD		0.49	120		AVERAGE YIELD		#DIV/0!	130	
pH		-	150		pH		-	150		pH			150	
TEMP (c)		-	180		TEMP (c)		-	180		TEMP (c)			180	
EC (mS/cm)		-	210		EC (mS/cm)		-	210		EC (mS/cm)			210	

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			240	
DATE:		TIME:			DATE:		TIME:			DATE:			300	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	360	
													420	
1			1		1			1		1			480	
2			2		2			2		2			540	
3			3		3			3		3			600	
5			5		5			5		5			720	
7			7		7			7		7			840	
10			10		10			10		10			960	
15			15		15			15		15			1080	
20			20		20			20		20			1200	
30			30		30			30		30			1440	
40			40		40			40		40			1680	
50			50		50			50		50			1920	
60			60		60			60		60			2160	
70			70		70			70		70			2400	
80			80		80			80		80			2640	
90			90		90			90		90			2880	
100			100		100			100		100			3120	
110			110		110			110		110			3360	
AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	3600	
pH			150		pH			150		pH			3840	
TEMP (c)			180		TEMP (c)			180		TEMP (c)			4080	
EC (mS/cm)			210		EC (mS/cm)			210		EC (mS/cm)			4320	

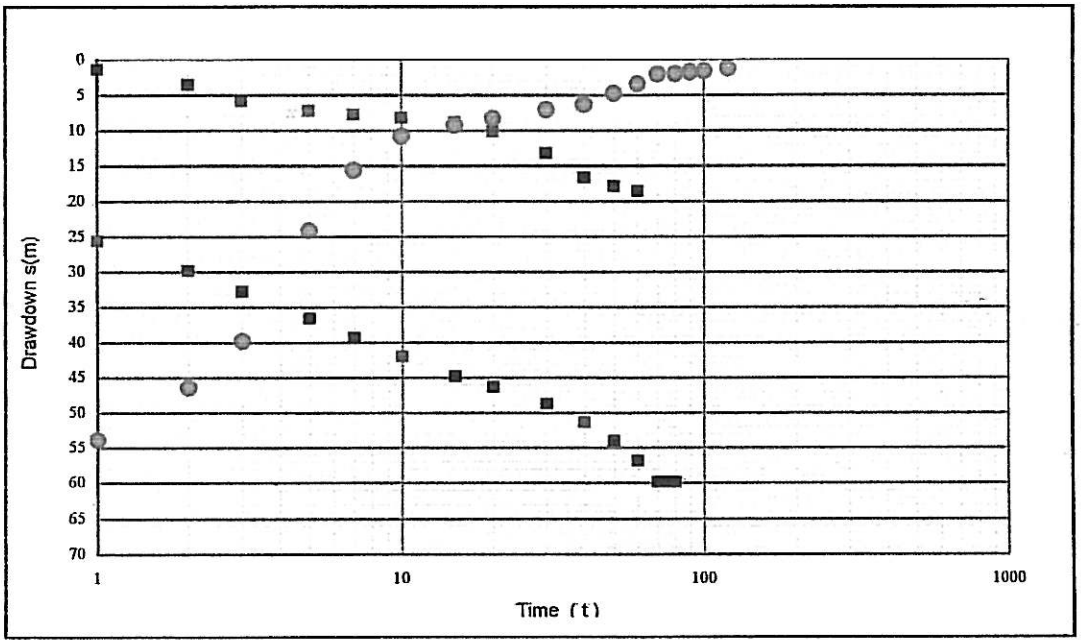
Comments: During the recovery test two water strikes was identified 1) 25.88m and 2) 47.14 m

STEP & CONSTANT DISCHARGE TEST GRAPHICS

PROJ NO : KHAMANGA BAY		MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 7	CO-ORDINATES:		DISTRICT:	AMATOLA
ALT BH NO:	0	LATITUDE	32 51' 01.5"	SITE NAME:	KHAMANGA BAY
ALT BH NO:	0	LONGITUDE:	28 06' 59.1"		

BOREHOLE DEPTH (m)	104.00	DATUM LEVEL ABOVE CASING (m):	0.37	EXISTING PUMP:	EXIST B/H
WATER LEVEL (mbgl):	7.08	CASING HEIGHT (magl):	0.00	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	67.00	DIAM PUMP INLET (mm):	132.00	PUMP TYPE:	BP77H

STEPPED DISCHARGE TEST & RECOVERY



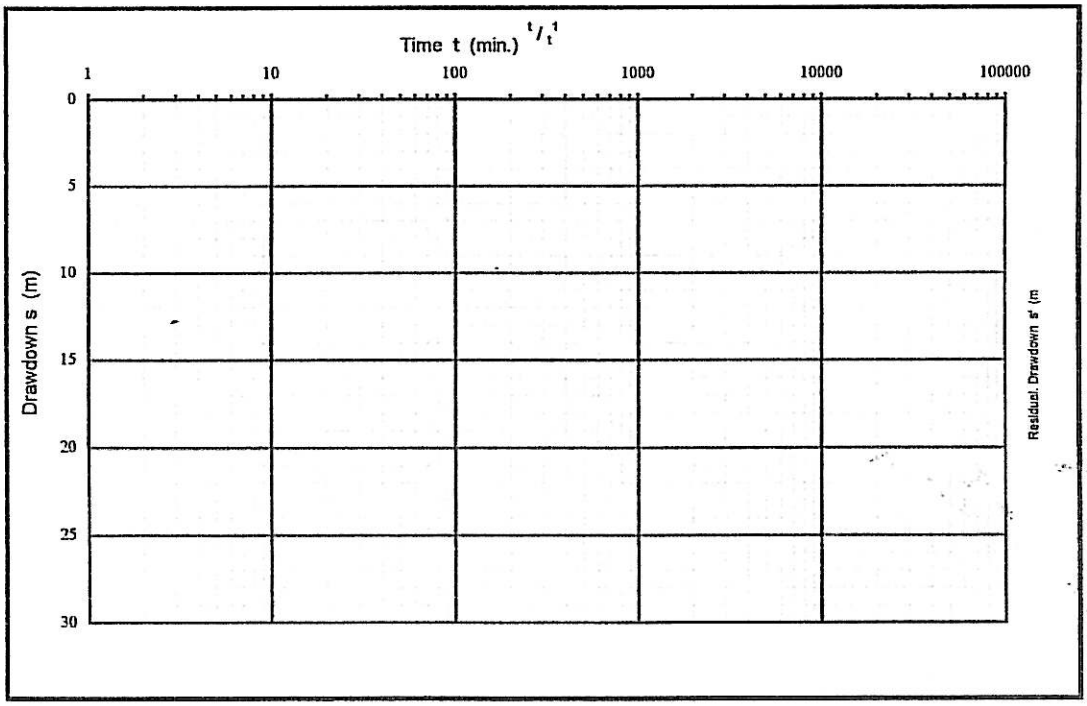
■' = Drawdown data.
○' = Recovery data.

DISCHARGE RATES (Q)

Q1=	0.25	l/s
Q2 =	0.49	l/s
Q3 =	-	l/s
Q4 =	-	l/s
Q5 =	-	l/s

S.W.L = 7.08 m.b.g.l.

CONSTANT DISCHARGE TEST & RECOVERY



■' = Drawdown data.
_ = Recovery data.

Q = - l/s.

S.W.L = 7.08 m.b.g.l.

T = - m²/day

Abstraction	0.2	l/s
	17	m³/day
	518	m³/month

Class 2 water

COMMENTS

Tel: (043) 748 2723; Fax (043) 748 2723
5 High Field road, Beacon Bay, 5205
E-mail: adgeoconsul@telkomsa.r

AD Geo Consultants cc

BOREHOLE TEST RECORD

CONSULTANT: AD GEO CONSULTANTS CC

DISTRICT: AMATOLA

PROVINCE: EASTERN CAPE

SITE NAME: KHAMANGA BAY DEVELOPMENT - GAME PARK

PROJECT NO. KHAMANGA BAY

DATE TESTED:

MAP REFERENCE: 3228CC

CO-ORDINATES:

LATITUDE: 32 50' 12.06"

LONGITUDE: 28 04' 33.12"

BOREHOLE NO: Bh 9 **Monitor 1:** Bh 11 **Monitor 2:** Bh 10 **Monitor 3:** Bh 12

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: EXIST B/H

BOREHOLE DEPTH: (mbgl) 105 m

BOREHOLE DEPTH:	115	**WATER LEVEL (mbgl):**	32.49	**CASING HEIGHT (magl):**	0.2
DATUM LEVEL ABOVE CASING (m):	0.41	**DEPTH OF PUMP(m):**	89.8	**Diam pump inlet (mm):**	132
EXISTING PUMPTYPE:	Submersible Pump	**CONTRACTORS:**	KHAMANGA	**TEST PUMP TYPE:**	BP16H

COMMENTS:

4 Boreholes drilled with in a area of 400 m.

Bh 9 - Equipped with submersible pump (supply water to reception / restaurant building)

Bh 10 - Newly drilled borehole (never been equipped - filled with rocks)

Bh 11 - Old borehole equipped with an old mono pump (borehole was used for tomato package plant - not in use)

Bh 12 - Old borehole - filled with rocks and old pipes

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	0
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	0
CASING DETECTION:	NO	0	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	0
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	0	LAYFLAT (M):	M	0

FORM 5 E

STEP DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 9	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR HOLE:	Bh 11	LATITUDE	32 50' 12.06"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - GAME PARK
MONITOR HOLE:	Bh 10 Bh 12	LONGITUDE:	28 04' 33.12"		

BOREHOLE DEPTH (m)	115.00	DATUM LEVEL ABOVE CASING (m):	0.41	EXISTING PUMP:	Submersible Pump
WATER LEVEL (mbgl):	32.49	CASING HEIGHT (magl):	0.2	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	89.80	DIAM PUMP INLET (mm):	132	TEST PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM		DISCHARGE RATE 2					DISCHARGE RATE 3			RPM	
DATE:	0.00	TIME:	10:00		DATE: -		TIME:	-		DATE: -		TIME:	-	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.78		1		1	13.00		1		1	25.71		1	50.10
2	2.50		2		2	13.36		2		2	27.65		2	47.73
3	3.48		3		3	13.60		3		3	28.90		3	43.70
5	4.65		5		5	13.96		5		5	31.76	1.02	5	36.90
7	5.46		7		7	14.33		7		7	34.29		7	31.10
10	6.52		10		10	14.94	0.53	10		10	37.80		10	24.08
15	7.83		15		15	16.23	0.54	15		15	42.58		15	15.40
20	8.82		20		20	17.42		20		20	46.32		20	12.90
30	11.33	0.39	30		30	19.25		30		30	51.55		30	10.00
40	12.03		40		40	20.55	0.54	40		40	53.24		40	8.30
50	12.10		50		50	21.50		50		50	55.60		50	6.80
60	12.20	0.39	60		60	22.23		60		60	57.13	1.02	60	5.93
70	12.33		70		70	22.89	0.53	70		66	57.31	1.06	70	5.33
80	12.50	0.40	80		80	23.33		80		70	57.31	0.81	80	4.85
90	12.33		90		86	23.72		90		80	57.31	0.81	90	4.54
100			100		90			100		100			100	4.23
120			110		95			110		110			120	3.68
AVERAGE YIELD		0.39	120		AVERAGE YIELD		0.54	120		AVERAGE YIELD		1.02	130	3.45
pH		-	150		pH		7.37	150		pH		7.47	150	3.04
TEMP (c)		-	180		TEMP (c)		20.90	180		TEMP (c)		21.80	180	2.53
EC (mS/cm)		-	210		EC (mS/cm)		146	210		EC (mS/cm)		145	1260	1.20

DISCHARGE RATE 4			RPM		DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			1980	0.80
DATE:		TIME:			DATE:		TIME:			DATE:			300	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	360	
1			1		1			1		1			420	
2			2		2			2		2			480	
3			3		3			3		3			540	
5			5		5			5		5			600	
7			7		7			7		7			720	
10			10		10			10		10			840	
15			15		15			15		15			960	
20			20		20			20		20			1080	
30			30		30			30		30			1200	
40			40		40			40		40			1440	
50			50		50			50		50			1680	
60			60		60			60		60			1920	
70			70		70			70		70			2160	
80			80		80			80		80			2400	
90			90		90			90		90			2640	
100			100		100			100		100			2880	
110			110		110			110		110			3120	
AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	3360	
pH			150		pH			150		pH			3600	
TEMP (c)			180		TEMP (c)			180		TEMP (c)			3840	
EC (mS/cm)			210		EC (mS/cm)			210		EC (mS/cm)			4080	
													4320	

Comments: During the recovery test two water strikes was identified 1) 25.88m and 2) 47.14 m

CONSTANT DISCHARGE TEST & RECOVERY

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 9	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	Bh11	LATITUDE:	32 50' 12.06"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - GAME PARK
MONITOR BH NO:	Bh 12	LONGITUDE:	28 04' 33.12"		
BOREHOLE DEPTH:	115.00	DATUM LEVEL ABOVE CASING (m):	0.41	EXISTING PUMP:	Submersible Pump
WATER LEVEL (mbgl)::	32.49	CASING HEIGHT (magl):	0.20	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	89.80	DIAM PUMP INLET(mm):	132.00	PUMP TYPE:	BP16H

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED		TEST COMPLETED		DURATION:	
DATE:	TIME:	DATE:	TIME:	TYPE OF PUMP:	BP16H

DISTANCE BETWEEN DISCHARGE :	OBSERVATION HOLE 1	OBSERVATION HOLE 2	OBSERVATION HOLE 3
AND OBSERVATION HOLES IN M:	NR: Bh 11	NR: Bh 10	NR: Bh 12

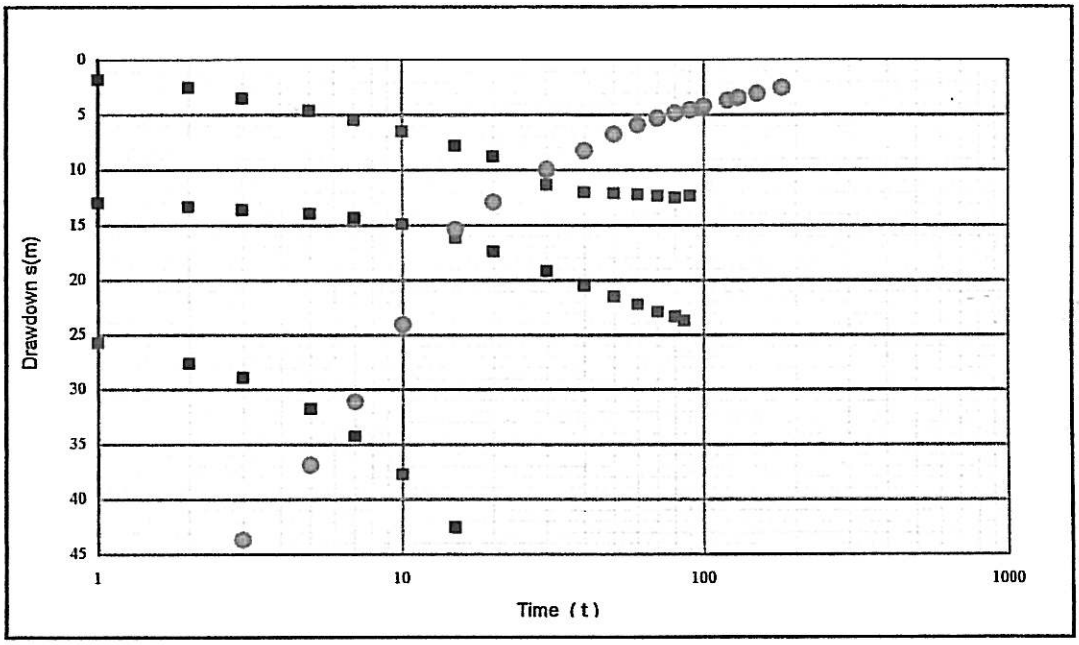
DISCHARGE BOREHOLE					Distance; 38.55			Distance: -			Distance: -	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	2.21		1	19.8	1	0		1			1	
2	3.66		2	18	2	0		2			2	
3	4.56		3	16.1	3	0		3			3	
5	5.94		5	13.6	5	0		5			5	
7	6.93		7	12.6	7	0		7			7	
10	7.85		10	11.2	10	0		10			10	
15	9.54		15	9.9	15	0		15			15	
20	10.46	0.50	20	9.1	20	0		20			20	
30	12.49		30	8.35	30	0		30			30	
40	13.29		40	8.05	40	0.021		40			40	
50	13.63		50	7.7	50	0.021		60			60	
60	14.00		60	7.45	60	0.021		90			90	
70	14.55		70	7.22	70	0.021		120			120	
80	15.67		80	7.1	80	0.028		150			150	
90	16.78		90	6.82	90	0.032		180			180	
100	17.31		100	6.63	100	0.033		210			210	
110	17.85		110	6.44	110	0.039		240			240	
120	18.46		120	6.23	120	0.04		300			300	
150	19.00		150	5.77	150	0.041		360			360	
180	19.74		180	5.4	180	0.043		420			420	
210	20.12		210	5.4	210	0.049		480			480	
240	20.22		240	4.93	240	0.05		720			720	
300	20.53		300	4.59	300	0.058		960			960	
360	20.63		360	4.23	360	0.059		1200			1200	
420	20.71		420	4.06	420	0.061		1440			1440	
480	20.81		540	3.83	480	0.072		1680			1680	
540	20.91	0.50	1080	2.96	540	0.079		1920			1920	
600	21.00		1500	2.19	600	0.089		2160			2160	
720	21.15		2100	1.35	720	0.085		1810			1810	
840	21.33		1820		840	0.09		1820			1820	
960	21.45		1830		960	0.095		1830			1830	
1080	21.65		1840		1080	0.1		1840			1840	
1200	21.70		1850		1200	0.105		1850			1850	
1320	22.00	0.50	1920		1320	0.11		1920			1920	
1440	22.15		2040		1440	0.12		2040			2040	
2880	22.53	0.53	2160		2880	0.125		2160			2160	
3360	22.63	0.50	2280		3360	0.13		2280			2280	
3600	22.70		2400		3600	0.135		2400			2400	
3840	22.75		2520		3840	0.14		2520			2520	
4080	22.80		2640		4080	0.14		2640			2640	
4320	23.15		2760		4320	0.14		2760			2760	
4320	23.25		2880		4320	0.15		2880			2880	
4200			4200		4200	0.15		4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				4320		W/L	12.69		W/L		W/L	
Average yield (l/s):				0.51								

STEP & CONSTANT DISCHARGE TEST GRAPHICS

PROJ NO : KHAMANGA BAY		MAP REFERENCE:	3226CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 9	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	Bh11	LATITUDE	32 50' 12.06"	SITE NAME:	KHAMANGA BAY
MONITOR BH NO:	Bh 12	LONGITUDE:	28 04' 33.12"		

BOREHOLE DEPTH (m)	105 m	DATUM LEVEL ABOVE CASING (m):	0.20	EXISTING PUMP:	EXIST B/H
WATER LEVEL (mbgl):	8.85	CASING HEIGHT (magl):	0.85	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	38.16	DIAM PUMP INLET (mm):	180.00	PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY



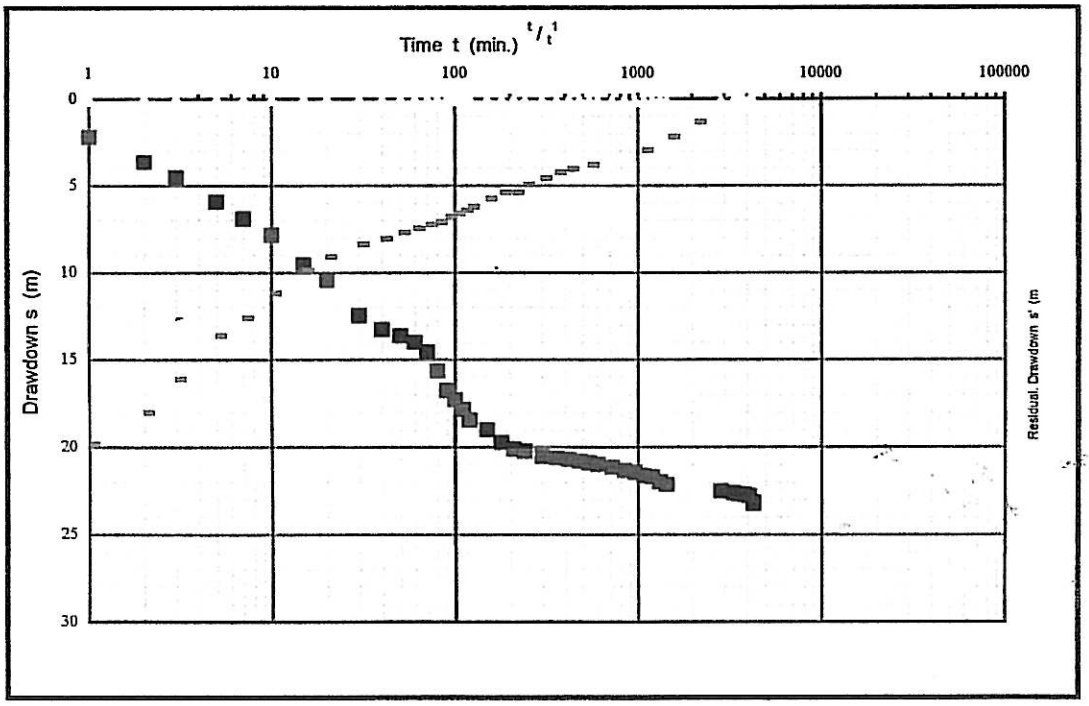
■ = Drawdown data.
○ = Recovery data.

DISCHARGE RATES (Q)

Q1 =	0.39	l/s
Q2 =	0.54	l/s
Q3 =	-	l/s
Q4 =	-	l/s
Q5 =	-	l/s

S.W.L = 8.85 m.b.g.l.

CONSTANT DISCHARGE TEST & RECOVERY



■ = Drawdown data.
– = Recovery data.
= Monitor b/hole data.

Q = 0.5 l/s.

S.W.L = 8.85 m.b.g.l.

T = 0.48 m²/day

Abstraction 0.3 l/s
26 m³/day
778 m³/month

Class 2 water

COMMENTS

Tel: (043) 748 2723; Fax: (043) 748 2723
5 High Field road, Beacon Bay, 5205
E-mail: adgeoconsul@telkomsa.net

AD Geo Consultants cc

BOREHOLE TEST RECORD

CONSULTANT: AD GEO CONSULTANTS CC

DISTRICT: AMATOLA

PROVINCE: EASTERN CAPE

SITE NAME: KHAMANGA BAY DEVELOPMENT - GAME PARK

PROJECT NO. KHAMANGA BAY

DATE TESTED: 8/6/2003

MAP REFERENCE: 3228CC

CO-ORDINATES:

LATITUDE: 32 50' 13.7"

LONGITUDE: 28 04' 34.7"

BOREHOLE NO: Bh 11 **Monitor 1:** Bh 9 **Monitor 2:** Bh 10 / 12

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: EXIST B/H

BOREHOLE DEPTH: (mbgl) 64.9 m

BOREHOLE DEPTH:	64.9	**WATER LEVEL (mbgl):**	13.14	**CASING HEIGHT (magl):**	0
DATUM LEVEL ABOVE CASING (m):	0.28	**DEPTH OF PUMP(m):**	53	**Diam pump inlet (mm):**	132
EXISTING PUMPTYPE:	OPEN	**CONTRACTORS:**	KHAMANGA	**TEST PUMP TYPE:**	BP16H

COMMENTS:

4 Boreholes drilled with in an area of 400 m.

Bh 9 - Equipped with a submersible pump (supply water to reception / restaurant building)

Bh 10 - Newly drilled borehole (never been equipped - filled with rocks)

Bh 11 - Old borehole equipped with old mono pump (borehole was used for tomato package plant - not in use)

Bh 12 - Old borehole - filled with rocks and old pipes

DESCRIPTION:	UNIT	QTY		UNIT
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M
CASING DETECTION:	NO	0	SAND/GRAVEL/SILT PUMPED?	YES/NO
STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO
BOREHOLE MARKING	NO	0	SLUG TEST:	NO
SITE CLEANING & FINISHING	NO	0	LAYFLAT (M):	M

FORM 5 E

STEP DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 11	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR HOLE:	Bh 9	LATITUDE	32 50' 13.7"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - GAME PARK
MONITOR HOLE:	Bh 10 / 12	LONGITUDE:	28 04' 34.7"		
BOREHOLE DEPTH (m)	64.90	DATUM LEVEL ABOVE CASING (m):	0.28	EXISTING PUMP:	OPEN
WATER LEVEL (mbgl):	13.14	CASING HEIGHT (magl):	0	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	53.00	DIAM PUMP INLET (mm):	132	TEST PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1		RPM			DISCHARGE RATE 2					DISCHARGE RATE 3		RPM		
DATE: 8/6/2003		TIME: 10:30			DATE: -		TIME: -			DATE: -		TIME: -		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.06		1		1	9.95		1		1			1	37.24
2	1.93		2		2	10.55		2		2			2	34.13
3	2.47		3		3	10.90		3		3			3	31.09
5	3.25		5		5	11.20		5		5			5	24.51
7	3.87		7		7	11.43		7		7			7	19.30
10	4.60	0.52	10		10	11.75		10		10			10	11.67
15	5.49		15		15	12.10	1.83	15		15			15	9.00
20	6.13		20		20	12.55		20		20			20	7.89
30	6.85		30		30	16.13		30		30			30	6.37
40	7.20		40		40	21.20	1.83	40		40			40	5.00
50	7.37		50		50	26.30		50		50			50	3.80
60	7.70		60		60	31.25		60		60			60	2.96
70	8.25	0.65	70		70	35.55	1.83	70		70			70	2.45
80	8.50		80		80	39.86		80		80			80	2.10
90	8.70		90		86	39.86	0.83	90		90			90	1.81
100	8.80		100		90	39.86	0.76	100		100			100	0.65
120	9.00		110		95	39.86	0.76	110		110			120	0.00
AVERAGE YIELD		0.52	120		AVERAGE YIELD		1.83	120		AVERAGE YIELD		#DIV/0!	130	
pH		-	150		pH		-	150		pH			150	
TEMP (c)		-	180		TEMP (c)		-	180		TEMP (c)			180	
EC (mS/cm)		-	210		EC (mS/cm)		-	210		EC (mS/cm)			210	

DISCHARGE RATE 4		RPM			DISCHARGE RATE 5		RPM			DISCHARGE RATE 6			240	
DATE:		TIME:			DATE:		TIME:			DATE:			300	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	360	
													420	
1			1		1			1		1			480	
2			2		2			2		2			540	
3			3		3			3		3			600	
5			5		5			5		5			720	
7			7		7			7		7			840	
10			10		10			10		10			960	
15			15		15			15		15			1080	
20			20		20			20		20			1200	
30			30		30			30		30			1440	
40			40		40			40		40			1680	
50			50		50			50		50			1920	
60			60		60			60		60			2160	
70			70		70			70		70			2400	
80			80		80			80		80			2640	
90			90		90			90		90			2880	
100			100		100			100		100			3120	
110			110		110			110		110			3360	
AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	3600	
pH			150		pH			150		pH			3840	
TEMP (c)			180		TEMP (c)			180		TEMP (c)			4080	
EC (mS/cm)			210		EC (mS/cm)			210		EC (mS/cm)			4320	

Comments: During the recovery test two water strikes was identified 1) 25.88m and 2) 47.14 m

CONSTANT DISCHARGE TEST & RECOVERY

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 11	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	Bh 9	LATITUDE:	32 50' 13.7"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - GAME PARK
MONITOR BH NO:	Bh 10 / 12	LONGITUDE:	28 04' 34.7"		
BOREHOLE DEPTH:	64.90	DATUM LEVEL ABOVE CASING (m):	0.28	EXISTING PUMP:	OPEN
WATER LEVEL (mbgl)::	13.14	CASING HEIGHT (magl):	0.00	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	53.00	DIAM PUMP INLET(mm):	132.00	PUMP TYPE:	BP16H

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED		TEST COMPLETED		DURATION:	
DATE: 9/6/2003	TIME: 11:30	DATE:	TIME:	TYPE OF PUMP:	BP16H

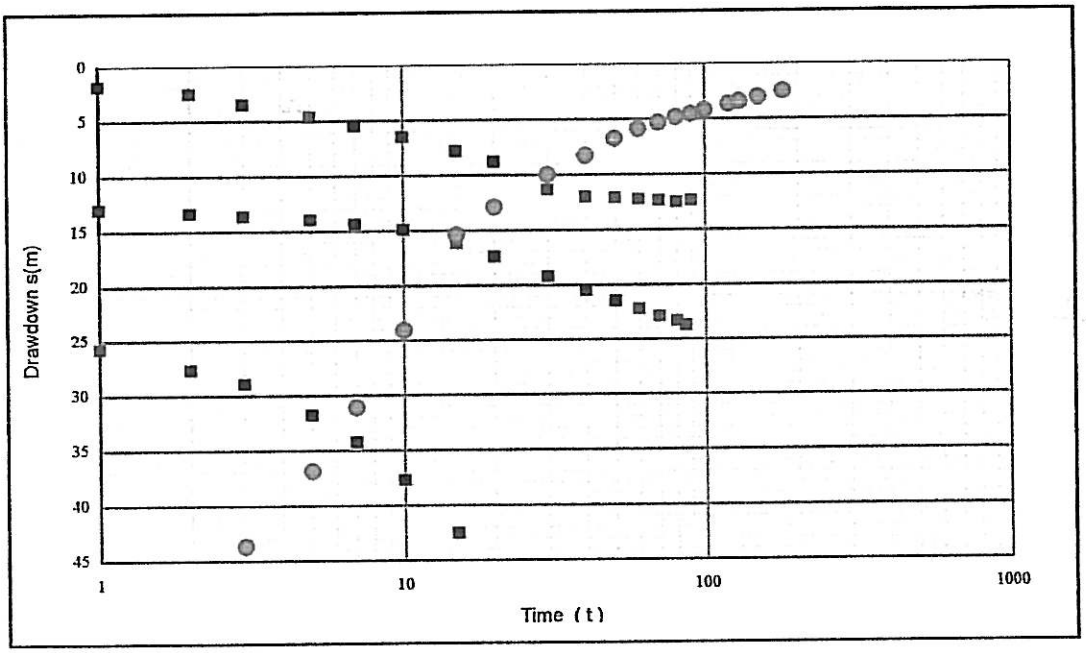
DISTANCE BETWEEN DISCHARGE :	OBSERVATION HOLE 1	OBSERVATION HOLE 2	OBSERVATION HOLE 3
AND OBSERVATION HOLES IN M:	NR: -	NR: -	NR: -

DISCHARGE BOREHOLE					Distance; -			Distance: -			Distance: -	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	0.89		1	22.33	1			1			1	
2	1.51		2	22.07	2			2			2	
3	1.94		3	20.77	3			3			3	
5	2.65		5	18.22	5			5			5	
7	3.21		7	15.87	7			7			7	
10	3.67	0.55	10	15.54	10			10			10	
15	4.46	0.64	15	10.64	15			15			15	
20	5.13		20	8.52	20			20			20	
30	5.93	0.66	30	6.13	30			30			30	
40	6.25		40	5.2	40			40			40	
60	6.47		60	4.25	60			60			60	
90	6.79		90	3.56	90			90			90	
120	7.00		120	3.12	120			120			120	
180	7.30		150	2.8	150			150			150	
240	7.55		180	2.58	180			180			180	
300	7.55		210	2.41	210			210			210	
360	7.95		240	2.28	240			240			240	
420	8.10		300	2.05	300			300			300	
540	8.40		360	1.91	360			360			360	
600	8.60		420	1.81	420			420			420	
720	8.77		480	1.7	480			480			480	
840	9.50		720	1.23	720			720			720	
960	9.25		960	0.84	960			960			960	
1080	9.86		1200	0.635	1200			1200			1200	
1200	10.50		1440	0.445	1440			1440			1440	
1320	11.50	0.52	1680	0.153	1680			1680			1680	
1440	11.80		1920	0.08	1920			1920			1920	
1560	12.55		2160	0.045	2160			2160			2160	
1680	15.25		1810		1810			1810			1810	
1800	19.10		1820		1820			1820			1820	
1920	20.50		1830		1830			1830			1830	
2160	21.90		1840		1840			1840			1840	
2400	22.45	0.51	1850		1850			1850			1850	
2640	22.53		1920		1920			1920			1920	
2880	22.62		2040		2040			2040			2040	
3120	22.76		2160		2160			2160			2160	
3360	22.82		2280		2280			2280			2280	
3600	22.83	0.58	2400		2400			2400			2400	
3840	22.95		2520		2520			2520			2520	
4080	23.05		2640		2640			2640			2640	
4320	23.15		2760		2760			2760			2760	
3121			2880.		2880			2880			2880	
4200			4200		4200			4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				4320		W/L			W/L			W/L
Average yield (l/s):				0.58								

STEP & CONSTANT DISCHARGE TEST GRAPHICS

PROJ NO : KHAMANGA BAY		MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	Bh 9	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	Bh11	LATITUDE	32 50' 12.06"	SITE NAME:	KHAMANGA BAY
MONITOR BH NO:	Bh 12	LONGITUDE:	28 04' 33.12"		
BOREHOLE DEPTH (m)	105 m	DATUM LEVEL ABOVE CASING (m):	0.20	EXISTING PUMP:	EXIST B/H
WATER LEVEL (mbgl):	8.85	CASING HEIGHT (magl):	0.85	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	38.16	DIAM PUMP INLET (mm):	160.00	PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY



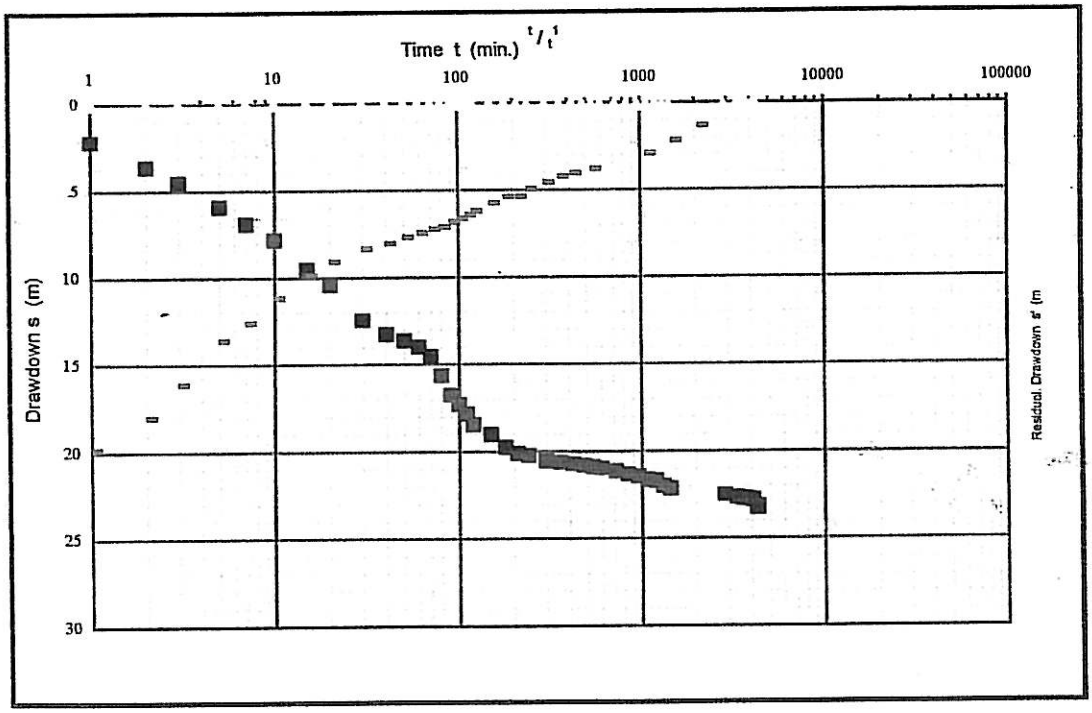
■' = Drawdown data.
● = Recovery data.

DISCHARGE RATES (Q)

Q1 =	0.39	l/s
Q2 =	0.54	l/s
Q3 =	-	l/s
Q4 =	-	l/s
Q5 =	-	l/s

S.W.L = 8.85 m b.g.l.

CONSTANT DISCHARGE TEST & RECOVERY



■' = Drawdown data.
– = Recovery data.
= Monitor b/hole data.

Q = 0.5 l/s.

S.W.L = 8.85 m.b.g.l.

T = 0.48 m²/day

Abstraction 0.3 l/s
26 m³/day
778 m³/month

Class 2 water

COMMENTS

Tel: (043) 748 2723; Fax: (043) 748 2723
5 High Field road, Beacon Bay, 5205
E-mail: adgeoconsul@telkomsa.net

AD Geo Consultants cc

BOREHOLE TEST RECORD

CONSULTANT: AD GEO CONSULTANTS CC

DISTRICT: AMATOLA

PROVINCE: EASTERN CAPE

SITE NAME: KHAMANGA BAY DEVELOPMENT - CARAVAN PARK (TREVERS)

PROJECT NO. KHAMANGA BAY DEVELOPMENT

DATE TESTED: 22/6/2003

MAP REFERENCE: 3228CC

CO-ORDINATES:

LATITUDE: 32 50' 19.0"

LONGITUDE: 28 06' 50.4"

BOREHOLE NO: KHAM 6 **Monitor b/h:** KHAM 4 **Monitor b/h:** KHAM 5 / 7

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: NEWLY DRILLED BOREHOLE

BOREHOLE DEPTH: (mbgl) 60 m

BOREHOLE DEPTH:	60	**WATER LEVEL (mbgl):**	5.48	**CASING HEIGHT (magl):**	0.4
DATUM LEVEL ABOVE CASING (m):	0	**DEPTH OF PUMP(m):**	52.5	**Diam pump inlet (mm):**	132
EXISTING PUMPTYPE:	NEW B/H	**CONTRACTORS:**	KHAMANGA	**TEST PUMP TYPE:**	BP16H

COMMENTS:

This borehole is located within the dune area 200m from the coast area. Annual rain fall of the area is 900mm, Starage capasity of the fresh water 9600m3.

Total of 3 addisional boreholes were drilled to monitor the water levels and quality (kham 4, 5 & 7)

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	0
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST:	M	0
CASING DETECTION:	NO	0	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	0
BOREHOLE MARKING	NO	0	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	0	LAYFLAT (M):	M	0

FORM 5 E

STEP DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	KHAM 6	CO-ORDINATES:		DISTRICT:	AMATOLA
ALT BH NO:	KHAM 4	LATITUDE	32 50' 19.0"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - CARAVAN PARK (TREVERS)
ALT BH NO:	0	LONGITUDE:	28 06' 50.4"		

BOREHOLE DEPTH (m)	60.00	DATUM LEVEL ABOVE CASING (m):	0	EXISTING PUMP:	NEW B/H
WATER LEVEL (mbgl):	5.48	CASING HEIGHT (magl):	0.4	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	52.50	DIAM PUMP INLET (mm):	132	TEST PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1		RPM			DISCHARGE RATE 2					DISCHARGE RATE 3		RPM		
DATE: 26/7/2003		TIME: 15:00			DATE: 26/7/2003		TIME: 16:00			DATE: 26/07/2003		TIME: 17:00		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	1.18		1		1	10.08		1		1			1	20.72
2	1.95		2		2	10.25		2		2			2	19.29
3	2.55	0.85	3		3	10.40		3		3			3	17.94
5	3.58		5		5	11.00		5		5			5	15.30
7	4.38	1.00	7		7	12.05		7		7			7	13.58
10	5.40		10		10	14.55		10		10			10	10.91
15	6.59	1.06	15		15	16.52	1.83	15		15			15	7.29
20	7.53		20		20	18.57		20		20			20	4.86
30	8.57		30		30	21.68		30		30			30	2.88
40	9.18	1.04	40		40	23.55	1.83	40		40			40	2.18
50	9.65		50		50	25.50		50		50			50	1.79
60	9.81		60		60	26.13		60		60			60	1.52
70			70		70	27.40	1.83	70		70			70	1.25
80			80		80			80		80			80	1.16
90			90		90			90		90			90	1.05
100			100		100			100		100			120	0.80
110			110		110			110		110			180	0.57
AVERAGE YIELD		0.99	120		AVERAGE YIELD		1.83	120		AVERAGE YIELD		#DIV/0!	240	0.45
pH		7.15	150		pH		7.16	150		pH			150	
TEMP (c)			180		TEMP (c)			180		TEMP (c)			180	
EC (mS/cm)		118	210		EC (mS/cm)		121	210		EC (mS/cm)			210	

DISCHARGE RATE 4		RPM			DISCHARGE RATE 5					DISCHARGE RATE 6				
DATE:		TIME:			DATE:		TIME:			DATE:				
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1		1			1		1			300	
2			2		2			2		2			360	
3			3		3			3		3			420	
5			5		5			5		5			480	
7			7		7			7		7			540	
10			10		10			10		10			600	
15			15		15			15		15			720	
20			20		20			20		20			840	
30			30		30			30		30			960	
40			40		40			40		40			1080	
50			50		50			50		50			1200	
60			60		60			60		60			1440	
70			70		70			70		70			1680	
80			80		80			80		80			1920	
90			90		90			90		90			2160	
100			100		100			100		100			2400	
110			110		110			110		110			2640	
AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	120		AVERAGE YIELD		#DIV/0!	2880	
pH			150		pH			150		pH			3120	
TEMP (c)			180		TEMP (c)			180		TEMP (c)			3360	
EC (mS/cm)			210		EC (mS/cm)			210		EC (mS/cm)			3600	
													3840	
													4080	
													4320	

Comments:

CONSTANT DISCHARGE TEST & RECOVERY

PROJ NO :	KHAMANGA BAY	MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	KHAM 6	CO-ORDINATES:		DISTRICT:	AMATOLA
ALT BH NO:	KHAM 4	LATITUDE:	32 50' 19.0"	SITE NAME:	KHAMANGA BAY DEVELOPMENT - CARAVAN PARK (TREVERS)
ALT BH NO:	0	LONGITUDE:	28 06' 50.4"		
BOREHOLE DEPTH:	60.00	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	NEW B/H
WATER LEVEL (mbgl)::	5.48	CASING HEIGHT (magl):	0.40	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	52.50	DIAM PUMP INLET(mm):	132.00	PUMP TYPE:	BP16H

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED		TEST COMPLETED		DURATION:	
DATE: 27/06/2003	TIME: 11:10	DATE:	TIME:	TYPE OF PUMP:	BP16H

DISTANCE BETWEEN DISCHARGE : AND OBSERVATION HOLES IN M:	OBSERVATION HOLE 1	OBSERVATION HOLE 2	OBSERVATION HOLE 3
	NR: KHAM 4	NR: KHAM 5	NR: KHAM 7

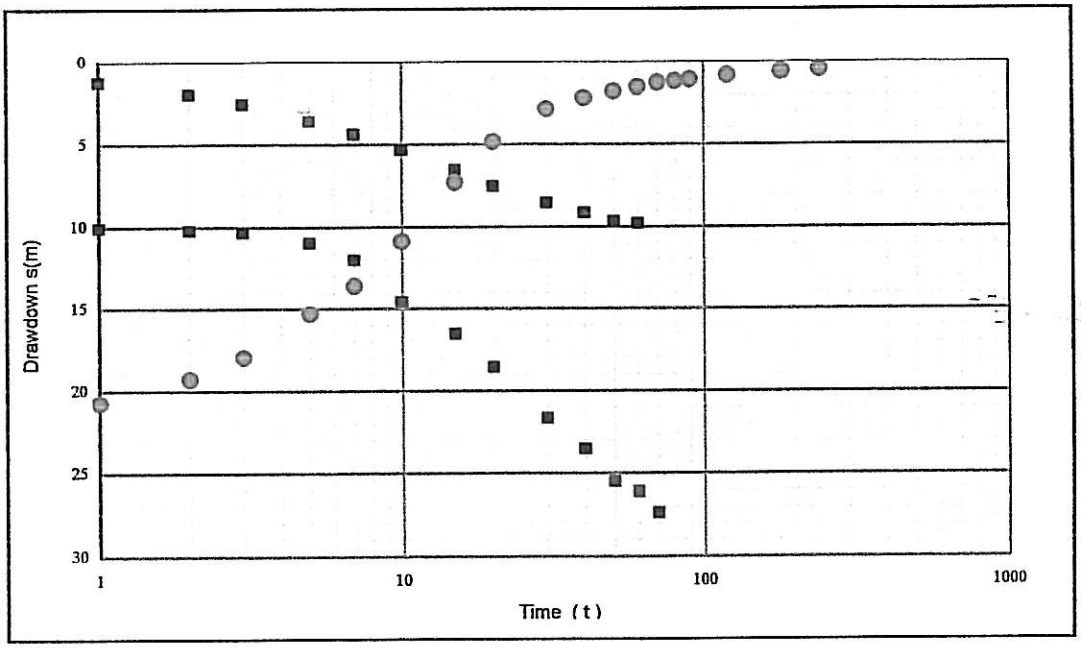
DISCHARGE BOREHOLE					Distance; 105 m			Distance: 78 m			Distance 350 m	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	2.29		1	22.33	2	0.2		3	0.1		5	0.1
2	3.64		2	22.07	36	0.6		22	0.3		30	0.16
3	4.46		3	20.77	72	1.3		41	0.67		67	0.177
5	6.30	1.21	5	18.22	98	0.24		65	1.12		131	0.18
7	7.56		7	15.87	118	1.96		87	1.35		189	0.2
10	9.13		10	15.54	159	3.21		126	1.69		264	0.12
15	10.60	1.33	15	10.64	206	3.75		184	2.86		312	0.115
20	11.85	1.33	20	8.52	268	4.15		247	2.36		376	0.05
30	13.66		30	6.13	330	4.49		308	2.57		435	0.02
40	14.77		40	5.2	392	4.65		373	2.75		493	0.05
60	16.32	1.40	60	4.25	451	4.56		433	2.84		552	0.09
90	17.08	1.39	90	3.56	508	4.66		493	2.85		620	0.09
120	18.49	1.39	120	3.12	568	5.1		551	3.13		671	0.09
180	19.23	1.39	150	2.8	637	5.27		615	3.16		741	0.07
240	20.26	1.40	180	2.58	688	5.29		666	3.24		861	0.04
300	20.71	1.40	210	2.41	757	5.4		736	3.35		982	0.04
360	20.46	1.42	240	2.28	877	5.53		856	3.36		1101	0.04
420	20.45	1.39	300	2.05	997	5.55		976	3.48		1220	0.12
540	20.70	1.35	360	1.91	1113	5.72		1093	3.5		1341	0.12
600	20.95	1.36	420	1.81	1231	5.8		1213	3.63		1459	0.095
720	21.10	1.39	480	1.7	1350	5.95		1330	3.78		1576	0.106
840	21.09	1.42	720	1.23	1591	5.9		1448	3.87		1699	0.13
960	21.25	1.39	960	0.84	1827	6.2		1691	3.9		1821	0.15
1080	21.26	1.43	1200	0.635	2071	6.18		1926	4.05		2061	0.2
1200	21.85	1.39	1440	0.445	2312	6.24		2171	4.21		2312	0.18
1320	22.00	1.43	1680	0.153	2557	6.2		2411	4.2		2541	0.19
1440	22.15	1.41	1920	0.08	2792	6.42		2656	4.15		2781	0.195
1560	22.43	1.42	2160	0.045	3042	6.49		2891	4.34		3011	0.2
1680	22.53	1.39	1810		3272	6.43		3147	4.36		3256	0.19
1800	22.70	1.43	1820		3517	6.48		3377	4.34		3491	0.19
1920	22.98	1.41	1830		3761	6.51		3621	4.4		3735	0.24
2160	23.29	1.42	1840		4005	6.42		3860	4.45		3967	0.24
2400	23.39	1.39	1850		4236	6.65		4101	4.55		1800	
2640	23.48	1.39	1920		1920			4343	4.58		1920	
2880	23.59	1.39	2040		2040			2040			2040	
3120	23.65	1.44	2160		2160			2160			2160	
3360	23.75	1.48	2280		2280			2280			2280	
3600	23.95	1.49	2400		2880			2880			2880	
3840	24.25	1.22	2520		3120			3120			3120	
4080	24.35	1.44	2640		2640			2640			2640	
4320	25.22	1.44	2760		2760			2760			2760	
3121			2880		2880			2880			2880	
4200			4200		4200			4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				4320		W/L	4.57		W/L	9.18	W/L	13.47
Average yield (l/s):				1.39								

STEP & CONSTANT DISCHARGE TEST GRAPHICS

PROJ NO : KHAMANGA BAY		MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO.	KHAM 6	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	KHAM 4	LATITUDE	32 50' 19.0"	SITE NAME:	KHAMANGA BAY
MONITOR BH NO:	KHAM 7, KHAM 5	LONGITUDE:	28 05' 50.4"		

BOREHOLE DEPTH (m)	60 m	DATUM LEVEL ABOVE CASING (m):	0.20	EXISTING PUMP:	NEWLY DRILLED BOREHOLE
WATER LEVEL (mbgl):	8.85	CASING HEIGHT (magl):	0.85	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	38.16	DIAM PUMP INLET (mm):	160.00	PUMP TYPE:	BP16H

STEPPED DISCHARGE TEST & RECOVERY



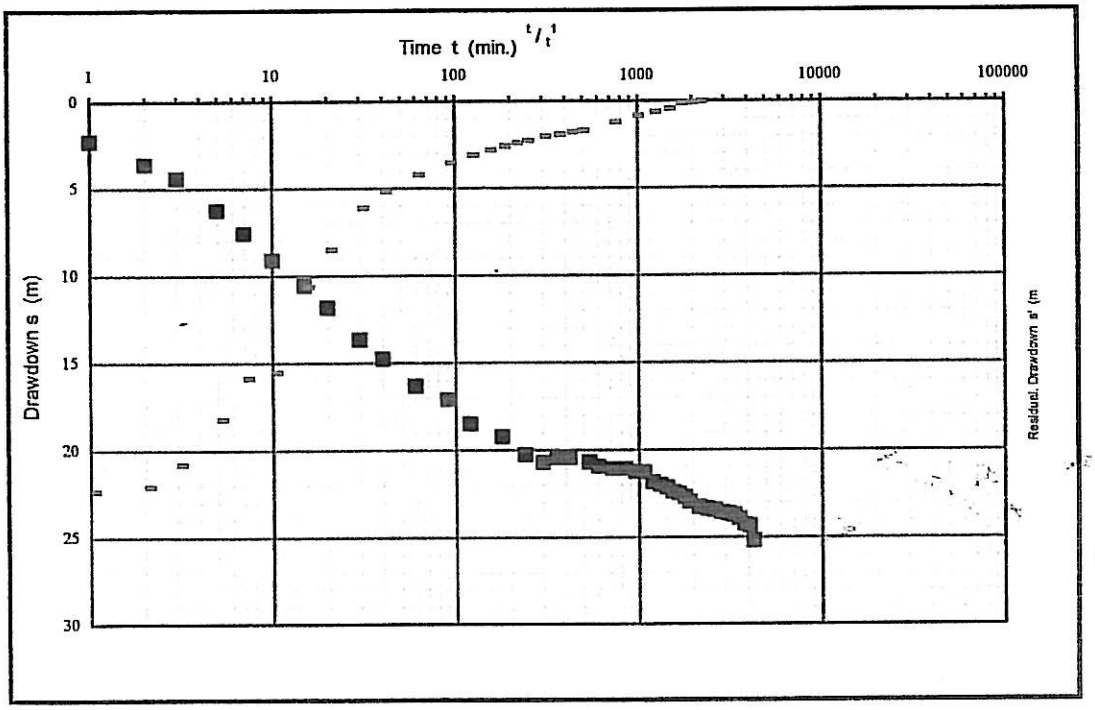
■ = Drawdown data.
o = Recovery data.

DISCHARGE RATES (Q)

Q1 = 0.99 l/s
Q2 = 1.83 l/s
Q3 = l/s
Q4 = l/s
Q5 = l/s

S.W.L = 8.85 m.b.g.l.

CONSTANT DISCHARGE TEST & RECOVERY



■ = Drawdown data.
_ = Recovery data.

Q = 1.4 l/s.

S.W.L = 8.85 m.b.g.l.

T = m^2/day

Spec. Cap. = m^2/day/m

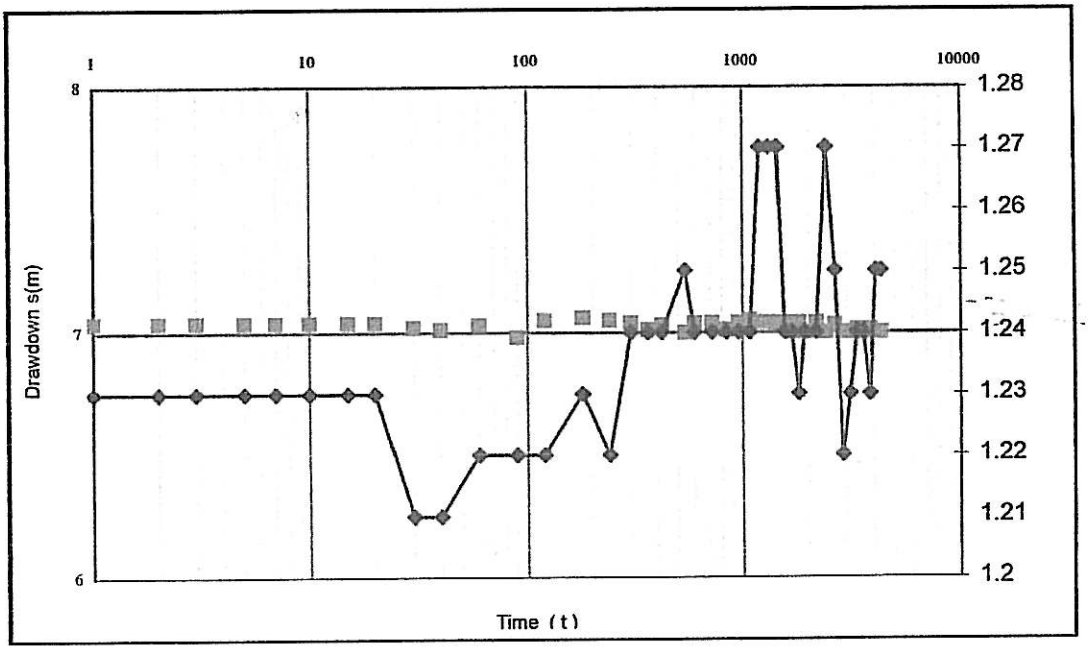
COMMENTS

STEP & CONSTANT DISCHARGE TEST GRAPHICS

PROJ NO : KHAMANGA BAY		MAP REFERENCE:	3228CC	PROVINCE:	EASTERN CAPE
BOREHOLE NO:	KHAM 6	CO-ORDINATES:		DISTRICT:	AMATOLA
MONITOR BH NO:	KHAM 4	LATITUDE	32 50' 19.0"	SITE NAME:	KHAMANGA BAY
MONITOR BH NO:	KHAM 7, KHAM 5	LONGITUDE:	28 05' 50.4"		

BOREHOLE DEPTH (m)	60 m	DATUM LEVEL ABOVE CASING (m):	0.20	EXISTING PUMP:	NEWLY DRILLED BOREHOLE
WATER LEVEL (mbgl):	8.85	CASING HEIGHT (magl):	0.85	CONTRACTOR:	KHAMANGA
DEPTH OF PUMP (m):	38.16	DIAM PUMP INLET (mm):	160.00	PUMP TYPE:	BP16H

MONITORING OF WATER QUALITY ON KHAM 6

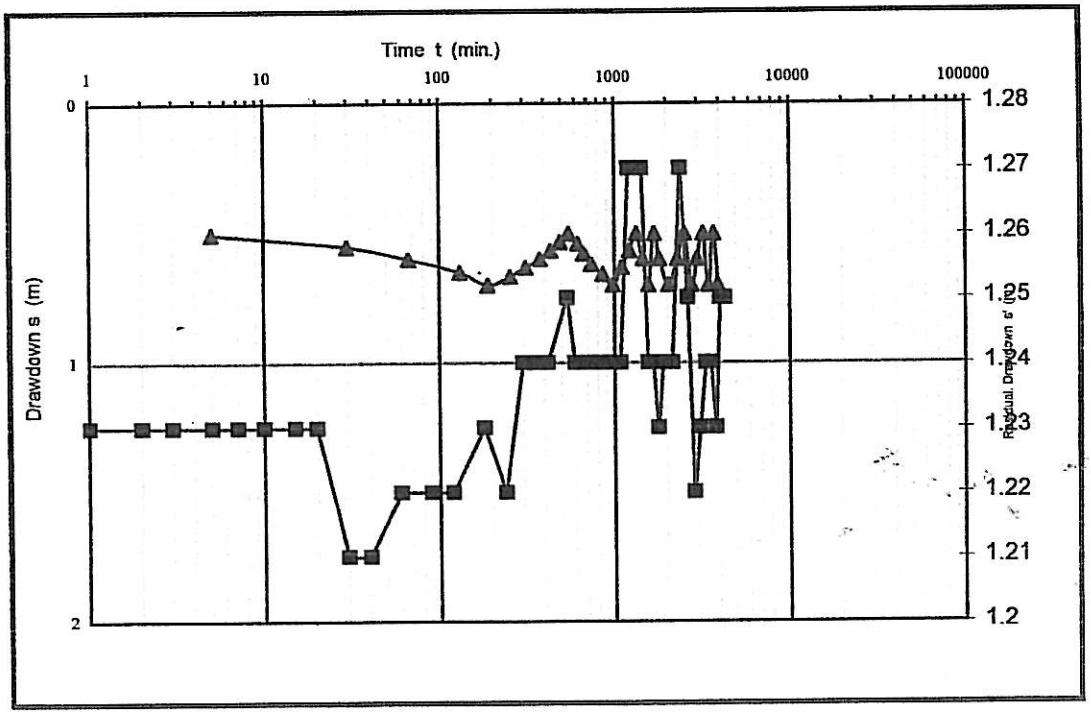


♦ = EC (mSm/cm)

■ = (pH)

S.W.L = 8.85 m.b.g.l.

TIDE / PUMP EFFECT ON BOREHOLE KHAM 7



■ = Drawdown data Bh7

▲ = Tide data

Q = 1.4 l/s.

S.W.L = 8.85 m.b.g.l.

T = m²/day

Spec. Cap. = m²/day/m

COMMENTS

APPENDIX C

Chemical test results

Chemical analyses of water

Borehole No.	Bh 4 (32° 50' 33.66" / 28° 06' 57.12")						
Project	George's Place - private borehole						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.080	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	129.500	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.700	1	0.100	1.000	20.000	50.000	50.000
Alkalinity	224.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	0.800	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	281.000	2	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	81.300	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	196.000	1	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	64.500	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	161.000	0	200.000	375.000	750.000	750.000	
Magnesium (Mg)	35.800	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	147.000	0	242.900	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	308.000	2	200.000	300.000	600.000	600.000	
Potassium (K)	3.720	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	0.730	1	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.060	1	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 2

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	Bh 7 (32° 51' 01.5" / 28° 06' 59.1")						
Project	Khamanga Bay Development (Allan' place)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.050	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	121.900	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.900	1	0.100	1.000	20.000	50.000	50.000
Alkalinity	266.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	0.800	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	214.000	2	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	70.400	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	249.000	2	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	22.500	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	56.000	0	200.000	375.000	750.000	750.000	
Magnesium (Mg)	17.300	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	71.000	0	242.000	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	127.000	0	200.000	300.000	600.000	600.000	
Potassium (K)	2.620	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	0.490	0	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.060	1	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 2

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups.
	Drinking Aesthetic :	Some effects possible after lifetime use Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	No 9 - GAME PARK (32 50' 12.6" / 28 04' 34.44")						
Project	KHAMANGA BAY HOUSING DEVELOPMENT						
District	AMATOLA DISTRICT MUNICIPALITY						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	6.740	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	100.000	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.800	1	0.100	1.000	20.000	50.000	50.000
Alkalinity	109.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	3.000	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	219.000	2	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	51.700	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	174.000	1	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	12.000	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	30.000	0	200.000	375.000	750.000	750.000	
Magnesium (Mg)	13.100	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	54.000	0	242.900	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	84.000	0	200.000	300.000	600.000	600.000	
Potassium (K)	1.020	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	0.800	1	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.040	0	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water: 2

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	Bh 11 - GAME PARK (32 50'13.7" / 28 04'34.7")						
Project	KHAMANGA BAY HOUSING DEVELOPMENT						
District	AMATOLA DISTRICT MUNICIPALITY - EASTERN CAPE						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	6.860	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	128.500	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.000	0	0.100	1.000	20.000	50.000	50.000
Alkalinity	208.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	2.000	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	200.000	2	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	82.000	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	163.000	1	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	41.500	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	104.000	0	200.000	378.000	750.000	750.000	
Magnesium (Mg)	27.000	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	111.000	0	242.900	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	215.000	1	200.000	300.000	600.000	600.000	
Potassium (K)	2.700	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)		0	0.750	1.000	1.500	3.500	3.500
Iron (Fe)	1.640	2	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 2

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups.
	Drinking Aesthetic :	Some effects possible after lifetime use Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	KHAM 1 (32° 51' 21.3" / 28° 06' 13.6")						
Project	Khamanga Bay Development (Valley east of development site)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.290	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	423.000	3	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.000	0	0.100	1.000	20.000	50.000	50.000
Alkalinity	352.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	0.600	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	1219.000	4	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	103.000	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	764.000	3	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	87.000	1	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	217.000	1	200.000	375.000	750.000	750.000	
Magnesium (Mg)	73.300	1	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	302.000	1	242.000	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	519.000	2	200.000	300.000	600.000	600.000	
Potassium (K)	14.800	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	1.690	3	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.070	1	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water: 4

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Chemical analyses of water

Borehole No.	KHAM 2 (32° 51' 11.1" / 28° 06' 00.9")						
Project	Khamanga Bay Development (Valley east of development site)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.050	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	435.000	3	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	2.100	2	0.100	1.000	20.000	50.000	50.000
Alkalinity	461.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	0.200	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	1160.000	3	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	110.000	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	704.000	3	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	127.000	1	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	317.000	1	200.000	375.000	750.000	750.000	
Magnesium (Mg)	99.500	1	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	410.000	2	242.000	247.000	694.000	1388.000	1388.000
Total hardness (T.H.)	727.000	3	200.000	200.000	600.000	600.000	
Potassium (K)	12.400	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	1.460	2	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.150	1	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 3

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	KHAM 3 (32° 51' 08.0" / 28° 05' 59.6")						
Project	Khamanga Bay Development (Valley east of development site)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	6.930	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	392.000	3	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	4.100	2	0.100	1.000	20.000	50.000	50.000
Alkalinity	371.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)	0.800	0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	1143.000	3	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)	118.000	0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	723.000	3	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	101.000	1	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	252.000	1	200.000	375.000	750.000	750.000	
Magnesium (Mg)	83.100	1	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	342.000	1	242.900	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	594.000	2	200.000	300.000	600.000	600.000	
Potassium (K)	8.350	0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)	1.490	2	0.700	1.000	1.500	3.500	3.500
Iron (Fe)	0.390	1	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 3

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	KHAM 4 (32° 50' 21.2" / 28° 06' 49.2")						
Project	Khamanga Bay Development (Trevers Caravan Park)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.750	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	93.500	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	20.000	3	0.100	1.000	20.000	50.000	50.000
Alkalinity	109.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)		0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	193.000	1	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)		0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	173.000	1	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	46.400	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	116.000	0	200.000	375.000	750.000	750.000	
Magnesium (Mg)	11.400	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	47.000	0	242.000	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	163.000	0	200.000	300.000	600.000	600.000	
Potassium (K)		0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)		0	0.700	1.000	1.500	3.500	3.500
Iron (Fe)		0	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.002	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 3

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	KHAM 5 (32° 50' 16.1" / 28° 06' 48.4")						
Project	Khamanga Bay Development (Trevers Caravan Park)						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.690	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	247.000	2	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	106.000	4	0.100	1.000	20.000	50.000	50.000
Alkalinity	199.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)		0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	613.000	3	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)		0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	466.000	3	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	97.500	1	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	243.000	1	200.000	375.000	750.000	750.000	
Magnesium (Mg)	58.000	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	239.000	0	242.800	347.000	694.000	1388.000	1388.000
Total hardness (T.H.)	482.000	2	200.000	300.000	600.000	600.000	
Potassium (K)		0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)		0	0.700	1.000	1.500	3.500	3.500
Iron (Fe)		0	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.000	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water 4

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

Chemical analyses of water

Borehole No.	KHAM 6 (32 50' 19.0" / 28 06' 50.4")						
Project	Khamanga Bay Development - Trevers Caravan park						
District	Amatole District Municipality						
Constituent (mg/l)	Tested	Class	Class 0 <	Class 1 <	Class 2 <	Class 3 <	Class 4 >
pH	7.950	0	5 - 9.5	4.5 - 5 or 9.5 - 10	4 - 4.5 or 10 - 10.5	3 - 4 or 10.5 - 11	< 3 or > 11
EC (mS/m)	120.100	1	70.000	150.000	370.000	520.000	520.000
Turbidity (NTU)	0.000	0	0.100	1.000	20.000	50.000	50.000
Alkalinity	133.000						
Ammonia (as N)		0	1.000	2.000	10.000	10.000	
Nitrate (as N)		0	6.000	10.000	20.000	40.000	40.000
Chloride (Cl)	267.000	2	100.000	200.000	600.000	1200.000	1200.000
Sulphate (SO4)		0	200.000	400.000	600.000	1000.000	1000.000
Sodium (Na)	196.500	1	100.000	200.000	400.000	1000.000	1000.000
Calcium (Ca)	42.500	0	80.000	150.000	300.000	300.000	
Calcium (CaCO3)	106.000	0	200.000	375.000	750.000	750.000	
Magnesium (Mg)	19.100	0	70.000	100.000	200.000	400.000	400.000
Magnesium (MgCO3)	79.000	0	242.000	342.000	694.000	1388.000	1388.000
Total hardness (T.H.)	185.000	0	200.000	300.000	600.000	600.000	
Potassium (K)		0	25.000	50.000	100.000	500.000	500.000
Fluoride (F)		0	0.700	1.000	1.500	3.500	3.500
Iron (Fe)		0	0.050	1.000	5.000	10.000	10.000
Total Count		0	100.000	1000.000	1000.000		
Total coliforms (T.col)		0	0.000	10.000	100.000	1000.000	1000.000
Faecal coliforms (Fc)		0	0.001	1.000	10.000	100.000	100.000
TDS		0	450.000	1000.000	2400.000	3400.000	3400.000
Arsenic (As)		0	0.010	0.050	0.200	2.000	2.000
Cadmium (Cd)		0	0.003	0.005	0.020	0.050	0.050
Copper (Cu)		0	1.000	1.300	2.000	15.000	15.000
Manganese (Mn)		0	0.100	0.400	4.000	10.000	10.000
Zinc (Zn)		0	20.000	20.000			

Class of water: 2

Nitrate (as N)*4.42 = Nitrate (as NO3)

Class 0	Ideal water quality-suitable for lifetime use.
Class 1	Good water quality-suitable for use, rare instances of negative effects.
Class 2	Marginal water quality-conditionally acceptable. Negative effects may occur in some sensitive groups.
Class 3	Poor water quality-unsuitable for use without treatment. Chronic effects may occur.
Class 4	Dangerous water quality-totally unsuitable for use. Acure effects may occur.

Class 0	Drinking health :	No effects, suitable for many generations.
	Drinking Aesthetic :	Waters is pleasing.
	Food preparation :	No effects.
	Bathing :	No effects.
	Laundry :	No effects.
Class 1	Drinking health :	Suitable for lifetime use. Rare instances of sub-clinical effects.
	Drinking Aesthetic :	Some aesthetic effects may be apparent.
	Food preparation :	Suitable for lifetime use.
	Bathing :	Minor effects on bathing or on bathing or on bath fixtures.
	Laundry :	Minor effects on laundry or on fixtures.
Class 2	Drinking health :	May be used without health effects by majority of individuals of all ages, but may cause effects in some individuals in sensitive groups. Some effects possible after lifetime use
	Drinking Aesthetic :	Poor taste and appearance are noticeable.
	Food preparation :	May be used without health or aesthetic effects by the majority persons
	Bathing :	Slight effects on bathing or on bath fixtures.
	Laundry :	Slight effects on bathing or on bath fixtures.
Class 3	Drinking health :	Poses a risk of chronic health effects, especially in babies, children and the elderly.
	Drinking Aesthetic :	Bad taste and appearance may lead to rejection of the water.
	Food preparation :	Poses a risk of chronic health effects, especially in children and elderly
	Bathing :	Significant effects on bathing or on bath fixtures.
	Laundry :	Significant effects on laundry or on fixtures.
Class 4	Drinking health :	Severe acute health effects, even with short-term use.
	Drinking Aesthetic :	Taste and appearance will lead to rejection of the water.
	Food preparation :	Severe acute health effects, even with short-term use.
	Bathing :	Serious effects on bathing or on bath fixtures.
	Laundry :	Serious effects on bathing or on bath fixtures.

Comments

APPENDIX D

Detail geological borehole logs

AD GEO CONSULTANTS CC
5 High Field Road
BEACON BAY, 5205
TEL NO: +27 43 7482723
FAX NO: +27 43 748 2723

PERCUSSION DRILLING RECORD | **METHOD:**

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : TARGET AREA 1 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED : 3/5/2003

BOREHOLE Nr. : KHAM 1 GEOPH PEG No.: Line 4/60
WATER LEVEL: 22.31 LATITUDE : 32° 51' 21.3"
B/HOLE DEPTH 78 LONGITUDE : 28° 06' 13.6"
ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

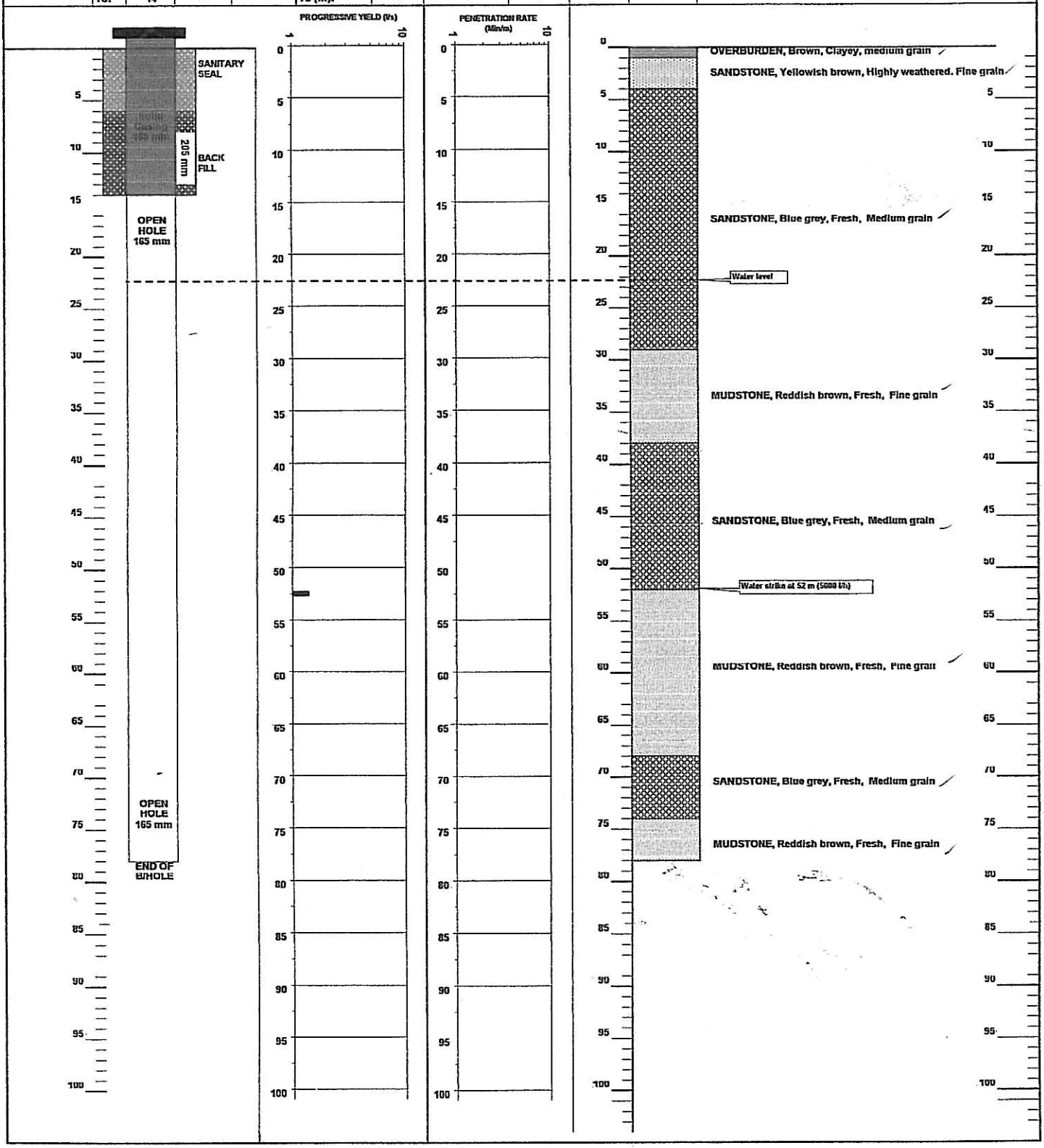
Borehole Diameter (mm)			
Diam:	205	165	-
From:	0	14	-
To:	14	78	-

Casing Detail						
Diam. OD (mm	178	-	-	-	-
Thickness	4	-	-	-	-
Material	Steel	-	-	-	-
Plain/Perf.	Plain	-	-	-	-
From (m):	0.39	-	-	-	-
To (m):	14	-	-	-	-

LITHOLOGY

Geology: BEAUFORD GROUP, TARKASTAD SUBGROUP, Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills

Drilling Target: Bedding plane fractures



AD GEO CONSULTANTS CC
5 High Field Road
BEACON BAY, 5205
TEL NO: +27 43 7482723
FAX NO: +27 43 748 2723

PERCUSSION DRILLING RECORD

METHOD:

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : TARGET AREA 1 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED : 6/5/2003

BOREHOLE Nr. : KHAM 2 GEOPH PEG No.: Line 5/250
WATER LEVEL: 9.38 LATITUDE : 32° 51' 11.1"
B/HOLE DEPTH: 78 LONGITUDE : 28° 06' 00.9"
BLOW YIELD (l/s 5 ALTITUDE:

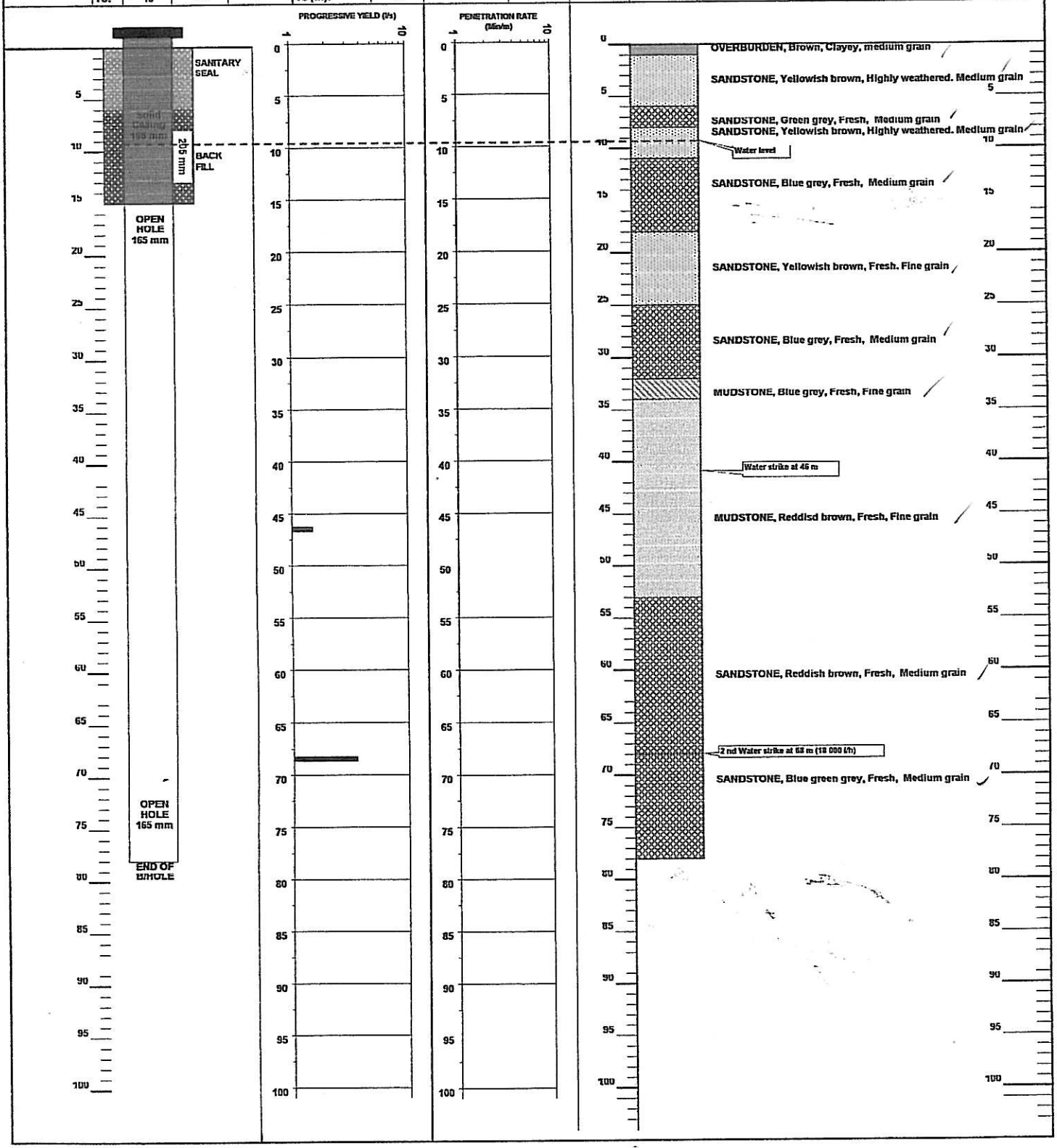
BOREHOLE CONSTRUCTION DETAIL

Borehole Diameter (mm)			
Diam:	205	165	-
From	0	15	-
To:	15	78	-

Casing Detail					
Diam. OD (mm)	178	-	-	-	-
Thickness	4	-	-	-	-
Material	Steel	-	-	-	-
Plain/Perf.	Plain	-	-	-	-
From (m):	0.49	-	-	-	-
To (m):	15	-	-	-	-

Geology: LITHOLOGY
BEAUFORD GROUP, TARKASTAD SUBGROUP,
Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills

Drilling Target: Bedding plane fractures



AD GEO CONSULTANTS CC
5 High Field Road
BEACON BAY, 5205
TEL NO: +27 43 7482723
FAX NO: +27 43 748 2723

PERCUSSION DRILLING RECORD

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : TARGET AREA 1 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED : 8/5/2003

METHOD:

BOREHOLE Nr. : KHAM 3 GEOPH PEG No.: Line 5/100
WATER LEVEL: 8.07 LATITUDE : 32° 51' 08.0"
B/HOLE DEPTH: 86 LONGITUDE : 28° 05' 59.6"
BLOW YIELD (l/s 1.67 ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

Borehole Diameter (mm)			
Diam	205	165	-
From	0	11	-
To:	11	86	-

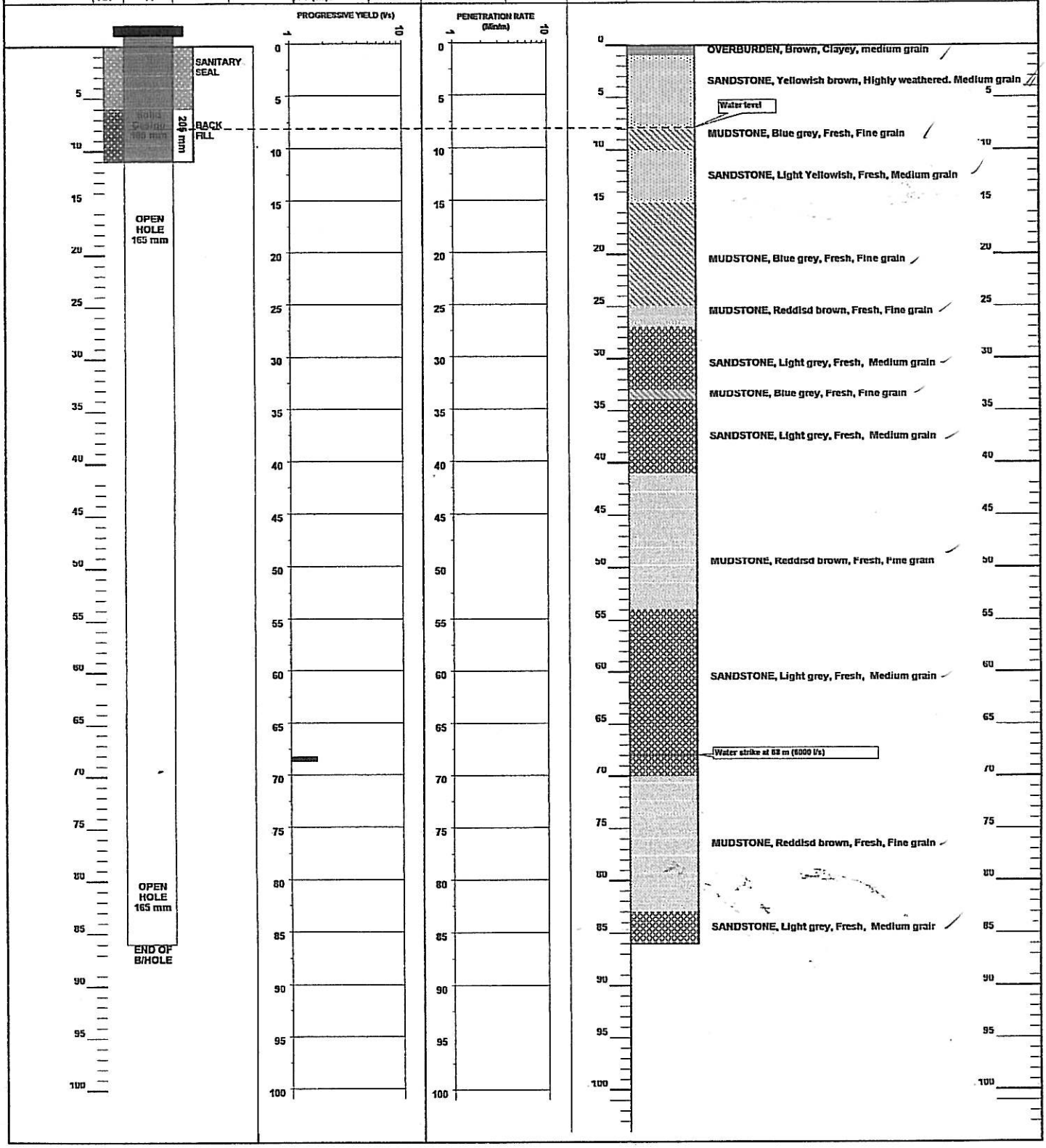
Casing Detail

Diam. OD (mm	178	-	-	-	-
Thickness	4	-	-	-	-
Material	Steel	-	-	-	-
Plain/Perf.	Plain	-	-	-	-
From (m):	0.47	-	-	-	-
To (m):	11	-	-	-	-

LITHOLOGY

Geology: BEAUFORD GROUP, TARKASTAD SUBGROUP, Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills

Drilling Target: Northern contact of an east - west trending dyke



AD GEO CONSULTANTS CC
5 High Field Road
BEACON BAY, 5205
TEL NO: +27 43 7482723
FAX NO: +27 43 748 2723

PERCUSSION DRILLING RECORD

METHOD:

CLIENT : KHAMANGA BAY PROJECT : KHAMANGA BAY
SITE : TARGET AREA 2 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED : 22/05/2003

BOREHOLE Nr. : KHAM 4 GEOPH PEG No.: Line 2/160
WATER LEVEL: 8.39 LATITUDE : 32° 50' 21.2"
B/HOLE DEPTH: 101 LONGITUDE : 28° 06' 49.2"
BLOW YIELD: 1.4 ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

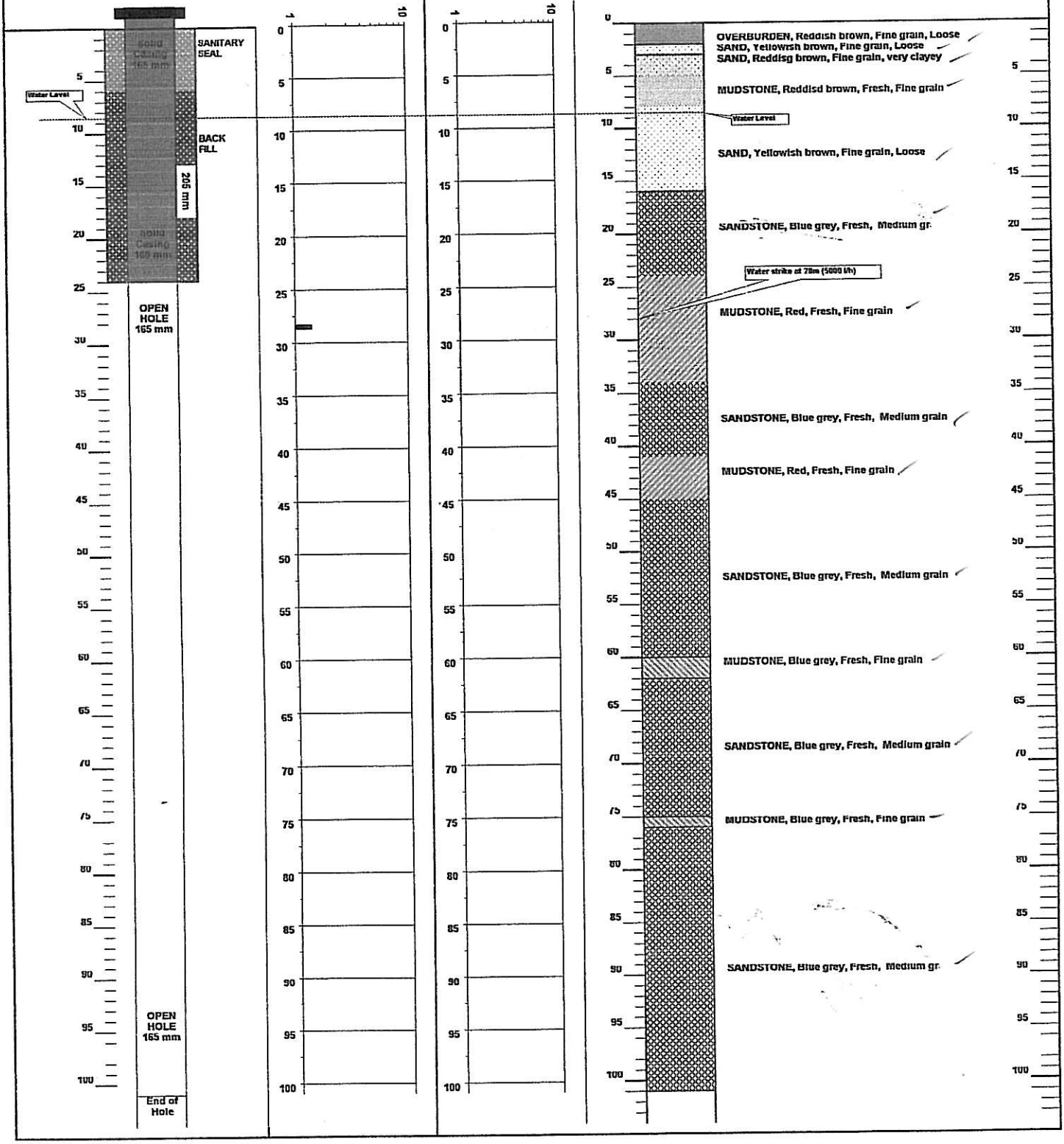
Borehole Diameter (mm)			
Diam:	205	165	-
From	0	24	-
To:	24	101	-

Casing Detail

Diam. OD (mm	178	-	-	-	-
Thickness	4	-	-	-	-
Material	Steel	-	-	-	-
Plain/Perf.	Plain	-	-	-	-
From (m):	0.3	-	-	-	-
To (m):	24	-	-	-	-

Geology: LITHOLOGY
BEAUFORD GROUP, TARKASTAD SUBGROUP, Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills

Drilling Target: Bedding plane fractures



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PERCUSSION DRILLING RECORD

METHOD:

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : TARGET AREA 2 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED : 26/5/2003

BOREHOLE Nr. : KHAM 5 GEOPH PEG No.: Line 1/ station 200
WATER LEVEL: 4.57 LATITUDE : 32° 50' 16.1"
B/HOLE DEPTH: 78 LONGITUDE : 28° 06' 48.4"
BLOW YIELD: 0.28 ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

Borehole Diameter (mm)

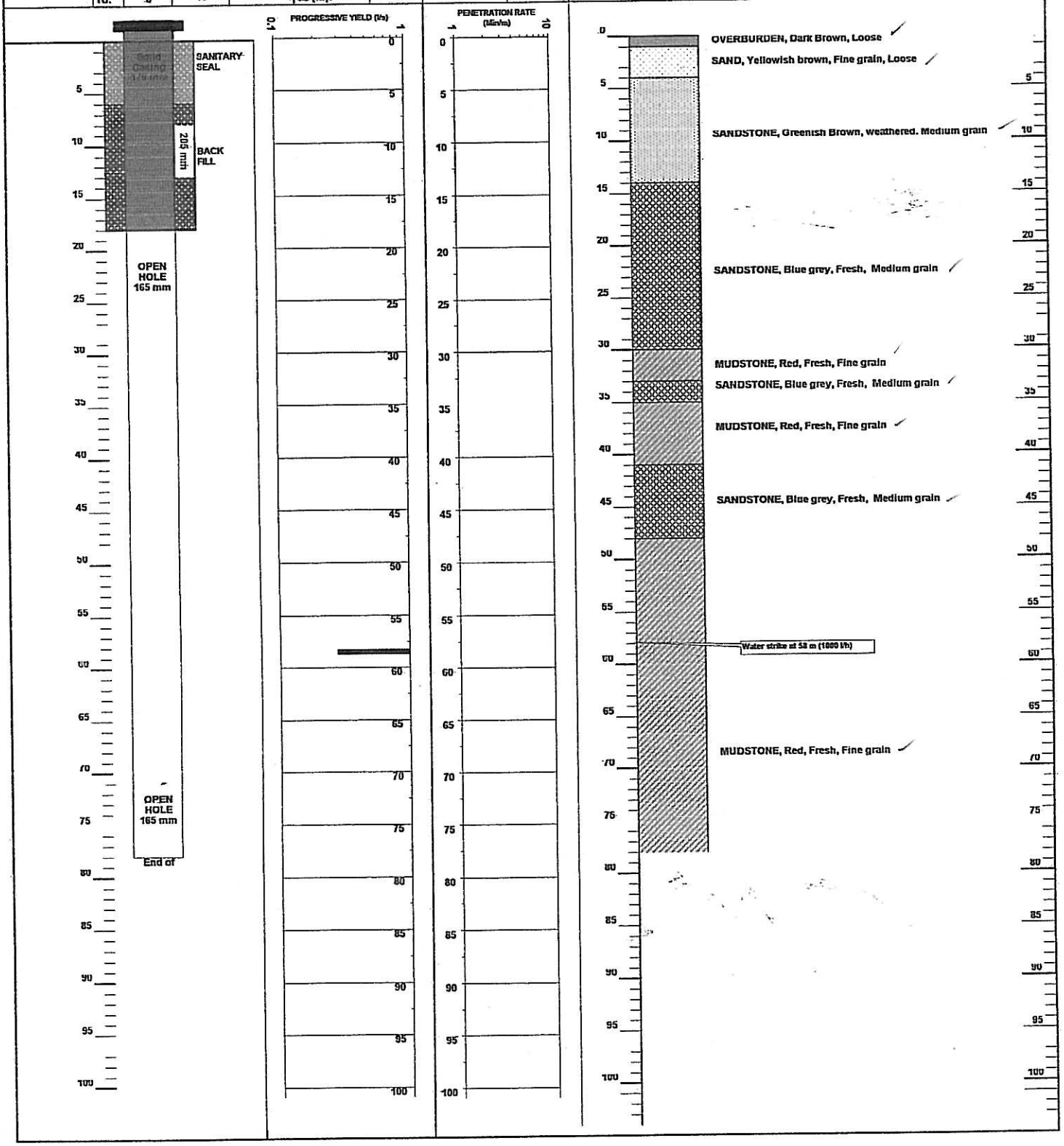
Diam	256	205	165
From	0	6	18
To:	6	18	78

Casing Detail

Diam. OD (mm	178			-	-
Thickness	4			-	-
Material	Steel			-	-
Plain/Perf.	Plain			-	-
From (m):	0.23			-	-
To (m):	18			-	-

Geology: LITHOLOGY
BEAUFORD GROUP, TARKASTAD SUBGROUP,
Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills

Drilling Target: Bedding plane fractures



AD GEO CONSULTANTS CC
5 High Field Road
BEACON BAY, 5205
TEL NO: +27 43 7482723
FAX NO: +27 43 748 2723

PERCUSSION DRILLING RECORD

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : TARGET AREA 2 DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED :

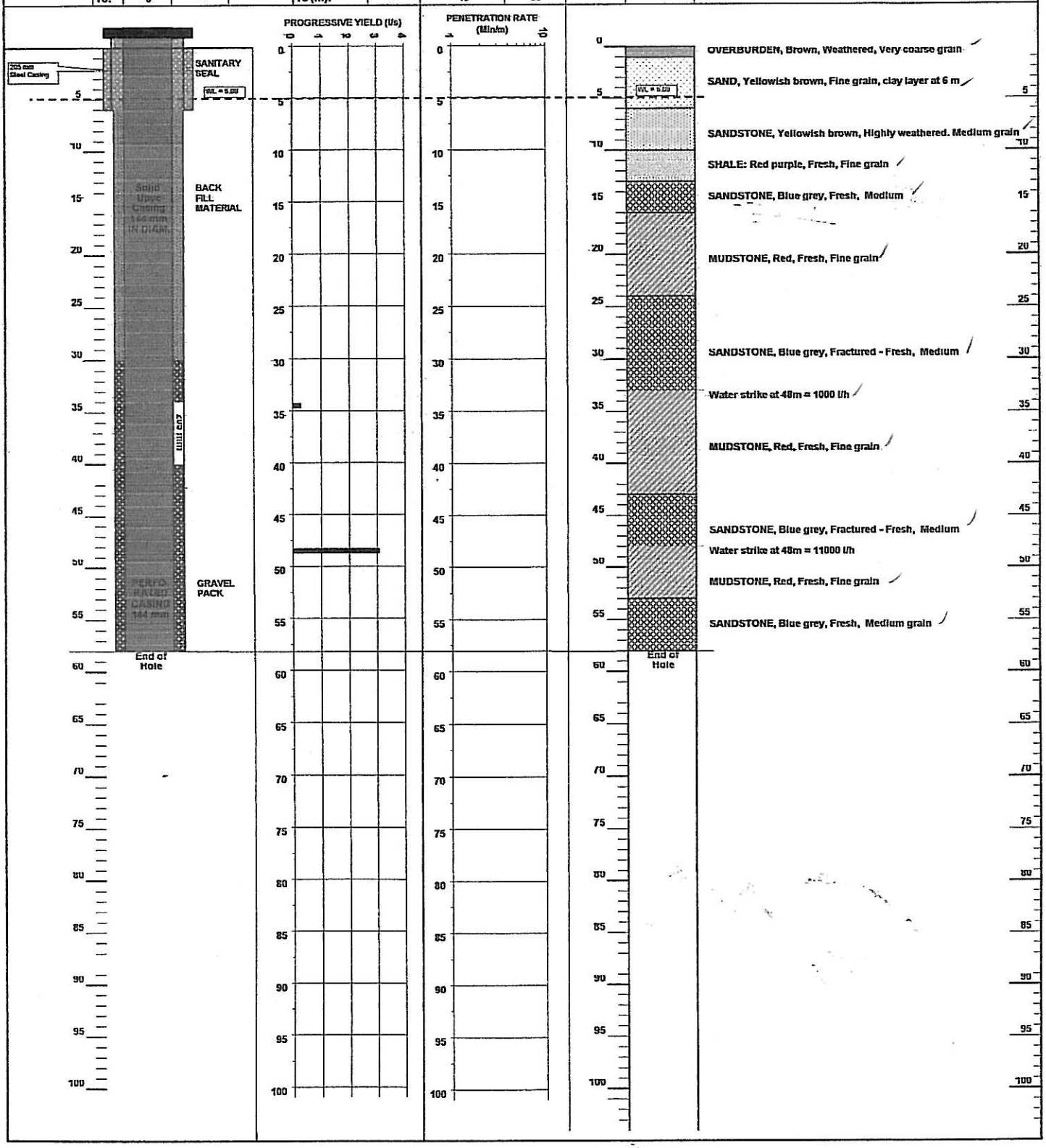
METHOD:
BOREHOLE Nr. : KHAM 6 GEOPH PEG No.:
WATER LEVEL: 5.48 LATITUDE : 32° 50' 19.0"
B/HOLE DEPTH: 58 LONGITUDE : 28° 06' 50.4"
BLOW YIELD: 3.06 ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

Borehole Diameter (mm)			
Diam:	256	205	165
From	0	6	-
To:	6	58	-

Casing Detail					
Diam. OD (mm	205	144	144	-	-
Thickness	6	8	8	-	-
Material	Steel	Upvc	Upvc	-	-
Plain/Perf.	Plain	Plain	Perf 3mm	-	-
From (m):	0.4	0.4	43	-	-
To (m):	6	43	58	-	-

Geology: LITHOLOGY
BEAUFORD GROUP, TARKASTAD SUBGROUP,
Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills
Drilling Target: Bedding plane fractures



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PERCUSSION DRILLING RECORD | **METHOD:**

CLIENT : KHAMANGA BA' PROJECT : KHAMANGA BAY
SITE : CARAVAN PARK DRILLER : DRILLING AFRICA TRUST
LOG : DANIEL DATE STARTED :

BOREHOLE Nr. : KHAM 7 GEOPH PEG No GEOLOGICAL
WATER LEVEL: 13.47 LATITUDE : 32° 50' 29.8"
B/HOLE DEPTH: 62 LONGITUDE : 28° 06' 54.1"
BLOW YIELD (l/s) 3.05 ALTITUDE:

BOREHOLE CONSTRUCTION DETAIL

Borehole Diameter (mm)			
Diam	205	165	-
From	0	6	-
To:	6	62	-

Casing Detail					
Diam. OD (mm	205	144	144	-	-
Thickness	6	3	3	-	-
Material	Steel	Upvc	Upvc	-	-
Plain/Perf.	Plain	Plain	Perf 3mm	-	-
From (m):	0.4	0.4	43	-	-
To (m):	6	50	62	-	-

Geology: LITHOLOGY
BEAUFORD GROUP, TARKASTAD SUBGROUP,
Burgersdorp Formation (Grey,brown,red mudstone, sandstone, Dolerite dykes and sills
Drilling Target: Bedding plane Fractures