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Geohydrological Assessment for the Supply of Groundwater to Villages in the Aganang Local Municipality near the Houtriver Dam, LIMPOPO Province

Prepared for:
African EPA

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September 2005

Compiled by
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Geohydrological Assessment for the Supply of Groundwater to Villages in the Aganang Local Municipality near the Houtriver Dam, LIMPOPO Province

12 September 2005

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1 INTRODUCTION

1.1 General

Africa Geo-Environmental Services, (AGES) was requested to conduct a geohydrological assessment to identify and evaluate the **existing boreholes**, and to assess the **regional groundwater potential** in order to determine the sustainable volume and groundwater quality of the available groundwater in the vicinity of Kalkspruit near to the Houtriver Dam in the Aganang Local municipality of the Limpopo Province.

1.2 Terms of reference

AGES was appointed by Ms Bongiwe Mculu, Director : Municipal Support and Capacity Building of the Department of Provincial and Local Government, Pretoria to conduct the required geohydrological assessment, and to facilitate the necessary actions leading to a resource evaluation for domestic water supply purposes and was confirmed in a letter dated 13 July 2005.

1.3 Liaison with Community

During the hydro-census phase of the project, the communities involved were identified, and arrangements regarding the possible interruption of the water supply during the yield-testing phase were discussed. Since none of the boreholes identified for testing are currently in use, there was no objection.

1.4 Objectives and Scope of the Investigation

The investigation was conducted with the following actions:

- Conduct a desktop review of available information and perform a site description (desk study) on the geology, structural geology, geohydrology, surface water and land use of the study area
- Conduct a **hydro-census** survey within the investigation area to determine the borehole locations, status, depth, potential pollution sources, springs and surface water features
- Conduct suitable **yield tests** at three existing boreholes and interpret the data within the regional geohydrological context.
- The yield tests include an assessment of the groundwater quality at selected boreholes to determine the suitability for domestic application
- Compile a GIS map reflecting the aquifer system (geological, structural geology, surface water catchments, and hydrogeological)
- Determine the groundwater yield from not only the existing boreholes, but also from the local aquifer, and to make utilisation recommendations for the sustainable use of groundwater in the area.
- To compile a geohydrological report to support water use licensing as required.

1.5 Study Area

Based on the requirements of the client, the study area has been restricted to portions of the cadastral farms Kalkspruit 633 KS and Malietzies 606 KS. These farms are located approximately 30 km north west of Pietersburg. Map 1 illustrates the regional location, and the study area.

1.6 Information Sources

The following sources of information were used during the investigation:

- Geological map
 - 2328 PIETERSBURG 1:250 000 Geological series, 1985. Geological Survey. Government Printer, Pretoria.
- Topographical map
 - 2329CA LONSDALE 1:50 000 Topographical map, Second Edition, 1983. Government Printer, Pretoria.
 - 2329CC GA-MASHASHANE 1:50 000 Topographical map, Second Edition, 1983. Government Printer, Pretoria.

2 SITE DESCRIPTIONS

2.1 Location

The study area is located approximately 30 km north west of Pietersburg, in the Aganang Local Municipality in the Limpopo Province of South Africa, centred at the following coordinates:

Latitude: 23° 45' South

Longitude: 29° 12' East

The area is approximately 9 km from east to west, 5 km from north to south and comprises a surface of approximately 45 km².

2.2 Physiographic Setting

The area is located over two quaternary catchments. Most of the study area slopes gently to the east towards the Houtriver dam and eventually the Hout River to the north east, and to numerous non-perennial streams above the dam to the north east.

Surface water drainage courses comprise systems of mostly small non-perennial streams, draining into non-perennial rivers. The study area is located within the Quaternary catchment areas A71E and A62E.

The mean annual rainfall in the area is in the order of 400 mm as recorded at the Roodeput, rainfall station, (station number 456,) for a period ranging from 1958 to 1989. The study area falls within the summer rainfall area of the country, with most of the rain falling between November and March.

2.3 Surface Hydrology

Although no major rivers intersect the area, there are numerous non-perennial streams that do drain the project area. The Hout River flows Northward along the eastern border of the study area. Drainage is by surface sheet-wash into the streams that then drain the area.

2.4 Regional Geological Setting

The area is underlain by a leucocratic migmatite and gneiss known as the **Hout River Gneiss**.

Generally the gneiss exhibits a moderate groundwater potential. Specific zones within the gneiss do however present a target for successful borehole development due to **localised** variations in the geology.

Higher groundwater potential may be associated to zones of deeper weathering in the gneiss. The deeper weathering is related to a variation in the chemical composition of the gneiss, or to a contact areola surrounding an intrusive dyke. The **Dolerite dyke intrusions** in the vicinity may thus offer an opportunity for preferential weathering along the contact zones, and may be investigated for possible borehole development.

Pegmatitic zones within the gneiss are related to the melting and re-crystallization of the material, and present the best target for successful borehole development in the gneiss. It should be noted that these pegmatitic zones are however localised within the gneiss.

It should once again be noted, that the gneiss as a unit exhibits a moderate groundwater potential

2.5 Geohydrological Setting

The following aquifers systems are defined within the study area, and are deemed significant during the assessment of the groundwater resources in the area.

- The **weathered gneiss**, particularly along low laying drainage paths. Typical borehole yields are as low as 0.2L/sec but well sited boreholes may yield up to 2L/sec on a 24-hour pumping cycle. It should be noted however that this aquifer is not laterally extensive, and only as deep as the weathered material, thus the aquifer is susceptible to extended periods of low rainfall.
- **Pegmatite zones** in the gneiss, although only localised, the pegmatite offers the greatest opportunity for successful boreholes. The pegmatite zones provide a preferential flow path for the groundwater, thus a relatively larger area may be exploited from a single point, typical boreholes yield 2L/sec on a 24 hour pumping cycle, but may be as high as 5L/sec.
- **Contact zones along dolerite** intrusions are also deemed a suitable target for groundwater development. Although less important on a regional scale, locally developed boreholes may yield up to 1L/sec on a 24-hour cycle.

3 HYDRO CENSUS

3.1 Data review

The Groundwater Information Project (GRIP) data base and other existing reports and data sources were reviewed to determine current information on the existing boreholes in the area.

3.2 Field visit

The existing boreholes deemed significant during the survey are summarised in Table 1 below:

Table 1: Results of the borehole Survey (WGS 84)

Borehole number	Latitude	Longitude	Status	Equipment	Comments
H04-0197 ✓	-23.78049	29.15895	Unused	Handpump	
H04-0198 ✓	-23.77119	29.16912	Unused	Windpump	
H04-0204*	-23.78069	29.21383	Unused	Mono-type	
H04-0206 ✓	-23.77025	29.21203	In use	Mono-type	Closed
H04-0601 ✓	-23.76883	29.19278	Unused	None	Closed
H04-0602 ✓	-23.76876	29.20651	In use	Mono-type	Closed
H04-0801 ✓	-23.78650	29.17174	In use	Submersible	Closed
H04-1812	-23.77538	29.16849	Destroyed		Deemed Dry
No Number	-23.78309	29.15752	Unused	Mono-type	

Based on the results of the survey, a number of boreholes were identified for possible yield testing, and chemical assessment.

5 WATER BALANCE AND SUSTAINABILITY

5.1 General

To ensure the sustainability of a groundwater reserve, one needs to gain an understanding of regional flow patterns, groundwater - surface water interactions and variations in groundwater quantity in time and space. A groundwater balance will assist in the determination of these factors.

Due to project limitations a regional water balance was not calculated. A water balance in the radius of influence of the production boreholes was however conducted. This is viewed as a conservative approach as the horizontal groundwater flow in the vicinity of the boreholes is set at zero.

The area of influence around a production borehole with regard to the groundwater level is a function of the pumping time, and is defined by geological structures and discontinuities in the vicinity of the abstraction point.

The radius of influence is defined as the area where the decrease in water level in the cone of depression around an abstraction point is greater than 0. The radius of influence is proportional to the transmissivity and the pumping time, and inversely proportional to the storativity of the aquifer.

Table 2 presents a summary of the water balance and the sustainability of the recommended yields.

5.2 Sustainability

The **first** test of sustainability is that the water level should not reach a predetermined level, even after extended pumping. The predetermined level has been set at the level of the main water strike. Table 2 indicates that using the Cooper-Jacob approximation of the Theis equation, the recommended abstraction would result in 75% of the available drawdown being used at borehole H04-0197, 42% at H04-0198, and 70% of the available drawdown at H04-0601. Based on these equations, the recommended rates are thus deemed to be sustainable, and the water level will not reach the pump intake during regular pumping

The **second** important test for sustainability determines the amount of water in storage, and ensures that there is sufficient water for abstraction during periods of extended drought.

Considering a conservative storativity (S) for weathered gneiss of 0.5E-3, an aquifer thickness of 20 metres, the borehole sustainability with no recharge can be determined. Implementing the recommended abstraction rates, H04-0197 will be sustainable for 1.3 years, H04-0198 for 5 years, and H04-0601 for 1 year with **NO** rainfall.

Based on the initial conservative approach of discounting the horizontal flow of groundwater into the radius of influence, and since no rainfall for 12 months is considered a worst-case scenario, the boreholes are deemed sustainable during periods of lower than average rainfall.

(Note: Since the storativity of the aquifer cannot be directly calculated, a conservative figure of 0.5E-3 is used for the gneiss aquifer.)

The **third** important test for sustainability determines the balance between the water being abstracted from the aquifer, and the water being recharged from rainfall in this case, in the direct vicinity of the abstraction borehole. A negative water balance would indicate that more water is being abstracted than is being recharged, and this will lead to the long term decline in water levels, and eventual water shortages.

Table 2: Borehole Utilisation

Borehole number	H04-0197	H04-0198	H04-0601
Recommended Q (12 hour cycle) (L/sec)	0,50	0,50	1,50
Installation Depth (mbgl)	36	36	60
Rainfall (mm/a)	400	400	400
Recharge (%)	5	5	5
Transmissivity (m²/day)	3	13	8
Saturated thickness (m)	20	20	20
Storativity (S)	5,00E-04	5,00E-04	5,00E-04
Available Drawdown (m)	22,00	10,00	46,00
Capacity Used (Cooper-Jacob method)	75,0%	42,0%	70,0%
Daily abstraction (m³/day)	43,2	43,2	129,6
Annual abstraction (12 month period) m³/a	15768	15768	47304
50% of radius of influence (m)	800	1600	1200
Area of influence (m²)	2009600	8038400	4521600
Volume of water in storage (m³)	20096	80384	45216
No of years sustainable	1,27	5,10	0,96
Volume recharged (m³ / a)	40192	160768	90432
Local Water Balance (m³ / a)	24424	145000	43128

Table 2 indicates that at the recommended abstraction rates, the water balance is positive for all three of the boreholes evaluated.

With the implementation of a water management plan, the boreholes are thus deemed sustainable.

6 RECOMMENDATIONS

6.1 Utilisation Recommendations

Table 2 presents a project summary and the utilisation recommendations of the three existing boreholes evaluated as part of this investigation.

It should be noted that the boreholes that have been evaluated during this project are existing boreholes, and although comment is made on the borehole development, Messrs AGES can take no **liability for borehole stability** during long-term use. Borehole stability is related to the correct installation of sufficient, suitable casing to ensure that zones of weathering and fracturing are adequately protected for sidewall failure.

Lower pumping yields over longer pumping schedules reduces the water level fluctuations in the borehole, and may reduce the chance of sidewall collapse in unstable boreholes.

Table 2: Utilisation recommendations

Borehole number	Water Chemistry	Max Abstraction Rate per 24 h	Max Abstraction Volume per 24h	Installation depth (mbdl)
H04-0197	1	0.5	43.2	36
H04-0198	2	0.5	43.2	36
H04-0601	1	1.5	129.6	60

6.2 Additional Source Development

6.2.1 Target areas

Additional boreholes may be drilled and developed based on the results of a detailed geophysical investigation conducted in target areas identified from the interpretation of remote sensing data. Weathered areas and pegmatite zones should be prioritised for resource development. It should be noted that suitable borehole positions should be identified outside of the villages to reduce the chance of poor groundwater quality from domestic pollution sources.

6.3 Monitoring and Management

It is recommended that the pumping rates as stated above be **implemented** and groundwater levels monitored on a monthly basis. Should the water level drop to within **2 metres** of the pump intake during regular pumping, the pumping rate should be reduced. Results of recorded abstraction rates, abstraction volumes, and water levels may then be re-evaluated.

Totalling flow meters should be installed on all production boreholes in order to monitor monthly abstraction volumes.

An **annual** assessment of the **groundwater quality** should be conducted to ensure that the water is potable, and suitable for domestic use.

The National Water Act (Act 36 of 1998) specifies that certain water uses need to be licensed. This licensing process will ensure a sustainable and equitable water supply for environmental and domestic use.

Should the abstraction of groundwater **exceed 10m³** per property per day, then according to the Section 21(a), (*Taking water from a resource*) the use **must be licensed**.

Details and the relevant forms may be obtained from your local DWAF office, and together with a geohydrological report, details on borehole development, utilisation recommendations, and abstraction rates should be submitted to DWAF for licensing.

7 REFERENCES

Manyaka, MS & Pieterse, A. (1998) Quality of domestic water supplies. Volume 1: Assessment guide. Water Research Commission. WRC Report no TT 101/98.

Appendix A

Maps

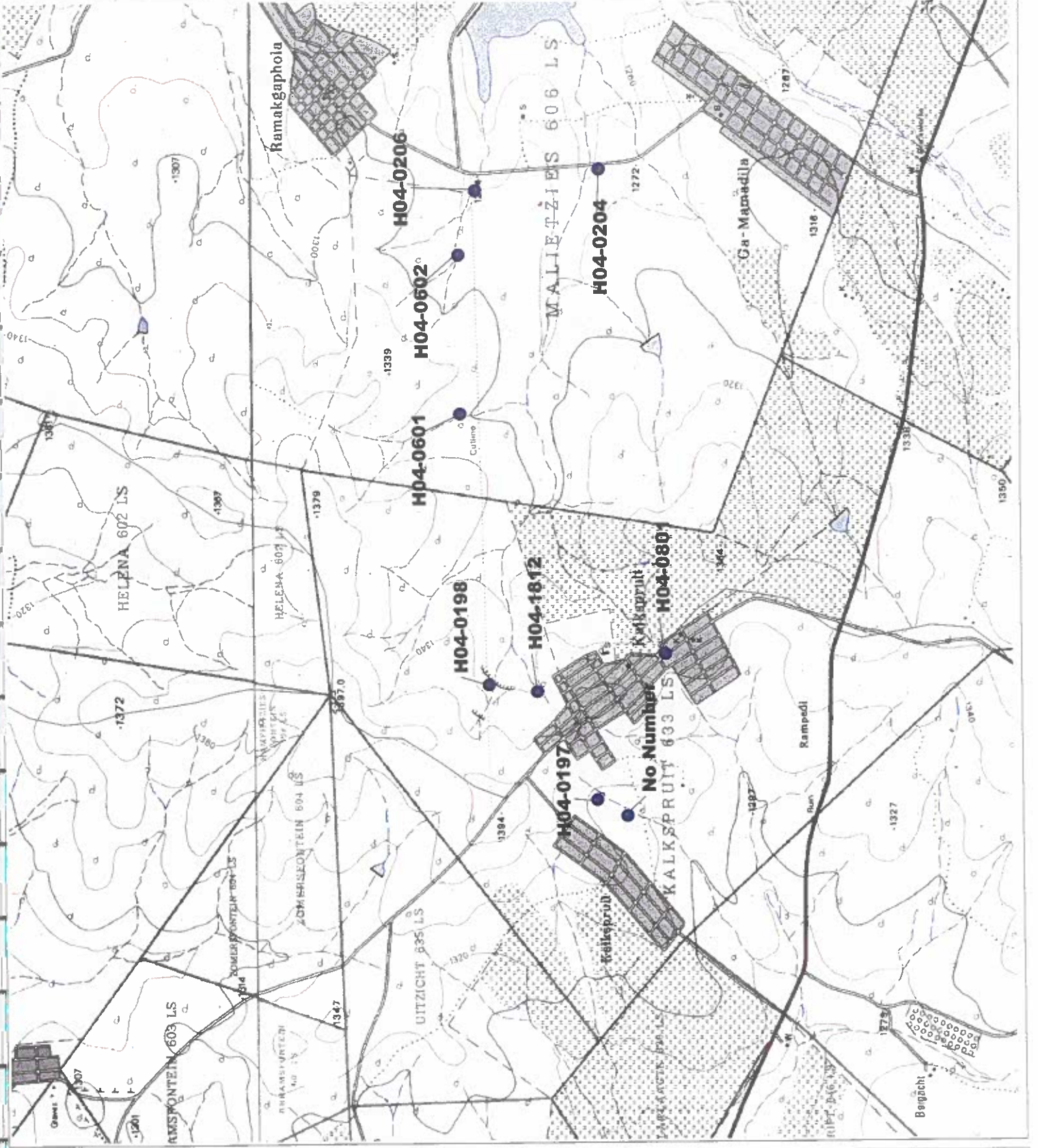


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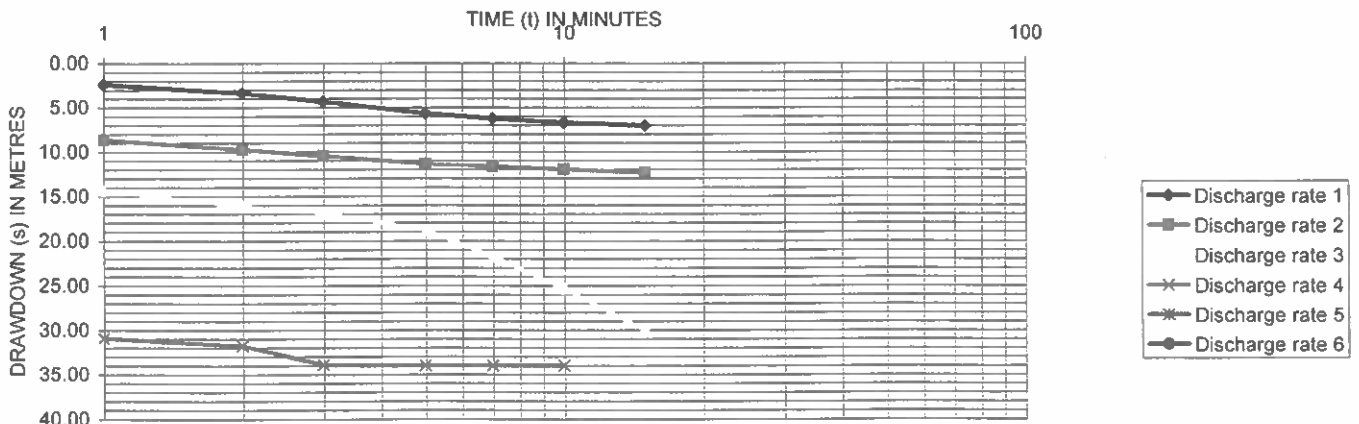


Appendix B

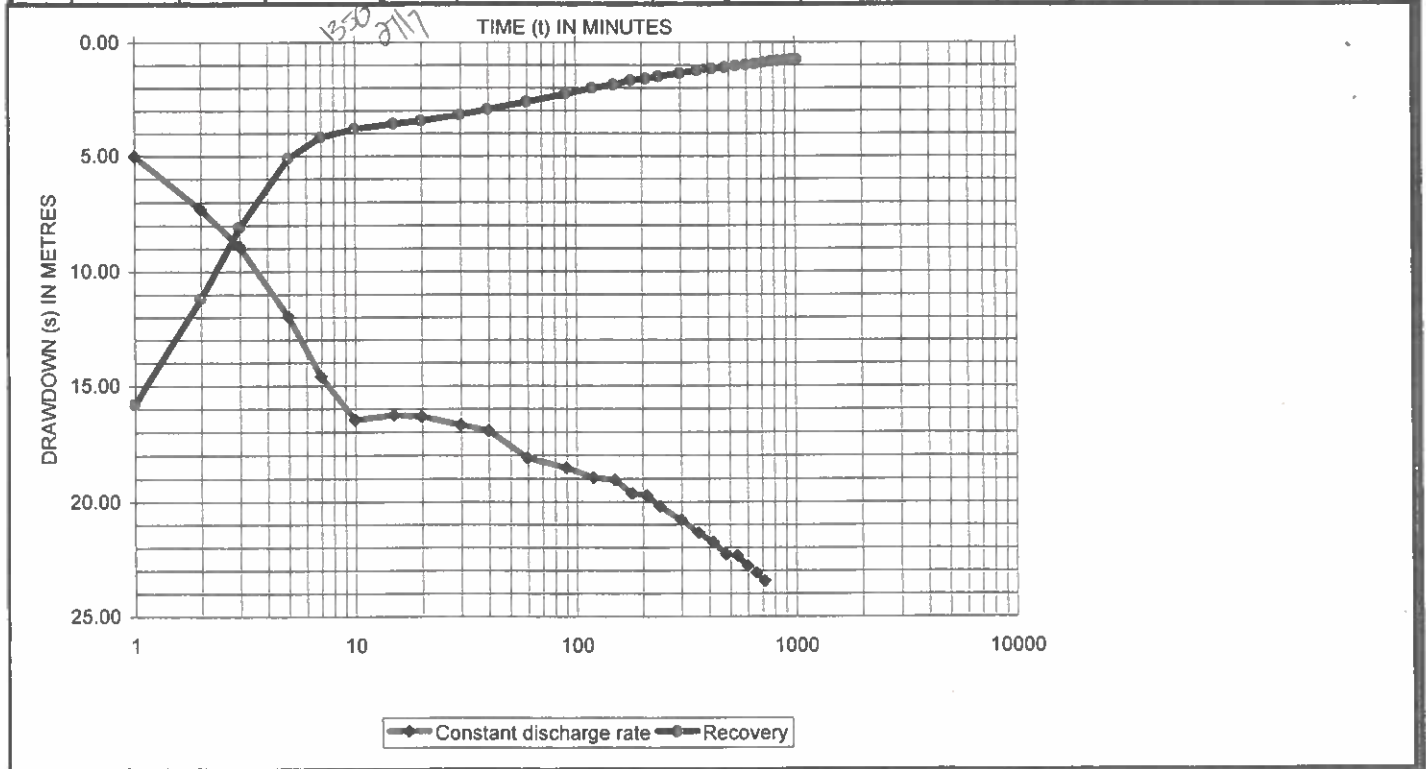
Detailed Yield Testing Results

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :		H04-U197		STATIC WATER LEVEL (m bdl):		13.97		DEPTH OF PUMP (m bdl):		80.00							
DISCHARGE RATE 1					DISCHARGE RATE 2					DISCHARGE RATE 3							
DATE:	26-Jul-05		TIME:	7H02		DATE:	26-Jul-05		TIME:	07H17		DATE:	26-Jul-05		TIME:	07H32	
Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)			
0	0.00		0	7.03	0	7.03		0	12.36	0	12.36		0	30.12			
1	2.36		1		1	8.67		1		1	14.35		1				
2	3.39		2		2	9.76	1.05	2		2	16.17	1.51	2				
3	4.35		3		3	10.48		3		3	16.88		3				
5	5.68	0.6	5		5	11.37	1	5		5	18.80	1.86	5				
7	6.25		7		7	11.67		7		7	21.76		7				
10	6.72	0.61	10		10	12.00	1	10		10	25.36	1.88	10				
15	7.03		15		15	12.36		15		15	30.12		15				
Average yield: 0.605				20	Average yield: 1.01666667				20	Average yield: 1.75				20			
EXISTING EQUIPMENT DETAIL:				30	EXISTING EQUIPMENT DETAIL:				30	EXISTING EQUIPMENT DETAIL:				30			
TYPE OF RESERVOIR:				40	TYPE OF ENCLOSURE:				40	PRESSURE GAUGE MANUFACTURER:				40			
RESERVOIR SIZE:				50	MATERIAL OF ENCLOSURE:				50	GAUGE READING (KpA):				50			
RESERVOIR CONDITION:				60	CONDITION OF ENCLOSURE:				60	MONITORING FACILITY:				60			
STAND HEIGHT (m):				70	WATER METER MANUFACTURER:				70	MAINTAINED:				70			
				80					80					80			
				90					90					90			
				100					100					100			
				110					110					110			
				120					120					120			
				150					150					150			
DISCHARGE RATE 4					DISCHARGE RATE 5					DISCHARGE RATE 6							
DATE:	26-Jul-05		TIME:	07H47		DATE:			TIME:			DATE:			TIME:		
Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)			
0	30.12		0	34.00	0	34.00		0	34.00	0	34.00		0	34.00			
1	30.91		1		1			1		1			1	18.80			
2	31.77	2.1	2		2			2		2			2	14.27			
3	33.88		3		3			3		3			3	9.63			
5	34.00	1.7	5		5			5		5			5	4.80			
7	34.00		7		7			7		7			7	3.21			
10	34.00	1.42	10		10			10		10			10	2.30			
15			15		15			15		15			15	1.80			
Average yield: 1.74				20	Average yield:				20	Average yield:				20	1.45		
EXISTING EQUIPMENT DETAIL:				30	EXISTING EQUIPMENT DETAIL:				30	EXISTING EQUIPMENT DETAIL:				30	1.13		
PUMP TYPE:				40	TYPE OF POWER:				40	TYPE OF RISER:				40	0.93		
SAND PUMP				50	ENGINE MANUFACTURER:				50	CLASS OF RISER:				50	0.81		
PUMP MANUFACTURER:				60	ENGINE MODEL:				60	DIAMETER OF RISER (mm):				60	0.67		
NO				70	ENGINE SERIAL No:				70	SHAFT DIAMETER (mm):				70			
PUMP SERIAL No:				80	ENGINE PULLEY DIAMETER (mm):				80	ELEMENT DIAMETER (mm):				80			
NO				90	POWER RATING (kW):				90	ELEMENT STROKE (mm):				90			
PUMP PULLEY DIAMETER (mm):				100	ENGINE CONDITION:				100					100			
NO				110					110					110			
PUMP INTAKE DEPTH (m):				120					120					120			
37				150					150					150			
PUMP RPM:				180					180					180			
NO				210					210					210			
PUMP CONDITION:				240					240					240			
NOT GOOD				300					300					300			
COMMENTS:														420			
12 PIPES AND PUMP 50MM PIPE														480			
ALLES GOED MAAR WERK NIE														540			
DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?														600			
														660			
														720			



BOREHOLE NO: H04-0197				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
PUMP DEPTH (mbdl):		48.00		No.:		No.:		No.:		No.:		
WATER LEVEL (mbdl):		13.97		DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):		
TEST STARTED		DATE: 26-Jul-05		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		
TEST COMPLETED		TIME: 08H51		BOREHOLE DEPTH:		BOREHOLE DEPTH:		BOREHOLE DEPTH:		BOREHOLE DEPTH:		
TIME - PUMPED (min):		720		TIME-RECOVERY(min):		1020		TOTAL TEST TIME:		1740		
AVERAGE YIELD (l/s):		1.24		DISTANCE (m):		DISTANCE (m):		DISTANCE (m):		DISTANCE (m):		
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)
0	2.95		23.46	0	0.00		0	0.00		0	0.00	
1	5.00		15.80	1			1			1		
2	7.30	0.80	11.18	2			2			2		
3	8.90		8.09	3			3			3		
5	11.98	1.17	5.10	5			5			5		
7	14.60		4.18	7			7			7		
10	16.49		3.81	10			10			10		
15	16.28	1.21	3.59	15			15			15		
20	16.34		3.45	20			20			20		
30	16.69	1.26	3.18	30			30			30		
40	16.94		2.95	40			40			40		
60	18.10	1.28	2.62	60			60			60		
90	18.54	1.28	2.27	90			90			90		
120	18.97	1.27	2.01	120			120			120		
150	19.06		1.86	150			150			150		
180	19.64	1.29	1.68	180			180			180		
210	19.73		1.59	210			210			210		
240	20.19	1.29	1.50	240			240			240		
300	20.79	1.28	1.35	300			300			300		
360	21.36	1.29	1.23	360			360			360		
420	21.77	1.28	1.15	420			420			420		
480	22.30	1.27	1.10	480			480			480		
540	22.35	1.28	1.02	540			540			540		
600	22.80	1.28	0.98	600			600			600		
660	23.10	1.27	0.94	660			660			660		
720	23.46	1.28	0.88	720			720			720		
780			0.83	780			780			780		
840			0.80	840			840			840		
900			0.78	900			900			900		
960			0.76	960			960			960		
1020			0.74	1020			1020			1020		



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BOREHOLE NO.:	H04-0198	PROJECT:	HOUTRIVIER/AGANANG WATER SUPPLY
ALTERNATIVE NO.:		SITE NAME:	KALKSPRUIT
BOREHOLE DEPTH (mbdl):	38.38	CASING DEPTH (mbdl):	32.67
DEPTH OF PUMP (mbdl):	36.00	CASING HEIGHT (magl):	0.00
PUMP INLET DIAMETER (mm):		CASING ID (mm):	160
STATIC WATER LEVEL (mbdl):	25.07	DATUM LEVEL (magl):	0.04
FIRST WATER STRIKE (mbgl):		CLIENT:	
MAIN WATER STRIKE (mbgl):		LATITUDE:	-23.7119
AVAILABLE DRAWDOWN	8.93	LONGITUDE:	29.16912
		EC (ms/m):	
		pH:	
		TDS (ppm):	

TEST DESCRIPTION	STEP	1	2	3	4	5	6	TOTAL:
CALIBRATION TEST:								(min) (hrs)
TEST DURATION (Minutes)		15	15	7				37 0.62
TEST YIELD (l/s)		0.58	1.11	1.42				MAXIMUM YIELD (l/s): 1.4
DRAWDOWN (m)		1.36	4.45	9.00	9.00	9.00	9.00	MAXIMUM DRAWDOWN: 9.0
RECOVERY (m)								TIME (min): 0.0
MULTI-RATE / STEP DRAWDOWN:								(min) (hrs)
TEST DURATION (Minutes)		0	0	0	0	0	0	0 0.00
TEST YIELD (l/s)								MAXIMUM YIELD (l/s): 0.0
DRAWDOWN (m)								MAXIMUM DRAWDOWN: 0.0
RECOVERY (m)								TIME (min): 0.0

CONSTANT DISCHARGE TEST	TEST DURATION	TEST YIELD	DRAWDOWN	RECOVERY:
(min)	(hrs)	(l/s)	(m)	(min) (hrs)
720	12.00	1.08	5.88	60 1.00
No. of boreholes	720 (min)	1440 (min)	2880 (min)	TOTAL: (min) (hrs)
				0 0.00

RECOVERY TEST	Cal (min)	Steps (min)	CD (min)	Total (min)
	0	0	60	60
TIME TOTAL (hrs):				1.00
CD - DRAWDOWN TOTALS (m):	AVAILABLE DRAWDOWN	UTILISED	% UTILISED	
	8.93	5.88	65.85	

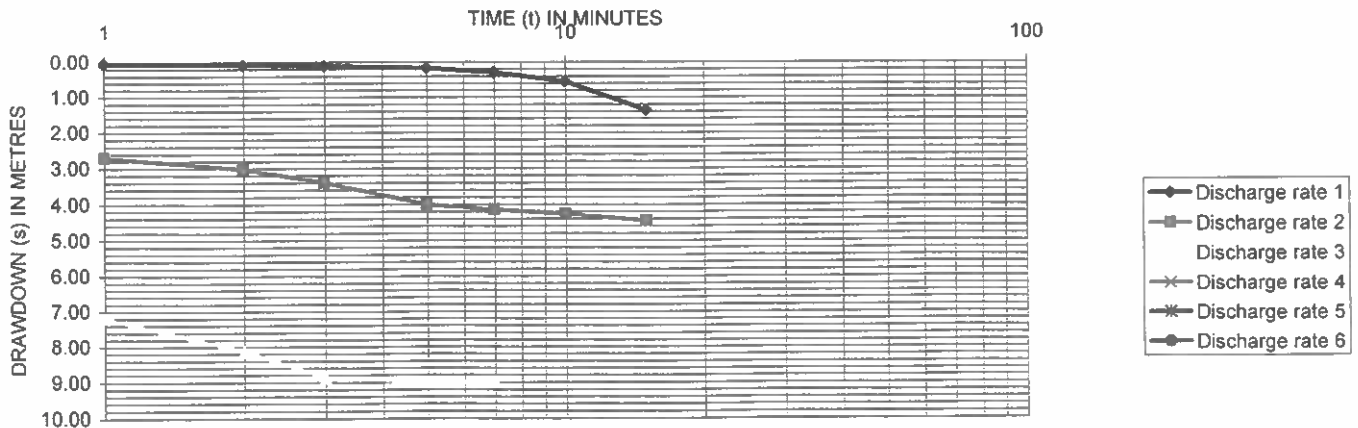
DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT	Sum	
INTER HOLE MOVE > 10 km	Km.	
FROM: SITE NAME:		
BOREHOLE No.:		
INTER HOLE MOVE < 10 km:	No.	
REMOVAL AND RE-ERECTION OF PUMP HOUSE:	No.	
REMOVAL OF EXISTING EQUIPMENT:	No.	
RE-INSTALLATION OF EXISTING EQUIPMENT:	No.	
WORK TIME RATE (REPAIRS):	Hour	
STANDING TIME:	Hour	

DESCRIPTION:	QUANTITY:	UNIT:
STRAIGHTNESS TEST:		No.
VERTICALITY TEST:		No.
CASING DETECTION:		No.
STEEL BOREHOLE COVER:		No.
BOREHOLE MARKING:		No.
SITE CLEANING / FINISHING:		No.
REPORTING & DATA RECORDING:		No.
SLUG TEST:		No.
LAYFLAT (m):		m

DESCRIPTION:	QUANTITY:	UNIT:
S U M M A R Y		
ESTABLISHMENT	Sum	
INTER HOLE MOVE > 10 km	Km.	
FROM: SITE NAME:		
BOREHOLE No.:		
INTER HOLE MOVE < 10 km:	No.	
REMOVAL AND RE-ERECTION OF PUMP HOUSE:	No.	
REMOVAL OF EXISTING EQUIPMENT:	No.	
RE-INSTALLATION OF EXISTING EQUIPMENT:	No.	
WORK TIME RATE (REPAIRS):	Hour	
STANDING TIME:	Hour	

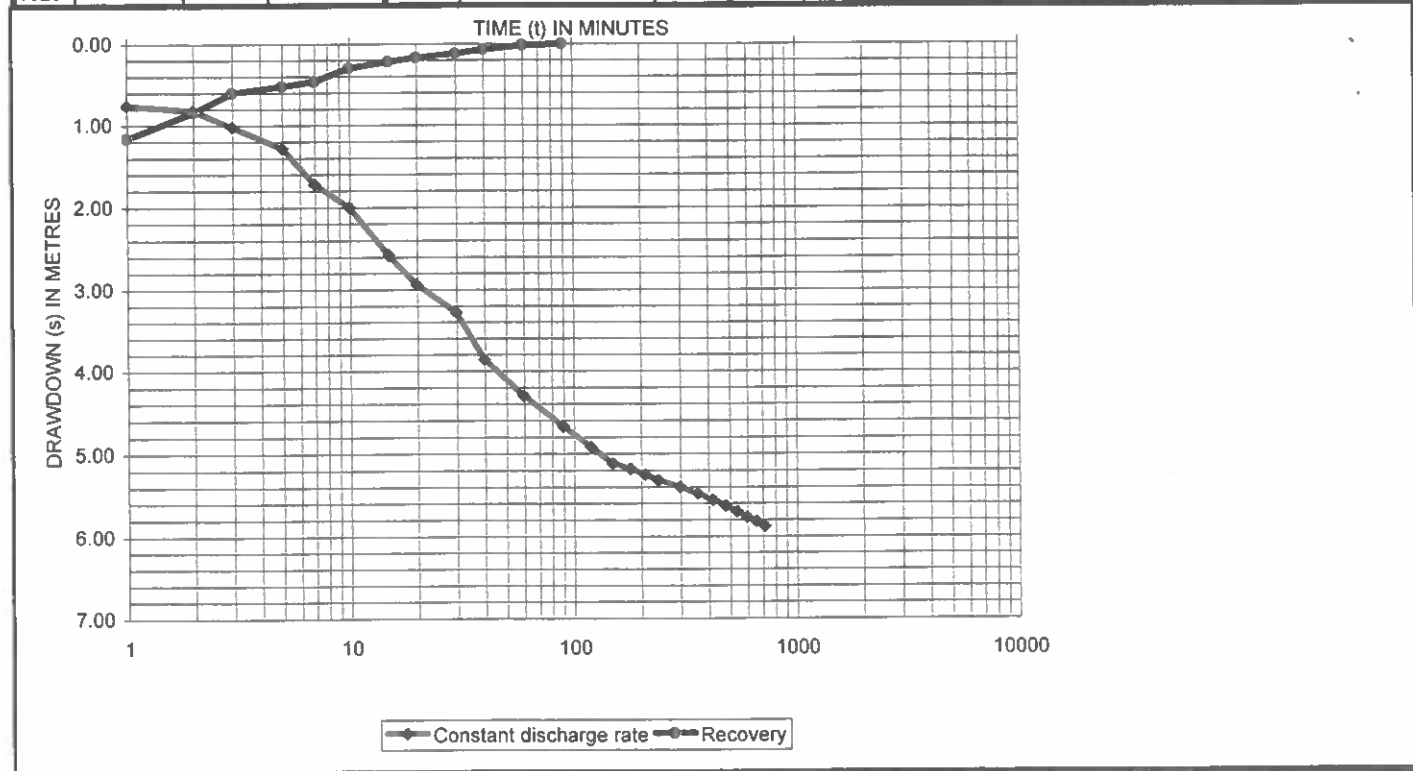
CALIBRATION TEST AND RECOVERY

BOREHOLE NO. : H04-U198					STATIC WATER LEVEL (mbdl): 25.07					DEPTH OF PUMP (mbdl): 0.00				
DISCHARGE RATE 1					DISCHARGE RATE 2					DISCHARGE RATE 3				
DATE: 21-Jul-05 TIME: 16H00					DATE: 21-Jul-05 TIME: 16H15					DATE: 21-Jul-05 TIME: 16H30				
Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
0	0.00		0	1.36	0	1.36		0	4.45	0	4.45		0	9.00
1	0.05		1		1	2.70		1		1	7.20		1	
2	0.08		2		2	3.02		2		2	8.12	1.59	2	
3	0.11		3		3	3.39	1.12	3		3	8.88	1.46	3	
5	0.17		5		5	4.00		5		5	9.00	1.42	5	
7	0.30		7		7	4.15		7		7	9.00	1.2	7	
10	0.56		10		10	4.27	1.1	10		10			10	
15	1.36	0.58	15		15	4.45		15		15			15	
Average yield: 0.58					Average yield: 1.11					Average yield: 1.4175				
EXISTING EQUIPMENT DETAIL:					EXISTING EQUIPMENT DETAIL:					EXISTING EQUIPMENT DETAIL:				
TYPE OF RESERVOIR: SEMENT					TYPE OF ENCLOSURE:					PRESSURE GAUGE MANUFACTURER:				
RESERVOIR SIZE:					MATERIAL OF ENCLOSURE:					GAUGE READING (Kpa):				
RESERVOIR CONDITION: POOR					CONDITION OF ENCLOSURE:					MONITORING FACILITY:				
STAND HEIGHT (m): 3m					WATER METER MANUFACTURER:					MAINTAINED:				
					WATER METER READING:									
DISCHARGE RATE 4					DISCHARGE RATE 5					DISCHARGE RATE 6				
DATE: TIME:					DATE: TIME:					DATE: TIME:				
Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)	Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
0	9.00		0	9.00	0	9.00		0	9.00	0	9.00		0	9.00
1			1		1			1		1			1	
2			2		2			2		2			2	
3			3		3			3		3			3	
5			5		5			5		5			5	
7			7		7			7		7			7	
10			10		10			10		10			10	
15			15		15			15		15			15	
Average yield:					Average yield:					Average yield:				
EXISTING EQUIPMENT DETAIL:					EXISTING EQUIPMENT DETAIL:					EXISTING EQUIPMENT DETAIL:				
PUMP TYPE: SAU WINDMEEL					TYPE OF POWER:					TYPE OF RISER: GALVANISED				
PUMP MANUFACTURER: NO					ENGINE MANUFACTURER:					CLASS OF RISER: 11 PIPES 12 ELEMENTS				
PUMP SERIAL No: NO					ENGINE MODEL:					DIAMETER OF RISER (mm): 50				
PUMP PULLEY DIAMETER (mm):					ENGINE SERIAL No:					CONDITION OF RISER: POOR				
PUMP INTAKE DEPTH (m): 33					ENGINE PULLEY DIAMETER (mm):					SHAFT DIAMETER (mm):				
PUMP RPM: NO					POWER RATING (kW):					ELEMENT DIAMETER (mm): 50				
PUMP CONDITION: POOR					ENGINE CONDITION:					ELEMENT STROKE (mm):				
COMMENTS:														
THE CASING IS POOR														
DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?														



BOREHOLE NO:		H04-0198		OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
PUMP DEPTH (mbdl):		36.00		No.:			No.:			No.:		
WATER LEVEL (mbdl):		25.07		DATUM LEVEL (magl):			DATUM LEVEL (magl):			DATUM LEVEL (magl):		
TEST STARTED		DATE: 22-Jul-05		CASING DEPTH (mbdl):			CASING DEPTH (mbdl):			CASING DEPTH (mbdl):		
TEST COMPLETED		TIME: 07H00		BOREHOLE DEPTH:			BOREHOLE DEPTH:			BOREHOLE DEPTH:		
TEST DATE:		TIME:		WATER LEVEL:			WATER LEVEL:			WATER LEVEL:		
TEST TIME:		TIME:		DISTANCE (m):			DISTANCE (m):			DISTANCE (m):		
TIME - PUMPED (min):		720		TIME-RECOVERY(min):			60			TOTAL TEST TIME: 780		
										AVERAGE YIELD (l/s): 1.08		
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)
0	0.07		5.88	0	0.00		0	0.00		0	0.00	
1	0.76		1.16	1			1			1		
2	0.82		0.84	2			2			2		
3	1.02		0.60	3			3			3		
5	1.28	1.07	0.52	5			5			5		
7	1.72		0.46	7			7			7		
10	2.00	1.07	0.30	10			10			10		
15	2.58		0.22	15			15			15		
20	2.94		0.17	20			20			20		
30	3.28	1.05	0.12	30			30			30		
40	3.86		0.07	40			40			40		
60	4.30	1.08	0.02	60			60			60		
90	4.67		0.00	90			90			90		
120	4.92	1.02		120			120			120		
150	5.12			150			150			150		
180	5.18	1.11		180			180			180		
210	5.25			210			210			210		
240	5.32	1.11		240			240			240		
300	5.40			300			300			300		
360	5.48	1.10		360			360			360		
420	5.56			420			420			420		
480	5.63	1.12		480			480			480		
540	5.70			540			540			540		
600	5.77	1.10		600			600			600		
660	5.82			660			660			660		
720	5.88			720			720			720		
780				780			780			780		
840				840			840			840		
900				900			900			900		
960				960			960			960		
1020				1020			1020			1020		

2030
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 D9A71E031

BOREHOLE NO.:	H04-0601	PROJECT:	HOUTRIVER/AGANANG WATER SUPPLY
ALTERNATIVE NO.:		SITE NAME:	MAMADILA / malietzies location
BOREHOLE DEPTH (m):	69.50	CASING DEPTH (m):	27.00
DEPTH OF PUMP (m):	60.00	CASING HEIGHT (m):	0.00
PUMP INLET DIAMETER (mm):		CASING ID (mm):	165
STATIC WATER LEVEL (m):	14.60	DATUM LEVEL (m):	0.04
FIRST WATER STRIKE (m):		CLIENT:	
MAIN WATER STRIKE (m):		LATITUDE:	-23.76883
AVAILABLE DRAWDOWN	45.40	LONGITUDE:	29.19278
		EC (mS/m):	
		pH:	
		TDS (ppm):	

RECOVERY TEST			
Cal (min)	Steps (min)	CD (min)	Total (min)
80	120	900	1100
TIME TOTAL (hrs):			18.33
CD - DRAWDOWN TOTALS (m):			
AVAILABLE DRAWDOWN	UTILISED	%	
45.40	34.46	75.90	

TEST DESCRIPTION	TOTAL:					
	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
CALIBRATION TEST:						
TEST DURATION (Minutes)	15	15	15			
TEST YIELD (l/s)	0.42	4.11	7.58			
DRAWDOWN (m)	0.62	10.20	41.00	41.00	41.00	41.00
RECOVERY (m)						80.0
MULTI-RATE / STEP DRAWDOWN:						
TEST DURATION (Minutes)	100	100	0	0	0	0
TEST YIELD (l/s)	3.20	6.00				
DRAWDOWN (m)	13.4	34.44				
RECOVERY (m)						120.0

CONSTANT DISCHARGE TEST	TEST DURATION		TEST YIELD		RECOVERY:	
	(min)	(hrs)	(l/s)	(m)	%	(min)
	1380	23.00	4.96	34.46	100.00	900
OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	OTHER (min)	TOTAL (hrs)
					0	0.00

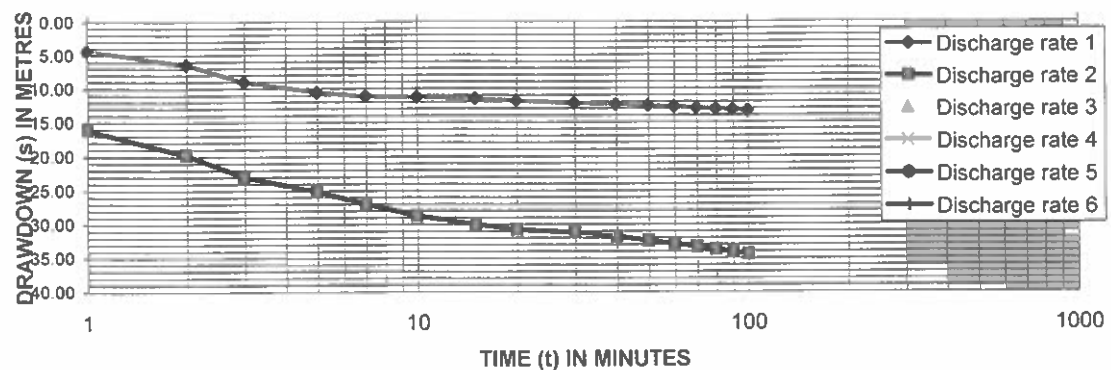
DESCRIPTION:	QUANTITY:		UNIT:
	Sum	Km.	
ESTABLISHMENT			No.
INTER HOLE MOVE > 10 km			No.
FROM: SITE NAME:			No.
BOREHOLE No.:			No.
INTER HOLE MOVE < 10 km:			No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:			No.
REMOVAL OF EXISTING EQUIPMENT:			No.
RE-INSTALLATION OF EXISTING EQUIPMENT:			No.
WORK TIME RATE (REPAIRS):			Hour
STANDING TIME:			Hour

SUMMARY	
STRAIGHTNESS TEST:	No.
VERTICALITY TEST:	No.
CASING DETECTION:	No.
STEEL BOREHOLE COVER:	No.
BOREHOLE MARKING:	No.
SITE CLEANING / FINISHING:	No.
REPORTING & DATA RECORDING:	No.
SLUG TEST:	No.
LAYFLAT (m):	m

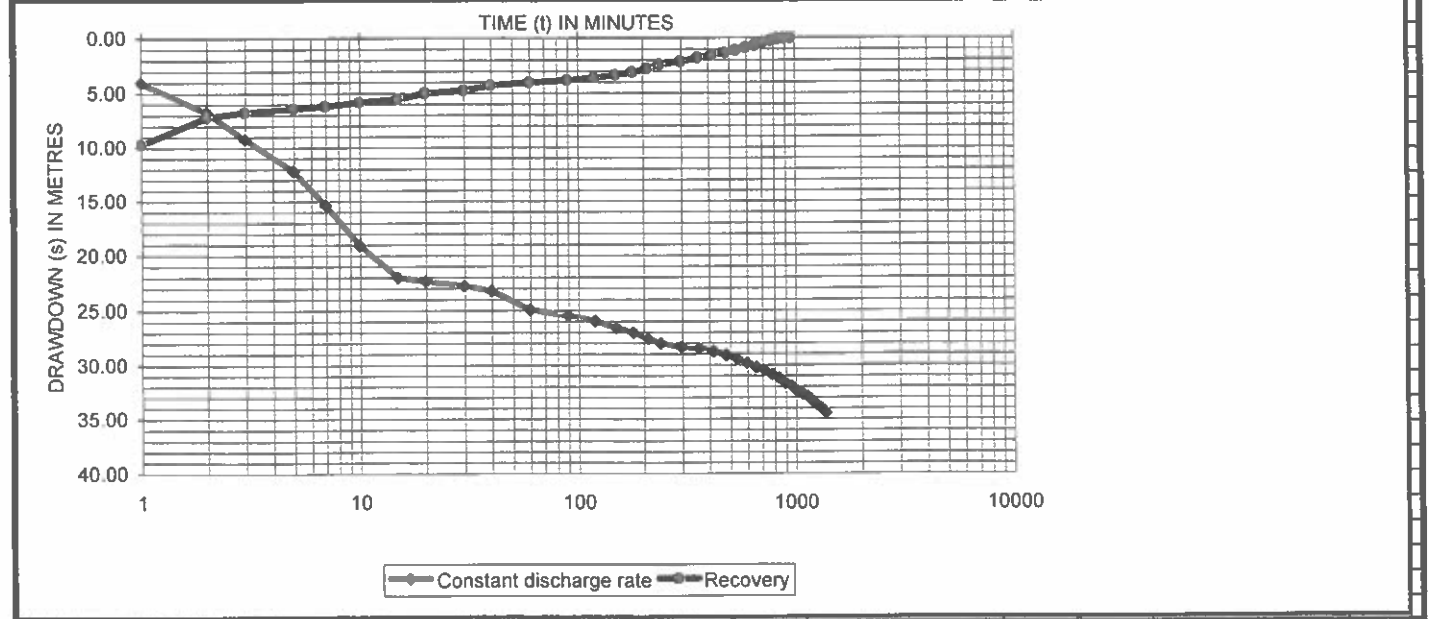
STEPPED DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :		H04-0601		STATIC WATER LEVEL (mbdl):		14.60		DEPTH OF PUMP (mbdl):		60.00				
DISCHARGE RATE 1			Time	Recovery 1	DISCHARGE RATE 2			Time	Recovery 2	DISCHARGE RATE 3			Time	Recovery 3
DATE: 23-Jul-05			(min)	(m)	DATE: 23-Jul-05			(min)	(m)	DATE:			(min)	(m)
TIME: 17H00			0	13.38	TIME: 18H40			0	34.44	TIME:			0	34.44
Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield
(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)
0	0.00		1			0	13.38		1			0	34.44	
1	4.36		2			1	16.10		2			1		
2	6.47	3.22	3			2	19.77	5.96	3			2		
3	9.02		4			3	23.01		4			3		
5	10.55	3.22	5			5	25.16		5			4		
7	11.14		7			7	27.00	6.07	7			7		
10	11.28		10			10	28.76		10			10		
15	11.50	3.20	15			15	30.01	5.98	15			15		
20	11.86		20			20	30.84		20			20		
30	12.20	3.21	30			30	31.20	5.99	30			30		
40	12.41		40			40	31.82		40			40		
50	12.60	3.22	50			50	32.46	6.01	50			50		
60	12.76		60			60	32.93		60			60		
70	13.00	3.18	70			70	33.35	6.02	70			70		
80	13.10		80			80	33.78		80			80		
90	13.24	3.18	90			90	34.13	6.01	90			90		
100	13.38		100			100	34.44	5.98	100			100		
110			110			110			110			110		
120			120			120			120			120		
Average yield (l/s): 3.20429			Average yield: 6.0025			Average yield:			Average yield:			Average yield:		
DISCHARGE RATE 4			Time	Recovery 4	DISCHARGE RATE 5			Time	Recovery 5	DISCHARGE RATE 6			Time	Recovery
DATE:			(min)	(m)	DATE:			(min)	(m)	DATE:			(min)	(m)
TIME:			0	34.44	TIME:			0	34.44	TIME:			0	34.44
Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield	Time	Drawdown	Yield
(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)	(min)	(m)	(l/s)
0	34.44		1			0	34.44		1			1	14.07	
1			2			1			2			2	7.50	
2			3			2			3			3	6.65	
3			4			3			4			4	6.32	
5			5			5			5			5	6.04	
7			7			7			7			7	5.64	
10			10			10			10			10	5.12	
15			15			15			15			15	4.36	
20			20			20			20			20	3.82	
30			30			30			30			30	3.14	
40			40			40			40			40	2.40	
50			50			50			50			50	1.76	
60			60			60			60			60	1.02	
70			70			70			70			70	0.74	
80			80			80			80			80	0.38	
90			90			90			90			90	0.17	
100			100			100			100			100	0.08	
110			110			110			110			110	0.02	
120			120			120			120			120	0	
150			150			150			150			150		
180			180			180			180			180		
210			210			210			210			210		
240			240			240			240			240		
300			300			300			300			300		
360			360			360			360			360		
420			420			420			420			420		
480			480			480			480			480		
Average yield:			Average yield:			Average yield:			Average yield:			Average yield:		
			720						720			720		

2050
8317



BOREHOLE NO:		H04-0601		OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3			
PUMP DEPTH (mbdl):		60.00		No.:			No.:			No.:			
WATER LEVEL (mbdl):		14.60		DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):		DATUM LEVEL (magl):	
TEST STARTED		DATE: 24-Jul-05		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):	
TEST COMPLETED		TIME: 08H00		BOREHOLE DEPTH:		BOREHOLE DEPTH:		BOREHOLE DEPTH:		BOREHOLE DEPTH:		BOREHOLE DEPTH:	
TIME - PUMPED (min):		1380		WATER LEVEL:		WATER LEVEL:		WATER LEVEL:		WATER LEVEL:		WATER LEVEL:	
TIME-RECOVERY(min):		900		DISTANCE (m):		DISTANCE (m):		DISTANCE (m):		DISTANCE (m):		DISTANCE (m):	
TOTAL TEST TIME:		2280		TOTAL TEST TIME:		2280		TOTAL TEST TIME:		TOTAL TEST TIME:		TOTAL TEST TIME:	
AVERAGE YIELD (l/s):		4.96		AVERAGE YIELD (l/s):		4.96		AVERAGE YIELD (l/s):		4.96		AVERAGE YIELD (l/s):	
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)	Time (min)	Drawdown (m)	Rec (m)	
0			34.46	0	0.00		0	0.00		0	0.00		
1	4.03		9.68	1			1			1			
2	6.70		7.17	2			2			2			
3	9.22	4.08	6.74	3			3			3			
5	12.18		6.42	5			5			5			
7	15.34	4.70	6.18	7			7			7			
10	19.07	5.01	5.83	10			10			10			
15	22.01		5.52	15			15			15			
20	22.34	5.00	5.01	20			20			20			
30	22.78		4.78	30			30			30			
40	23.23		4.30	40			40			40			
60	24.95	5.00	4.05	60			60			60			
90	25.48		3.84	90			90			90			
120	25.98		3.60	120			120			120			
150	26.60	5.05	3.36	150			150			150			
180	27.04		3.10	180			180			180			
210	27.62		2.78	210			210			210			
240	28.03	4.97	2.41	240			240			240			
300	28.37		2.15	300			300			300			
360	28.48		1.80	360			360			360			
420	28.79	4.99	1.53	420			420			420			
480	29.14		1.37	480			480			480			
540	29.46		1.11	540			540			540			
600	29.83	5.04	0.88	600			600			600			
660	30.26		0.67	660			660			660			
720	30.50		0.43	720			720			720			
780	30.88	5.10	0.26	780			780			780			
840	31.22		0.08	840			840			840			
900	31.70	5.11	0.03	900			900			900			
960	31.98		0.00	960			960			960			
1020	32.44	5.08		1020			1020			1020			
1080	32.69			1080			1080			1080			
1140	32.90	5.04		1140			1140			1140			
1200	33.38			1200			1200			1200			
1260	33.74	5.10		1260			1260			1260			
1320	34.02			1320			1320			1320			
1380	34.46	5.07		1380			1380			1380			



Appendix C

Detailed Water Quality Results



Laboratory Services
 P.O.Box 13106
 NORKEM PARK
 1631

S A N A S



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 LABORATORY

T0082

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Certificate of analysis

Client: AGES (Africa Geo-Environmental Services), Christine Vivier **No:** 2005/09/076
Address: PostNet Suite 74, Private Bag X07, ARCADIA, 0007 **Tel No:** 012-349-1862

Date Sampled: 15/08/2005 **Date certificate completed:** 12/09/2005
Date Sample received: 05/09/2005 **Date Analysed:** 06-07/09/2005

Sample description: Anganang Water Supply

Analysis results

<u>Sample no.</u>	<u>ERWAT no.</u>	<u>Container description</u>
[1] GP3432 - 1404-0098	05EX09/06/087	1L Plastic Bottle
[2] GP3433 - 1404-0193	05EX09/06/088	1L Plastic Bottle
[3] GP3434 - 1404-0601	05EX09/06/089	1L Plastic Bottle

CHEMICAL ANALYSIS

<u>DETERMINAND</u>	<u>Sample No.1</u>	<u>Sample No.2</u>	<u>Sample No.3</u>
Conductivity (mS/m @ 25°C)	79	66	41
Dissolved Solids (mg/L @ 180°C)	510	440	238
Total Alkalinity (mg/L CaCO ₃)	168	238	140
Chloride (mg/L Cl ⁻)	83	53	34
Fluoride (mg/L F ⁻)	0.2	0.2	0.6
Calcium (mg/L Ca)	17.1	12.5	5.9
Magnesium (mg/L Mg)	34.3	27.7	15.0
Potassium (mg/L K)	7.8	8.2	5.3
Sodium (mg/L Na)	60.3	68.8	42.8
Nitrate Nitrogen (mg/L N)	22.9	9.4	9.6
pH	7.4	7.2	7.3
Sulphate (mg/L SO ₄)	51	21	5
*Bicarbonate Alkalinity (mg/L HCO ₃ ⁻)	168	238	140
*Carbonate Alkalinity (mg/L CO ₃ ²⁻)	<10	<10	<10

*Not "SANAS" Accredited

Signed :
 Alison Chapman, Laboratory Manager

Date :
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