GROUNDWATER RESOURCE INFORMATION PROJECT
EASTERN CAPE PROVINCE

GROUNDWATER INFORMATION SOURCE REFERENCE SHEET

SOURCE REF NR:	AG118	Own Archive	X	Copy attached	X
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A: SOURCE DESCRIPTION

District Municipality:	Amatole		Chris Hani		O R Tambo	
	Ukhahlamba		Cacadu	X	Alfred Nzo	
Local Municipality:	Ikwezi					
Institution where Information is held:	AGES EC CC					
Branch of Institution:	EAST LONDON					
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B: TYPE OF INFORMATION

Information format:	Hard copy	X	Data Summary		Electronic Report	
	Specify Other:					
Report / Info Title:	Groundwater investigation in the town of Jansenville located in the Ikwezi Local Municipality of the Cacadu District Municipality – Eastern Cape Province – Phase 1					
Report Nr:	EC/03/43/HG		Date:	November 2003		
Author Details:	J.A MYBURGH					
Author's Qualification:	Hydrogeologist	X	Govt Dept		Project Manager	
	Engineer		Technician		Other	
	Specify Other:					
Captured by:	A VILJOEN	Date:	23/2/2004	Signed:	AVilJoen	

C: GEOHYDROLOGICAL CATEGORIZATION

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

Reference Co-ordinate:	Latitude	Longitude
	S 32° 57' 00"	E 24° 40' 00"

	Yes	No	Complete	Incomplete
Lithological & Construction Logs		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:

Reviewed by: F. de Jager Date: 11/3/04 Signed:

Project report: EC/03/43/HG

GeoCon

Preliminary report on the hydrogeological investigation:

GROUNDWATER INVESTIGATION IN THE TOWN OF JANSENVILLE LOCATED IN THE IKWEZI LOCAL MUNICIPALITY OF THE CACADU DISTRICT MUNICIPALITY- EASTERN CAPE PROVINCE

PHASE 1

November 2003

Project Team:
J. A. Myburgh,
T. Mafanya

SOUTHERN AFRICA GEOCONSULTANTS (PTY) LTD

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1 INTRODUCTION

Southern Africa GeoConsultants (PTY) Ltd – hereafter referred to as GeoCon- was appointed by VUBA IMAGINEERS cc to carry out a groundwater study at the town of Jansenville, located in the Ikwezi Local Municipality of the Cacadu District Municipality in the Eastern Cape Province.

The investigation included field surveys and an assessment of existing boreholes occurring in the project area and resulted in a reporting phase including the compilation of GIS based maps showing geology and structural geological features defined by lineaments from remote sensing and field observations.

1.1 Scope of investigation

GeoCon was appointed to render the following hydrogeological consultation services in the project area as part of the Phase 1 study:

- Project initiation, co-ordination and management
- Evaluation of existing information
- Evaluation of existing water sources
- Acquisition and evaluation of borehole drilling and testing quotations
- Pump testing evaluation of existing boreholes
- Analyses of pump testing data
- Delineation of aquifers & structures as well as target areas via remote sensing
- Geophysical survey across high potential target structures – identify drilling targets in better water quality zone
- Groundwater quality assessment
- Reporting with recommendations regarding the feasibility of utilising local groundwater sources - and the way forward should groundwater prove to be a sustainable water source for the town of Jansenville.

The required daily water demand for a 20-year design horizon was defined as a required sustainable flow rate of 20 l/s – i.e. **1728 m^3/day**.

1.2 Location of study area

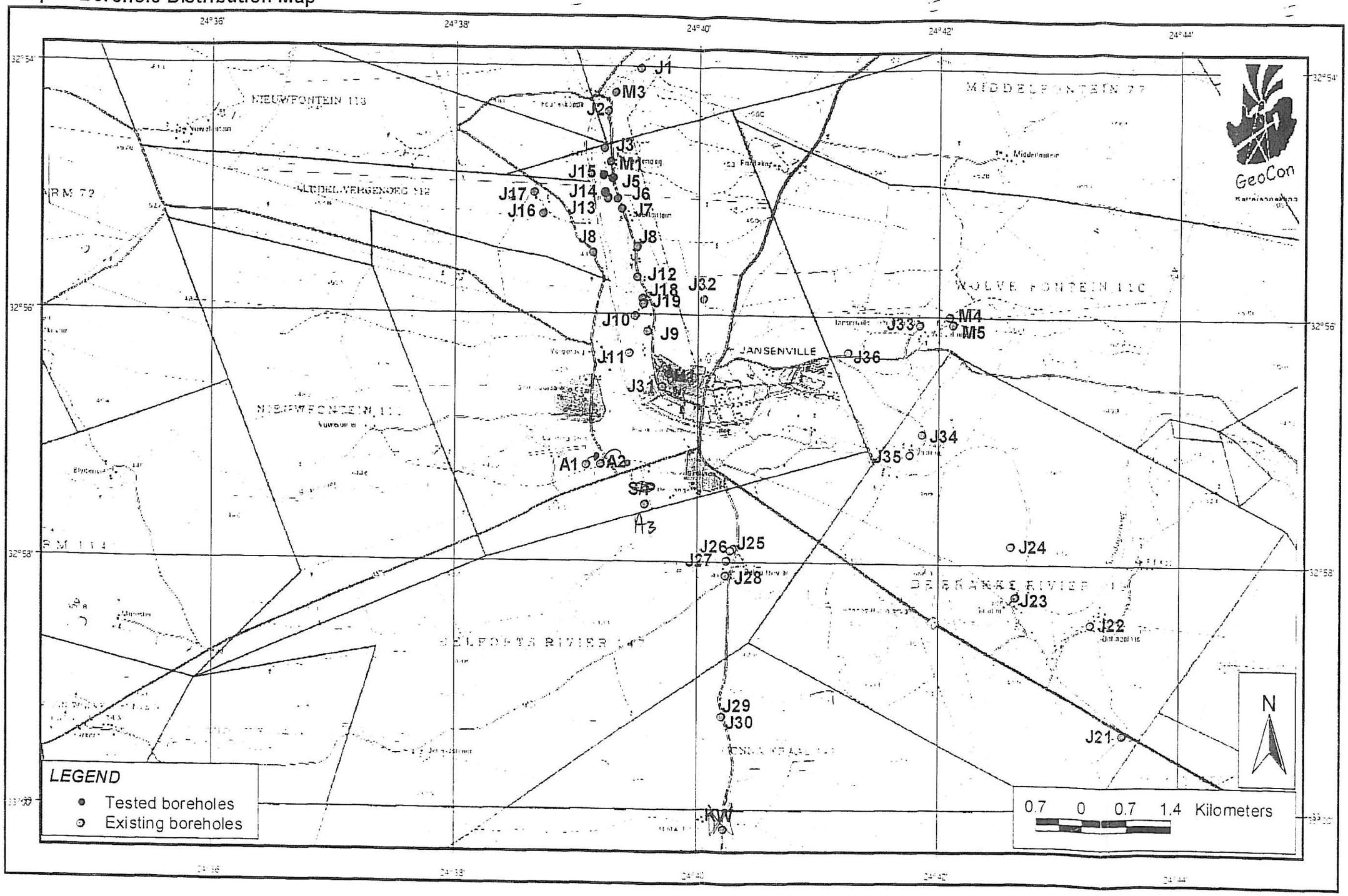
The town of Jansenville lies along the R75 route to Graaf Reinet. The town is situated along the banks of the Sundays River in the Ikwezi Local Municipality of the Cacadu District Municipality. The towns location relative to the Sundays River can be seen in the attached site locality map - Map 1.

1.3 Information sources

- Geological information was obtained from the 1:250 000 scale geological map- GRAAF REINET
- Hydrogeological information was obtained from the 1:500 000 scale hydrogeological map: 3324 Port Elizabeth.
- Topographical information was obtained from the 1:50 000 topographical map 3224 BA JANSENVILLE and 3224 GRAAF REINET NOORD.
- Jakoets & Associates 2002. Jansenville bulk water supply. Ikwezi Municipality Report No.

PROJECT: JANSENVILLE GROUNDWATER INVESTIGATION

Map 1: Borehole Distribution Map



2 EXISTING INFORMATION

2.1 Regional Geology

The regional geology of the Jansenville area comprises three formations belonging to the Karoo Supergroup. The geological succession in the Jansenville area can be viewed on the table below:

Formation	Lithological description
Middleton	Comprised of greenish grey mudstone and sandstone of the Adelaide Subgroup
Koonap	Mainly mudstone, sandstone and chert rich beds of the Adelaide Subgroup
Waterford	Mainly sandstone and shale of the Ecca Group

All these formations are characterized by its layered character, which marks a fluvial mode of deposition. These sediments were deposited during the Permian Period. The project area is intersected by the Sundays River, which flows in a easterly direction through the town. The presence of this river marks the occurrence of alluvial sand deposits along its banks. These deposits partially form an important aquifer in the study area.

Several faults and numerous folds occur in the study area. Folding of sedimentary rocks in the Jansenville area can be attributed to regional folding associated with the Cape Fold Belt and decreases in intensity towards the north. The regional geology of the project area is indicated in Map 2.

2.2 Hydrogeological setting

The 1:500 000 Queenstown Hydrogeological map describes the project area as underlain by predominantly arenaceous rocks of the Karoo Sequence. Groundwater occurrences are generally located intergranular and in fractured zones with expected yields varying between 0.5 and 2.0 l/s at successful boreholes. Higher yields are likely where folded structures, faults and / or alluvium, associated with river drainages occur.

2.3 Previous Studies – Hydrocensus and Potential Assessments

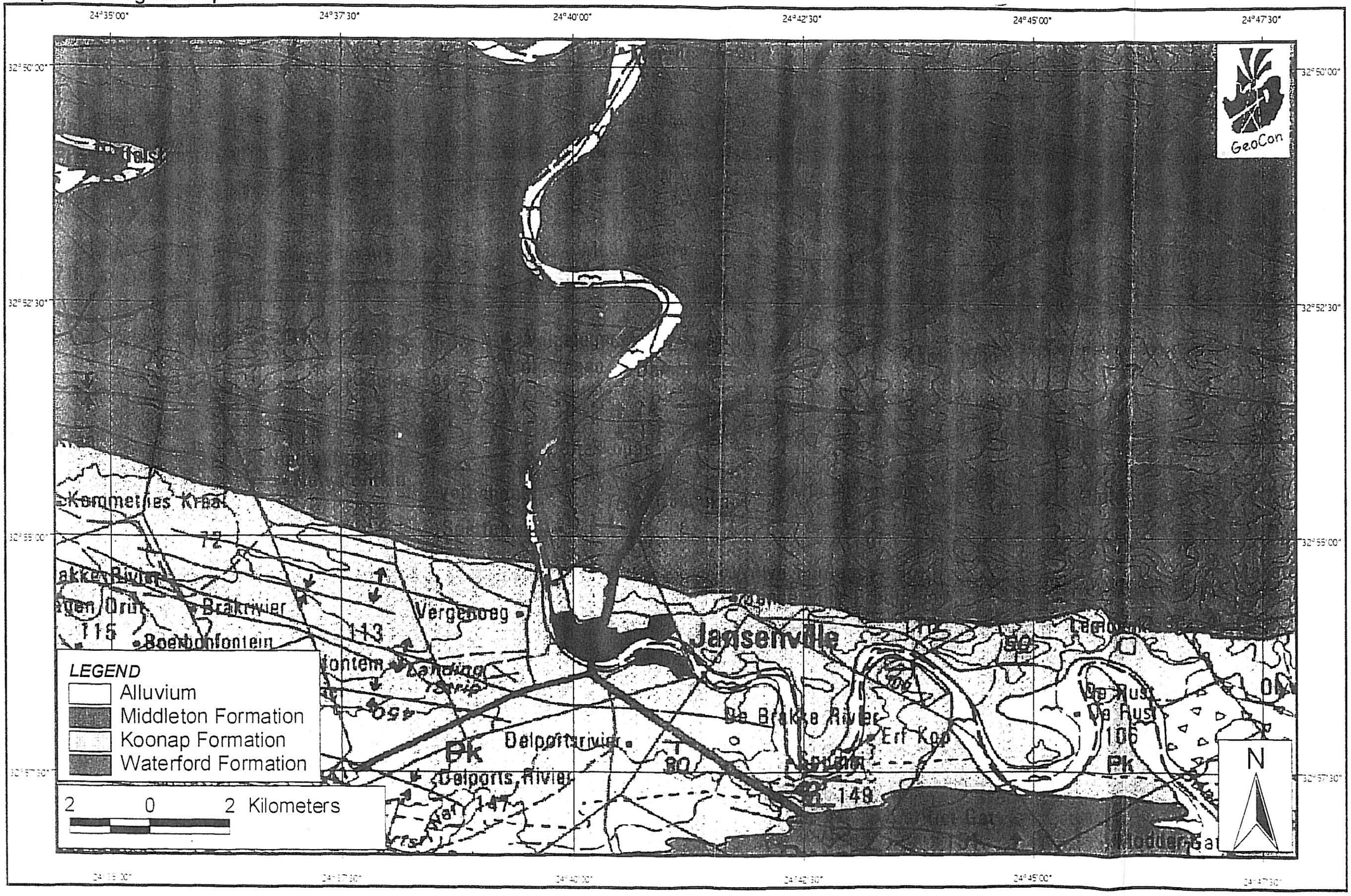
It has been reported that Jansenville mainly relies on groundwater for domestic and other water needs. This is confirmed by a study conducted by Jakoets and Associates, which revealed that about 50 boreholes exist in project area, with an average depth of 55m and yields ranging from 0.3 to 22 l/s.

The town production boreholes are developed in an aquifer closely associated with the Sundays River has poor water quality and is severely influenced by fluctuations in river water flow. Most boreholes drilled away from the river (in better water quality zone) have not been tested. There is a tendency for higher yielding boreholes to occur associated with an east west trending fold. Boreholes drilled away from the river are reported to have better water qualities

The existence of boreholes was verified on site and data from this report is attached in Appendix A for reference. Alluvium associated with the Sundays River increases recharge and yield potential and is an important aquifer in the study area, thus explaining the existence of numerous boreholes in the riverbed and along riverbanks. Although the alluvium along the Sundays River serves as an important local aquifer, water quality is known to be poor. According to the mentioned report poor water quality is due to accelerated levels of dissolved salts, which are associated with poor water quality occurring in the Sundays River.

PROJECT: JANSENVILLE GROUNDWATER INVESTIGATION

Map 2: Geological map



3 METHODOLOGY

3.1 Appointment of sub-contractors

Appointment of contractors responsible for the borehole testing and drilling was made through an informal tendering process in consultation with the client.

Steyns Drilling Trust was appointed to deliver drilling services and *AB Pumps* was appointed to deliver pump-testing services. *Intaba Construction* –was appointed to deliver groundwater-sampling services and pump testing evaluation of selected existing boreholes.

Borehole drilling and testing is done under the supervision of GeoCon with reference to the Department of Water Affairs and Forestry's Minimum Standards and Guideline Document – 1997.

3.2 Pump Testing

3.2.1 Pump testing procedure

Preliminary pump testing evaluations were done using existing equipment under the supervision and guidance of the hydrogeological consultant.

The water level response to the constant rate drawdown test, as well as the recovery after the test and monitoring data, was used to assess the hydraulic parameters of the aquifer.

3.2.2 Pump testing analysis

Two parameters are used to describe the physical properties of the aquifer, namely transmissivity (T) and storativity (S). The first of these two quantifies the rate at which water moves through the aquifer and the latter quantifies the aquifer's ability to release water. These two parameters can be determined by means of aquifer tests such as pumping tests. However in order to obtain accurate S values observation borehole water levels must be recorded.

Three different methods were used to determine the T values of the boreholes under investigation. They are:

- Cooper-Jacob analysis

  The Cooper-Jacob method is summarized in Kruseman and De Ridder (1991). This method was actually developed for porous flow aquifers. However if the pumping tests are correctly recorded, the method can be used to obtain information concerning the fractures (early T analyses) and the surrounding rock matrix (late-T analyses).

  The pump testing graphs from the Cooper-Jacob analyses are attached in Appendix B for reference.

- FC-analysis

  FC refers to flow characterization of groundwater flow to a borehole. This method of analysis takes into account factors such as the derivatives of drawdown versus time data, boundary information and error propagation. The method has been developed by the Institute for Groundwater Studies (IGS). An in-depth discussion of the method can be found on the IGS website http://www.uovs.ac.za/igs.

- Recovery method

  This test provides an indication of the ability of a borehole and groundwater system to recover from the stress of abstraction. This ability can again be analyzed to provide information in regard to the

hydraulic properties of the groundwater system and arrive at an optimum yield for the medium to long-term utilization of the borehole. Although referred to as a test, it rather represents a period of monitoring activity following a period of pumping. The rate at which the water level in the tested borehole (or any other borehole affected by the abstraction) recovers towards its starting level (the groundwater rest level before pumping started) is monitored in this period. For more information concerning this method refer to Kruseman and De Ridder (1991).

3.3 Chemical Water Analyses

Water samples were taken at the end of constant rate drawdown tests at boreholes that were pump tested. The samples are analysed as far as its physical and chemical and microbiological quality is concerned.

Results were evaluated by using the document: ***Quality of Domestic Water Supplies; Volume 1;Assessment Guide; Second Edition 1998; Water Research Commission No. TT101/98*** as well as the recommended limits set in SABS 241 of 1984.

The purpose of this Guide is to answer the following questions:

- Is the water suitable for domestic use?
- If not, what can be done to make it suitable for use?

This Guide allows the quality of water supplied for domestic use to be assessed by using a simple classification system. The system shows the nature of the effects of water quality on the domestic user for a range of concentration values for those substances commonly encountered in water. The information is presented in a simplified format so that a wide spectrum of users of the Guide will be able to understand the concepts of water quality as it affects the domestic user.

The Water Quality Assessment Guide define the following classes:

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. Acute effects may occur.

Table 1: Water Quality Assessment Guide.

4 RESULTS

4.1 Confirmative Hydrocensus

A confirmative hydrocensus was carried in the project area to confirm the existence of boreholes suggested by the Jakoets and Associates report as well as possible existing boreholes in the reported areas of better water quality. Additional boreholes were found and these include A1, A2, A3 and M5. All the relevant boreholes are indicated in Map 1 with detailed data indicated in Appendix A.

4.2 Pump testing

Borehole J14 was selected for pump testing due to its reported high yield to evaluate and estimate the yield potential of the local aquifer. Two more boreholes located in the proximity of J14 were selected as monitoring boreholes during the testing of J14. The constant rate discharge test lasted for 48 hours at a discharge rate of 10 l/s – causing a total drawdown of 8.2 m after 48 hrs. The data from monitoring boreholes was recorded during the pump testing of J14. The borehole was then allowed to recover with the water level responses measured.

Borehole, M4, a privately owned borehole which was reported to have a high yield and good water quality was found blocked and therefore could not be tested or sampled.

Pump testing data analysis revealed the aquifer is double porous supported by both fractures and matrix. The transmissivity values obtained reveal that during the early hours of pump testing water is drawn from the fracture and during late hours water comes from both fractures and matrix. The transmissivity values obtained from the pump test analyses are in order of 98.82m^3/d for early time transmissivity (i.e. estimated fracture T value) and 16.93 m^3/d for late time transmissivity (estimated matrix T value). The estimated storativity of the aquifer is in the order of 3.26×10^{-3}.

Based on results obtained from preliminary testing – it is evident that boreholes developed in the Sundays River aquifer – comprising shallow sandy alluvium overlying folded and fractured mudstone and sandstone – can be expected to have sustainable yields in the vicinity of 4 l/s – implying that the water demand can be met through the development of approximately 5 production boreholes in this aquifer system.

The relevant pump testing data is attached in Appendix B for reference.

4.3 Water quality analyses

Water samples from eight boreholes in the Jansenville area were collected for the purposes of analysing and evaluating the chemistry of groundwater in different zones of the project area. The boreholes considered include J1, J8, J13, J14, J15, J17, M5 and S/P. The distribution of these boreholes is indicated in Map1 For the analyses, samples were sent to AMATOLA WATER LABORATORY for analyses of its chemical water quality. A summary of results is indicated in the attached Project Summary Table and detail data is included in Appendix C. The results obtained were evaluated against the DWAF Guideline values for domestic water use (South African Water Quality Guidelines Volume 1, 1996).

The results obtained revealed that the electrical conductance (EC) of groundwater in the entire area is above the DWAF water quality standards of 70 mS/m. The EC values recorded range between 184 and 618 mS/m. The other element noted to be excessively high is Total Dissolved Solids, accompanied by chloride, sodium, magnesium and total hardness.

Regarding the comparison with DWAF water quality classification for drinking, the groundwater for the said region varies from class 2 (marginal water quality), which is observed in J17 to dangerous water quality

(class 4) observed in J1, J13, and J15. The rest of the water samples classifies as class 3 (poor water quality for drinking purposes) Boreholes sampled with there different classes are indicated in Map 3.

Best water quality was noted at boreholes in certain zones outside the Sundays River Aquifer. Boreholes J17 and M5 were noted to best represent the better water quality – See Map 3. Slightly elevated Fluoride levels noted at borehole M5 is not seen as critical. Water quality data for all the sampled sites is attached in Appendix C for reference.

4.4 Remote sensing – identification of better water quality exploration zones

Remote sensing was carried out using 1:50 000 scale stereoscopic aerial photography that is available for the study area. Prominent folding with fold axes orientated in a WNW direction can be noted throughout the study area. Several major EW trending faults are noted approximately 6.5km NE and 9.5km SW of Jansenville and is indicated in the attached Map 4. Occasional NS trending lineaments are noted in some areas and could possibly represent secondary faulting.

Based on lineaments and structures observed, six zones have been identified as possible high yielding groundwater exploration target areas. These zones all fall outside the poor water quality Sundays River Aquifer and reports from local farmers as well as limited preliminary water quality analyses predict better groundwater quality in these zones.

Zones have been prioritised based on their potential from 1 to 6 (refer to Map 4).

4.5 Water Treatment Options

The treatment of water of chemical composition represented by the combination of high yielding boreholes developed in the Sundays River Aquifer will require complicated and expensive techniques.

To remove the most problematic dissolved salts and associated electrical conductivity of the groundwater in the study area, energy-intensive processes are required, such as REVERSE OSMOSIS or electro dialysis: distillation, or demineralization with a mixed bed resin ion-exchange process. All large-scale salt removal processes require high levels of operator and maintenance skills as suspended matter or hard water easily fouls processes. The concentrated brine produced may further also present disposal problems. Home treatment kits using ion-exchange processes can be purchased, but these are expensive and treat only small volumes of water.

The usual method used for reducing the magnesium concentration in water is lime softening followed by re-carbonation. Other techniques that can be used are the use of ion-exchange resins or precipitation of the magnesium at high pH.

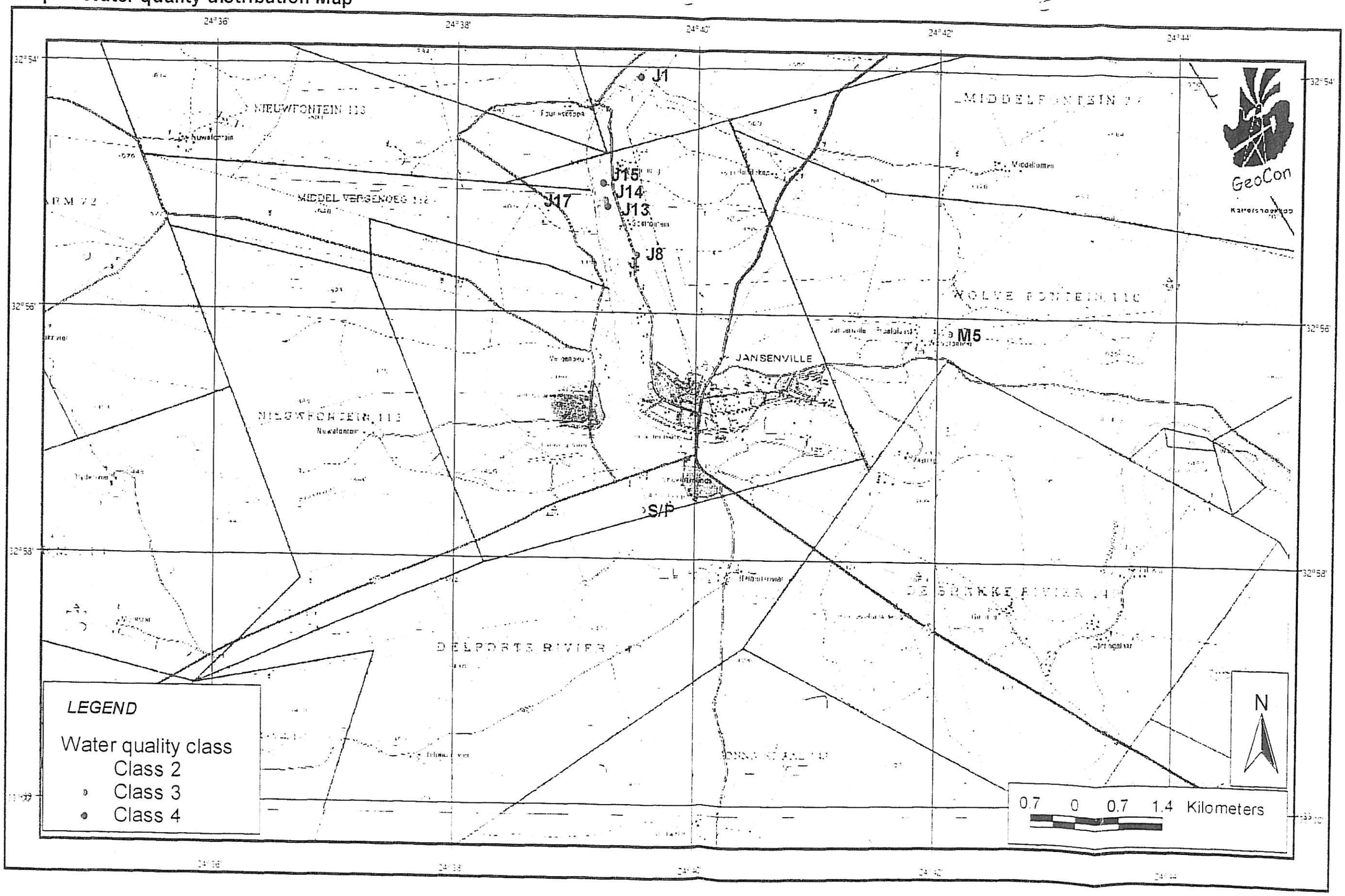
Total hardness can be removed from water by cat ion exchange softening, or by demineralization techniques. such as mixed-bed ion-exchange desalination. Other desalination techniques can also be used. Chemical precipitation and sedimentation are most frequently used when large volumes of water are treated.

Standardised chemical units are usually built to a capacity of 40 m^3 / hr, which is approximately half the required capacity. Such a unit will cost in the vicinity of R1 800 000 with additional installation requirements amounting to an additional R1 000 000. Operating costs of such a unit are between R5 per m^3 and R7 per m^3. Power supply costs will have to be allowed for at an additional R2 per m^3, while the replacement of membranes can be estimated at a further R 2 per m^3. Costs for the required 72 m^3 / hr unit may be the equivalent of double this estimate or slightly less. The operator required will have to have a high degree of capability and the environmental impacts of the disposed waste will have to be investigated.

A rough estimate of the most probable water treatment option available – being Reverse Osmosis can be summarised as follows:

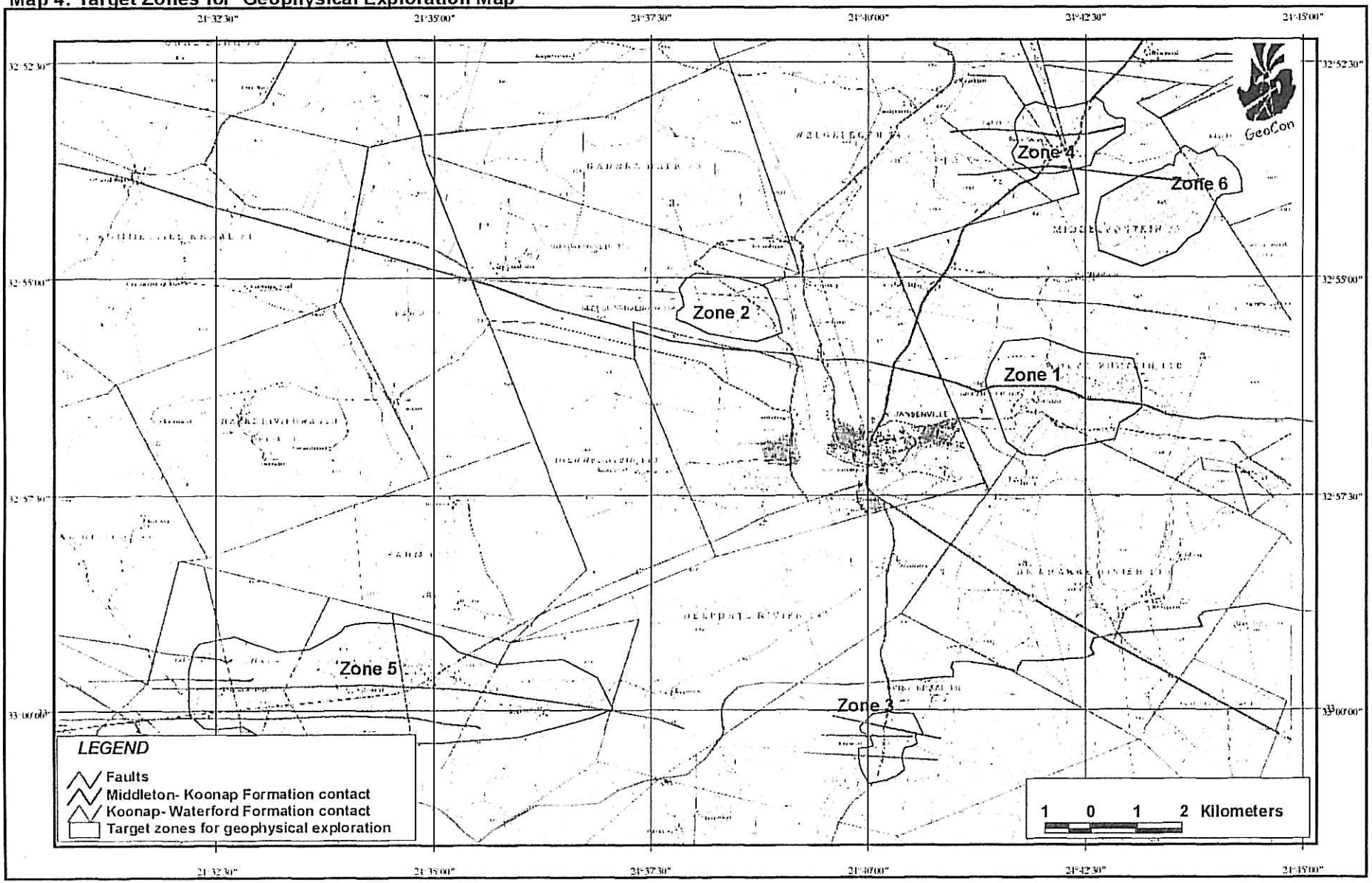
PROJECT: JANSENVILLE GROUNDWATER INVESTIGATION

Map 3: Water quality distribution Map



PROJECT: JANSENVILLE GROUNDWATER INVESTIGATION

Map 4: Target Zones for Geophysical Exploration Map



- *Development and implementation* — *R 5 200 000*
- *Daily operating costs – based on 72 m^3 / hr* — *R 19 000 / day*
- *Monthly operating costs – based on 72 m^3 / hr* — *R 500 000 / month*

Based on rough estimates obtained from water treatment specialists – it is evident that the removal of the problematic elements from groundwater in the project area is an expensive option should the total required daily volume need to be treated.

5 CONCLUSIONS

- Jansenville currently relies on groundwater for its domestic and other water needs.
- Numerous boreholes exist in the project area, with an average depth of 55m and yields ranging from 0.3 to 22 l/s. (± 50 bhs)
- Boreholes drilled away from the river are reported to have better water qualities
- The town production boreholes are developed in an aquifer closely associated with the Sundays River has poor water quality and is severely influenced by fluctuations in river water flow.
- There is a tendency for higher yielding boreholes to occur associated with an east west trending fold
- Several faults and numerous folds occur in the study area. Folding of sedimentary rocks in the Jansenville area can be attributed to regional folding associated with the Cape Fold Belt and decreases in intensity towards the north
- Higher yields are likely where folded structures, faults and / or alluvium, associated with river drainages occur.
- Alluvium associated with the Sundays River increases recharge and yield potential and is an important aquifer in the study area, thus explaining the existence of numerous boreholes in the riverbed and along riverbanks. Although the alluvium along the Sundays River serves as an important local aquifer, water quality is known to be poor
- Based on results obtained from preliminary testing – it is evident that boreholes developed in the Sundays River aquifer – comprising shallow sandy alluvium overlying folded and fractured mudstone and sandstone – can be expected to have sustainable yields in the vicinity of 4 l/s – implying that the water demand can be met through the development of approximately 5 production boreholes in this aquifer system
- Regarding the comparison with DWAF water quality classification for drinking water, the groundwater for the said region varies from class 2 (marginal water quality), which is observed in J17 to dangerous water quality (class 4) observed in J1, J13, and J15 in the Sunday River Aquifer Zone. The rest of the water samples classifies as class 3 (poor water quality for drinking purposes)
- Better water quality was noted at boreholes in certain zones outside the Sundays River Aquifer. Boreholes J17 and M5 were noted to best represent the better water quality.
- Prominent folding with fold axes orientated in a WNW direction can be noted throughout the study area.
- Several major EW trending faults are noted approximately 6.5 km NE and 9.5 km SW of Jansenville
- Based on lineaments and structures observed, six zones have been identified as possible high yielding – good water quality exploration target areas. These zones all fall outside the poor water quality Sundays River Aquifer and reports from local farmers as well as limited preliminary water quality analyses predict better groundwater quality in these zones.
- Zones have been prioritised based on their potential from 1 to 6.
- Based on rough estimates obtained from water treatment specialists – it is evident that the removal of problematic elements from groundwater in the project area is an expensive option should the total required daily volume need to be treated.

- Should the TOTAL daily volume of 1728 m^3 need to be treated – the development and implementation of a Reverse Osmosis Plant will cost approximately R 5 M and will have to be operated at a monthly cost of approximately R500 000.

- Numerical Water Balance Calc
- Treat different volumes?
- Split Lady- from marley/other water

6 RECOMMENDATIONS

1. The Jansenville community must urgently be made aware of the poor to dangerous water quality that is currently in use. Interim measures must be defined and taken to protect sensitive users.
2. The cost implication of water treatment must be evaluated by the client before any detailed aquifer analyses and testing be carried out for the Sundays River Aquifer
3. Should water treatment be considered – a detailed situational analyses and study for the design and accurate costing of a water treatment facility must be carried out by a water treatment specialist.
4. Exploration drilling must be carried out in the identified better water quality zones utilising the appointed contractors
5. Preliminary liaison with land owners in identified better water quality zones must be initiated
6. A cost definition for the development of, and infrastructure related to, better water quality production boreholes must be compiled once exploration results are known.

JANSENVILLE GROUNDWATER INVESTIGATION - PROJECT SUMMARY TABLE

VILLAGE NAME	ORIGINAL BOREHOLE NUMBER	ALLOCATED BOREHOLE NUMBER	Coordinate (WGS84) S	Coordinate (WGS84) E	PUMP TEST DATA: Date tested	Static water level (mbgl)	Borehole depth (m)	Test Pump depth (m)	Nr of Steps	Constant Rate Test: Rate (l/s)	Constant Rate Test: Duration (min)	Recovery Test: %	Recovery Test: Duration (min)	Pump test analyses: FC Analysis: Early time Transmissivity (m^2/d)	FC Analysis: Late time Transmissivity (m^2/d)	FC Analysis: Storativity	FC Analysis: Sustainable yield (l/s) 12/24hrs	Cooper Jacob analysis: Early time Transmissivity (m2/d)	Cooper Jacob analysis: Late time Transmissivity (m2/d)	Cooper Jacob analysis: Storativity	Cooper Jacob analysis: Sustainable yield (l/s) 12/24hrs	WATER CHEMISTRY: Final chemical water analyses: Drinking class	Food class	Bathing class	Laundry class	Problem constituent	MANAGEMENT RECOMMENDATIONS: Inst Depth (mbgl)	Duty cycle(hrs/24)	Abstraction Rate (l/s)	Comments & Recommendations
EXISTING BOREHOLES																														
Jansenville	J1	J1	32° 54' 1.6"	24° 39' 31.3"	Not tested																	4	4	3	4	Chloride, EC, Na	N/A			Treatment of water prior to use is recommended- detailed recommendations are outlined in the report
	J2	J2	32° 54' 22.0"	24° 39' 15.0"	Not tested																	No analysis conducted					N/A			
	J8	J8	32° 55' 28.0"	24° 39' 30.0"	Not tested																	3	3	3	3	EC, Chloride, Na	N/A			
	J13	J13	32° 55' 4.40"	24° 39' 15.0"	Not tested																	4	4	3	4	Ec, Chloride, TDS, Na	N/A			
	J14	J14	32° 55' 1.50"	24° 39' 13.0"	26/09/2003	26.17	-	50	-	10	2880	40.95	180	38.82	16.93	2.20E-03	2.33	33.4	25.1	3.25E-03	4.24	3	3	3	3	EC, Chloride, Total Hardness, Na	45	12	4.8	Treatment of water prior to use is required
	J15	J15	32° 54' 53.0"	24° 39' 13.0"	26/09/2003	27.69	Observation borehole															4	4	3	4	EC, TDS, Total Hardness, Na	N/A			Treatment of water prior to use is required
	J17	J17	32° 55' 1.30"	24° 38' 38.0"	Not tested																	2	3	3	3	EC, Chloride, Flouride, Total Hardness	N/A			Water from this borehole can be used without posing serious health risks
	M1	M1	32° 54' 55.0"	24° 39' 17.3"	26/09/2003	31.48	Observation borehole															No analysis conducted					N/A			N/A
	M5	M5	32° 56' 4.00"	24° 42' 6.30"	Not tested																	3	3	3	3	Flounde	N/A			Treatment of water prior to use is required
	S/P	S/P	-	-	Not tested																	3	3	3	3	EC, Total Hardness, Na	N/A			

APPENDIX A

HYDROCENSUS- BOREHOLE DATA

JANSENVILLE GROUNDWATER INVESTIGATION- HYDROCENSUS BOREHOLE DATA

Village/ Town	Borehole Number	Borehole Depth	Latitude	Longitude	EC	Yield	Water Level	Comments
				Existing boreholes from Jakoets and Associate report				
Jansenville	J1	Nm	-32.90044	24.65869	Nm	Nm	Nm	Town supply borehole, abnormal taste
	J2	Nm	-32.90619	24.65417	640	Nm	4.76	Possiblle hiigh iron content (brown color)
	J3	Nm	-32.91122	24.65361	Nm	Nm	Nm	Borehole equiopped with a windmill
	J4	Nm	-32.91292	24.65453	6.66	Nm	7.92	Boreholle unequipped
	J5	Nm	-32.91522	24.65492	Nm	Nm	10.15	Borehole unequipped
	J6	60	-32.91797	24.65558	Nm	7.5	30	Borehole used for cattlle watering
	J7	60	-32.91931	24.65619	Nm	0.3	36	Borehole near house of workers
	J8	Nm	-32.92442	24.65833	Nm	Nm	Nm	Town supply borehole
	J9	32	-32.93572	24.65981	Nm	Nm	11.2	Borehole used for cattlle watering
	J10	108	-32.93378	24.65808	609	6.25	Nm	
	J11	Nm	-32.93869	24.65731	Nm	10	6.16	
	J12	27	-32.92850	24.65833	516	Nm	Nm	
	J13	81	-32.91789	24.65411	652	18.75	5.93	Pump set @ 39 mbgl
	J14	69	-32.91708	24.65372	Nm	22.5	9	Borehole close to the river
	J15	60	-32.91483	24.65350	Nm	18.75	12.9	
	J16	Nm	-32.92006	24.64519	250	Nm	Nm	Borehole equipped with a windmill (occasionally dry)
	J17	66	-32.91719	24.64389	250	Nm	4.5	Springs visible in the area
	J18	Nm	-32.93139	24.65897	264	Nm	Nm	Borehole equipped with a windmill
	J19	Nm	-32.93192	24.65931	252	Nm	Nm	Borehole equipped with a windmill
	J20	Nm	-32.93208	24.65917	Nm	Nm	Nm	Equipped with an electrically driven moono pump
	J21	Nm	-32.98975	24.72539	321	Nm	Nm	Borehole equipped with a windmill
	J22	Nm	-32.97489	24.72081	317	Nm	Nm	Borehole equipped with a windmill
	J23	Nm	-32.97128	24.71044	690	Nm	Nm	Borehole equipped with a windmill
	J24	Nm	-32.96433	24.70981	540	Nm	Nm	Borehole equipped with a windmill
	J25	Nm	-32.96497	24.67156	317	Nm	Nm	Borehole equipped with a windmill
	J26	Nm	-32.96528	24.67111	317	Nm	Nm	Borehole equipped with a mono pump
	J27	Nm	-32.96667	24.67069	327	Nm	Nm	Borehole equipped with a windmill
	J28	Nm	-32.96858	24.67047	Nm	Nm	Nm	Borehole unequipped
	J29	Nm	-32.98769	24.67006	Nm	Nm	Nm	Borehole equipped with a windmill, waterr has a fresh taste
	J30	Nm	-32.98769	24.67006	237	Nm	Nm	Borehole equipped with a windmill
	J31	Nm	-32.94319	24.66183	890	Nm	Nm	Borehole equipped with a windmill
	J32	Nm	-32.93131	24.66744	274	Nm	Nm	Boreohole equipped with a windmill (Camp 9)
	J33	Nm	-32.93458	24.69717	274	Nm	Nm	Measurements taken at the office
	J34	Nm	-32.94942	24.69753	Nm	Nm	Nm	Equipped with a windmill, low yielding, fair water quality
	J35	Nm	-32.95206	24.69578	588	Nm	12.7	Borehole unequipped
	J36	Nm	-32.93833	24.68719	Nm	Nm	Nm	Borehole collapsed
				Additional hydrocensus boreholes				
	M1	Nm	-32.91522	24.65483	Nm	Nm	Nm	Not in use - Previously Municipal supply
	M2	Nm	-32.91292	24.65453	Nm	Nm	Nm	"
	M3	Nm	-32.90375	24.65511	Nm	Nm	Nm	Water is reported to have salty taste
	M4	Nm	-32.93347	24.70131	Nm	Nm	Nm	Open hole - Not equipped
	M5	Nm	-32.93444	24.70175	Nm	Nm	Nm	Equipped with a mono pump
	Hospitaal	Nm	-32.94150	24.66269	Nm	Nm	Nm	
	Kruit Water	Nm	-33.00281	24.67022	Nm	Nm	Nm	
	A1	Nm	-32.95381	24.65136	Nm	Nm	Nm	Not equipped - Previously utilized
	A2	Nm	-32.95378	24.65342	Nm	Nm	Nm	Not equipped "
	A3	Nm	-32.95908	24.65950	Nm	Nm	Nm	Equipped with a submersiblle pump

APPENDIX B

PUMP TESTING DATA

CALIBRATION TEST AND RECOVERY

BOREHOLE NO. :	J14	PROJECT:	Jansenville Groundwater Investigation - Vuba
ALTERNATIVE NO. :		SITE NAME:	
ALTERNATIVE NO. :		CLIENT:	

BOREHOLE DEPTH (mbdl):		CASING DEPTH (mbdl):		PUMP TYPE USED:	Submersible
DEPTH OF PUMP (mbdl):	50.00	CASING HEIGHT (magl):		OPERATOR:	Shaun Briel
PUMP INLET DIAMETER (mm):	110.00	CASING ID (mm):		CONTRACTOR:	Intaba Construction
STATIC WATER LEVEL (mbdl):	26.17	DATUM LEVEL (magl):	340.00	SUPERVISOR:	Shaun Briel

DISCHARGE RATE 1

DATE: | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF RESERVOIR:

RESERVOIR SIZE:

RESERVOIR CONITION:

STAND HEIGHT (m):

DISCHARGE RATE 2

DATE: 0 | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF ENCLOSURE:

MATERIAL OF ENCLOSURE:

CONDITION OF ENCLOSURE:

WATER METER MANUFACTURER:

WATER METER READING:

DISCHARGE RATE 3

DATE: 0 | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PRESSURE GAUGE MANUFACTURER:

GAUGE READING (KpA):

MONITORING FACILITY:

MAINTAINED:

DISCHARGE RATE 4

DATE: 0 | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

PUMP TYPE:

PUMP MANUFACTURER:

PUMP SERIAL No:

PUMP PULLEY DIAMETER (mm):

PUMP INTAKE DEPTH (m):

PUMP RPM:

PUMP CONDITION:

DISCHARGE RATE 5

DATE: 0 | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	

EXISTING EQUIPMENT DETAIL:

TYPE OF POWER:

ENGINE MANUACTURER:

ENGINE MODEL:

ENGINE SERIAL No:

ENGINE PULLEY DIAMETER (mm):

POWER RATING (kW):

ENGINE CONDITION:

DISCHARGE RATE 6

DATE: | TIME:

Time (min)	Drawdown (m)	Yield (l/s)	Time (min)	Recovery (m)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
			20	
			30	
			40	
			50	
			60	
			70	
			80	
			90	
			100	
			110	
			120	
			150	
			180	
			210	
			240	
			300	
			420	
			480	
			540	
			600	
			660	

EXISTING EQUIPMENT DETAIL:

TYPE OF RISER:

CLASS OF RISER:

DIAMETER OF RISER (mm):

CONDITION OF RISER:

SHAFT DIAMETER (mm):

ELEMENT DIAMETER (mm):

ELEMENT STROKE (mm):

COMMENTS:

DID THE BOREHOLE PRODUCE ANY SILT / SAND / GRAVEL ?

* TIME INTERVAL AT WHICH YIELD MEASUREMENT MUST BE TAKEN

STEPPED DISCHARGE TEST AND RECOVERY

OREHOLE NO. :	J14	PROJECT:	Jansenville Groundwater Investigation - Vuba
LTERNATIVE NO. :	0	SITE NAME:	0
ALTERNATIVE NO. :	0	CLIENT:	0

OREHOLE DEPTH (mbdl):	0.00	CASING DEPTH (mbdl):	0.00	PUMP TYPE USED:	Submersible
EPTH OF PUMP (mbdl):	50.00	CASING HEIGHT (magl):	0.00	OPERATOR:	Shaun Briel
PUMP INLET DIAMETER (mm):	110.000	CASING ID (mm):	0.000	CONTRACTOR:	Intaba Construction
TATIC WATER LEVEL (mbdl):	26.17	DATUM LEVEL (magl):	340.00		

DISCHARGE RATE 1			Time	*Recovery 1*
DATE:			(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	#DIV/0!		(l/s)	

DISCHARGE RATE 2			Time	*Recovery 2*
DATE:	00-Jan-00		(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	#DIV/0!			

DISCHARGE RATE 3			Time	*Recovery 3*
DATE:	00-Jan-00		(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	#DIV/0!			

DISCHARGE RATE 4			Time	*Recovery 4*
DATE:	00-Jan-00		(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
Average yield:	#DIV/0!			

DISCHARGE RATE 5			Time	*Recovery 5*
DATE:	00-Jan-00		(min)	(m)
TIME:			1	
Time	Drawdown		2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
			240	
			300	
			360	
			420	
			480	
			540	
			600	
			660	
			720	

DISCHARGE RATE 6			Time	*Recovery*
DATE:	00-Jan-00		(min)	(m)
TIME:			1	
Time	Drawdown	Yield	2	
(min)	(m)	(l/s)	3	
1			5	
2			7	
3			10	
5			15	
7			20	
10			30	
15			40	
20			50	
30			60	
40			70	
50			80	
60			90	
70			100	
80			110	
90			120	
100			150	
110			180	
120			210	
150			240	
180			300	
210			360	
240			420	
300			480	
360			540	
420			600	
480			660	

COMMENTS:

CONSTANT DISCHARGE TEST AND RECOVERY

BOREHOLE NO. :	J14	PROJECT:	Jansenville Groundwater Investigation - Vuba	CLIENT:	0
ALTERNATIVE NO. :	0	SITE NAME:	0		
DEPTH OF PUMP (mbdl):	50.00	PUMP TYPE USED:	Submersible	OPERATOR:	Shaun Briel
INLET DIAMETER (mm):	110	EXISTING EQUIPMENT:	0	CONTRACTOR:	Intaba Construction

TEST STARTED	DATE:	26/09/03	TEST COMPLETED	DATE:		TOTAL TIME - PUMPED (min):	TOTAL TEST TIME (min):
	TIME:	12:30 PM		TIME:		TOTAL TIME-RECOVERY(min):	AVERAGE YIELD (l/s): 10.00

DISCHARGE BOREHOLE		OBSERVATION BOREHOLE 1		OBSERVATION BOREHOLE 2		OBSERVATION BOREHOLE 3	
CASING HEIGHT (magl):	0.00	No. :	J15	No. :	M1	No. :	
CASING DEPTH (mbdl):	0.00	DATUM LEVEL (magl):	330	DATUM LEVEL (magl):	360	DATUM LEVEL (magl):	
CASING ID (mm):	0.00	CASING DEPTH (mbdl):		CASING DEPTH (mbdl):		CASING DEPTH (mbdl):	
BOREHOLE DEPTH (mbdl):	0.00	BOREHOLE DEPTH :		BOREHOLE DEPTH :		BOREHOLE DEPTH :	
WATER LEVEL (mbdl):	26.17	WATER LEVEL:	27.69	WATER LEVEL:	31.48	WATER LEVEL:	
DATUM LEVEL (magl):	340.00	DISTANCE (m):	256	DISTANCE (m):	352	DISTANCE (m):	

Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)
1	0.30		5.62	1			1			1		
2	0.48		5.57	2			2			2		
3	0.65		5.54	3			3			3		
5	0.91		5.50	5			5			5		
7	1.20		5.48	7			7			7		
10	1.60		5.46	10			10			10		
15	1.95		5.43	15			15			15		
20	2.19		5.40	20			20			20		
30	2.38		5.36	30	0.06		30	0.01		30		
40	2.54		5.31	40	0.08		40			40		
60	2.79	10.00	5.26	60	0.10		60	0.05		60		
90	3.05		5.14	90	0.11		90	0.06		90		
120	3.22		5.05	120	0.11		120	0.12		120		
150	3.34		4.96	150	0.11		150	0.12		150		
180	3.55		4.85	180	0.11		180	0.12		180		
210	3.62	10.00		210	0.11		210	0.11		210		
240	3.82			240	0.10		240	0.06		240		
300	3.98			300	0.10		300	0.04		300		
360	4.09	10.00		360	0.07		360	0.04		360		
420	4.45			420	0.07		420	0.04		420		
480	4.83			480	0.07		480	0.03		480		
540	5.05			540	0.07		540	0.03		540		
600	5.12			600	0.05		600	0.01		600		
660	5.25			720	0.05		720	0.01		720		
720	5.48			840	0.03		840	0.00		840		
780	5.60	10.00		960	0.01		960	0.00		960		
840	5.72			1080	0.00		1080	0.00		1080		
900	6.20			1200	0.00		1200	0.00		1200		
960	6.25			1320	0.00		1320	0.00		1320		
1020	6.29			1440	0.00		1440	0.00		1440		
1080	6.34			1800	0.00		1800	0.00		1800		
1140	6.38	10.00		2280	0.00		2280	0.00		2280		
1200	6.40			2880	0.00		2880	0.00		2880		
1260	6.46	10.00										
1320	6.57											
1380	6.69											
1440	6.75	10.00										

DISCHARGE BOREHOLE				OBSERVATION BOREHOLE 1			OBSERVATION BOREHOLE 2			OBSERVATION BOREHOLE 3		
Time (min)	Drawdown (m)	Yield (l/s)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)	Time (min)	Drawdown (m)	Recovery (m)
1500	6.80	10.00		1500			1500			1500		
1560	6.84			1560			1560			1560		
1620	6.87			1620			1620			1620		
1680	6.92			1680			1680			1680		
1740	6.94	10.00		1740			1740			1740		
1800	6.96			1800			1800			1800		
1860	6.99			1860			1860			1860		
1920	7.03	10.00		1920			1920			1920		
1980	7.05			1980			1980			1980		
2040	7.09			2040			2040			2040		
2100	7.14			2100			2100			2100		
2160	7.19			2160			2160			2160		
2220	7.26			2220			2220			2220		
2280	7.32			2280			2280			2280		
2340	7.39			2340			2340			2340		
2400	7.47			2400			2400			2400		
2460	7.56			2460			2460			2460		
2520	7.63	10.00		2520			2520			2520		
2580	7.71			2580			2580			2580		
2640	7.80			2640			2640			2640		
2700	7.88	10.00		2700			2700			2700		
2760	7.95			2760			2760			2760		
2820	8.09			2820			2820			2820		
2880	8.20	10.00		2880			2880			2880		

DESCRIPTION:	QUANTITY:	UNIT:
ESTABLISHMENT		Sum
INTER HOLE MOVE > 10 km		Km.
FROM: SITE NAME:		
BOREHOLE No:		
INTER HOLE MOVE < 10 km:	0	No.
REMOVAL AND RE-ERECTION OF PUMP HOUSE:	0	No.
REMOVAL OF EXISTING EQUIPMENT:	0	No.
RE-INSTALLATION OF EXISTING EQUIPMENT:	0	No.
WORK TIME RATE (REPAIRS):	0	Hour
STANDING TIME:	0	Hour
LATITUDE: LONGITUDE:		

SUMMARY

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
BOREHOLE DEPTH AFTER TEST:		m
BOREHOLE WATERLEVEL AFTER TEST:		m

TEST DESCRIPTION	STEP	1	2	3	4	5	6	TOTAL: (min)	TOTAL: (hrs)	RECOVERY: (m)	RECOVERY: (min)
CALIBRATION TEST:											
TEST DURATION (Minutes)								0	0.00	0.00	
TEST YIELD (l/s)								MAXIMUM (l/s)	0.0		
DRAWDOWN (m)		0.00	0.00	0.00	0.00			MAXIMUM (m)			
MULTI-RATE / STEP DRAWDOWN:											
TEST DURATION (Minutes)								0	0.00	0.00	
TEST YIELD (l/s)								MAXIMUM (l/s)	0.0		
DRAWDOWN (m)			0.00	0.00	0.00			MAXIMUM (m)	0.0		

RECOVERY TEST			
TIME TOTAL (hrs):			3.00
Cal	Steps	CD	Total
0	0	180	180
DRAWDOWN TOTALS (CD):			
AVAILABLE	UTIL-ISED		%
23.8	8.00		34.4

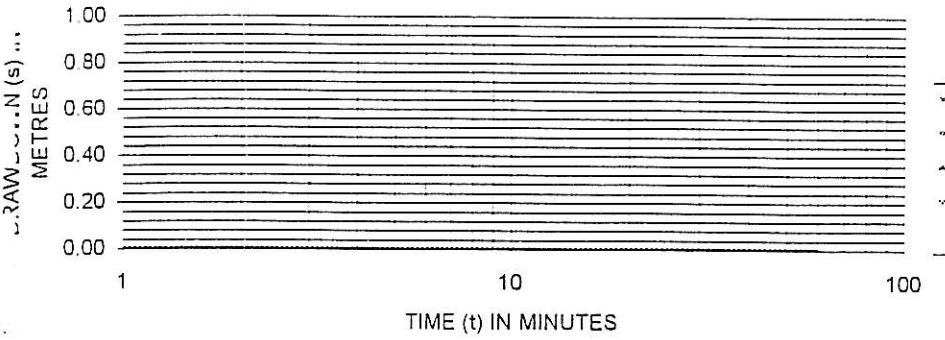
CONSTANT DISCHARGE TEST	TEST DURATION (min)	TEST DURATION (hrs)	TEST YIELD (l/s)	DRAWDOWN (m)	RECOVERY: (m)	RECOVERY: %	RECOVERY: (min)	RECOVERY: (hrs)
	2880	48.00	10.00	8.00	4.85	40.85	2	0.00

OBSERVATION BOREHOLES:	No. of boreholes	720 (min)	1440 (min)	2880 (min)	>2880 (min) nr.	>2880 (min) Time	TOTAL: (min)	TOTAL: (hrs)
							2	0.00

BOREHOLE NUMBER: J14

CALIBRATION TEST AND RECOVERY

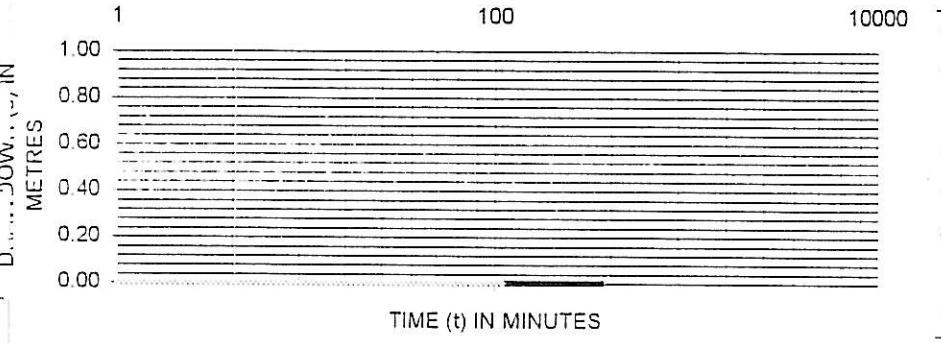
Discharge 1:	0.00	Discharge 2:		Discharge 3:		Discharge 4:		Discharge 5:		Discharge 6:	



Drawdown 1:	0.00
Drawdown 2:	0.00
Drawdown 3:	0.00
Drawdown 4:	0.00
Drawdown 5:	0.00
Drawdown 6:	0.00
Duration 1:	0
Duration 2:	
Duration 3:	
Duration 4:	
Duration 5:	
Duration 6:	
Recovery (m):	0.00
Recovery (min):	0

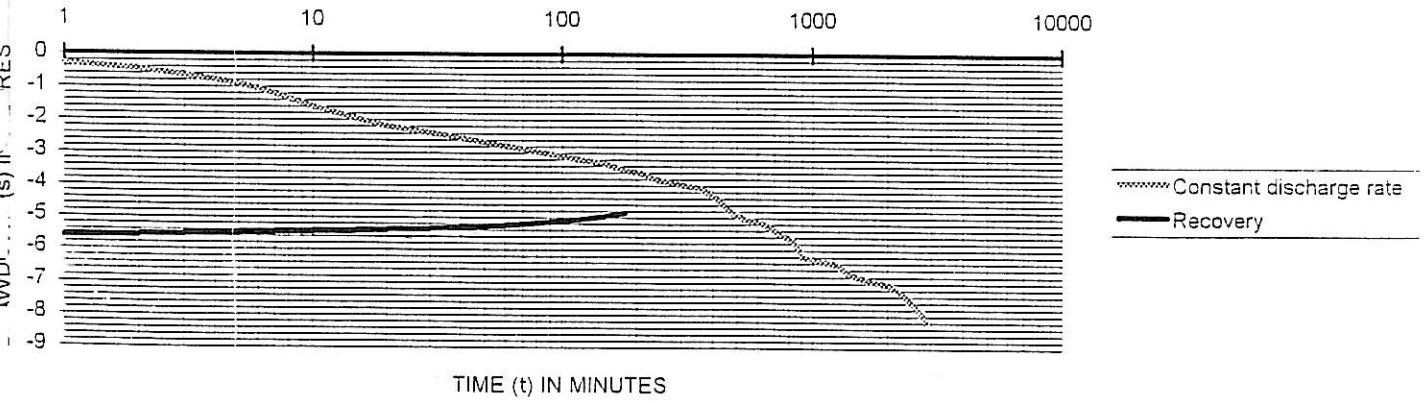
STEPPED DISCHARGE TEST AND RECOVERY

Discharge 1:		Discharge 2:		Discharge 3:		Discharge 4:		Discharge 5:		Discharge 6:	



Drawdown 1:	
Drawdown 2:	0.00
Drawdown 3:	0.00
Drawdown 4:	0.00
Drawdown 5:	0.00
Drawdown 6:	
Duration 1:	0
Duration 2:	
Duration 3:	
Duration 4:	
Duration 5:	
Duration 6:	
Recovery (m):	0.00
Recovery (min):	0

CONSTANT DISCHARGE TEST AND RECOVERY



T INFORMATION

te tested	26/09/03	Water level (mbgl)	26.17	Depth of pump (mbgl)		50
duration	0	CD discharge rate	10.00	CD drawdown		8.2
able drawdown (m)	23.83	% Recovery after CD	41	% after	0	min

APPENDIX C

CHEMICAL WATER ANALYSES

	Borehole Id			J1 / J2	J8	J13	J14	J15	J17	M5	S/P
	Date Sampled			19/09/2003	19/09/2003	19/09/2003	19/09/2003	19/09/2003	19/09/2003	30/09/2003	30/09/2003
	Drinking water class			4	3	4	3	4	2	3	3
Physical Properties	Electrical Conductivity	EC	mS / m	472.00	391.00	618.00	436.00	494.00	184.00	209.00	435.00
	Total Dissolved Salts	TDS	mg / l	2370.00	1960.00	3100.00	2200.00	2480.00	919.00	1050.00	2180.00
	pH Value	pH		7.02	7.06	6.96	6.99	7.15	7.45	7.36	7.57
	Turbidity		NTU	2.10	0.18	5.70	1.20	39.00	2.80	0.80	0.40
Chemical properties	Arsenic	As	mg / l								
	Cadmium	Cd	mg / l								
	Calcium	Ca	mg / l	270.00	223.00	455.00	288.00	285.00	130.00	117.00	256.00
	Chloride	Cl	mg / l	317.00	1011.00	1718.00	1177.00	1310.00	430.00	261.00	181.00
	Copper	Cu	mg / l								
	Fluoride	F	mg / l	1.00	1.10	1.10	1.20	1.10	1.10	2.10	1.30
	Iron	Fe	mg / l	0.49	0.24	0.90	0.37	4.60	1.06	0.10	0.10
	Total Hardness	$CaCO_3$	mg / l	1176.00	994.00	1881.00	1201.00	1247.00	576.00	568.00	1141.00
	Magnesium	Mg	mg / l	122.00	106.00	181.00	117.00	130.00	61.00	67.00	122.00
	Manganese	Mn	mg / l								
	Nitrate	N	mg / l	0.02	0.75	0.75	1.50	0.07	3.10	1.40	0.97
	Nitrate	NO_3	mg / l								
	Potassium	K	mg / l	4.90	5.70	6.90	4.60	5.00	3.90	5.00	4.90
	Sodium	Na	mg / l	606.00	472.00	713.00	527.00	641.00	178.00	267.00	579.00
	Sulphate	SO_4	mg / l	437.00	259.00	668.00	364.00	549.00	92.00	102.00	366.00
	Zinc	Zn	mg / l								
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.08	0.01	0.02	0.01	0.10	0.01	0.02	0.02
	P - Alkalinity	$CaCO_3$	mg / l	309.00	400.00	439.00	401.00	316.00	429.00	451.00	337.00
	M - Alkalinity	CaCO3	mg / l								
	Calcium Hardness	CaCO3	mg / l	674.00	557.00	1136.00	719.00	712.00	325.00	292.00	639.00
	Magnesium Hardness	CaCO3	mg / l	502.00	437.00	745.00	482.00	535.00	251.00	276.00	502.00
	Carbonate	CaCO3	mg / l								
	Bicarbonate	HCO_3	mg / l								
	Silica	Si	mg / l								
	Phosphor	PO_4 as P	mg / l								

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J1 + J2
Date Sampled	19/09/2003
Drinking water class	4
Sample Number	17684

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	EC	mS / m	472.00	3
	Total Dissolved Salts	TDS	mg / l	2370.00	2
	pH Value	pH		7.02	0
	Turbidity		NTU	2.10	2
Chemical properties	Arsenic	As	mg / l		0
	Cadmium	Cd	mg / l		0
	Calcium	Ca	mg / l	270.00	2
	Chloride	Cl	mg / l	1317.00	4
	Copper	Cu	mg / l		0
	Fluoride	F	mg / l	1.00	2
	Iron	Fe	mg / l	0.49	2
	Total Hardness	$CaCO_3$	mg / l	1176.00	3
	Magnesium	Mg	mg / l	122.00	3
	Manganese	Mn	mg / l		0
	Nitrate	N	mg / l	0.02	0
	Nitrate	NO_3	mg / l		0
	Potassium	K	mg / l	4.90	0
	Sodium	Na	mg / l	606.00	3
	Sulphate	SO_4	mg / l	437.00	2
	Zinc	Zn	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.08	
	P - Alkalinity	$CaCO_3$	mg / l	309.00	
	M - Alkalinity	CaCO3	mg / l		
	Calcium Hardness	CaCO3	mg / l	674.00	
	Magnesium Hardness	CaCO3	mg / l	502.00	
	Carbonate	CaCO3	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	Si	mg / l		
	Phosphor	PO_4 as P	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J8
Date Sampled	19/09/2003
Drinking water class	3
Sample Number	17685

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	*EC*	mS / m	391.00	3
	Total Dissolved Salts	*TDS*	mg / l	1960.00	2
	pH Value	*pH*		7.06	0
	Turbidity		NTU	0.18	1
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	223.00	2
	Chloride	*Cl*	mg / l	1011.00	3
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	1.10	2
	Iron	*Fe*	mg / l	0.24	2
	Total Hardness	$CaCO_3$	mg / l	994.00	3
	Magnesium	*Mg*	mg / l	106.00	3
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.75	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	5.70	0
	Sodium	*Na*	mg / l	472.00	3
	Sulphate	SO_4	mg / l	259.00	1
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.01	
	P - Alkalinity	$CaCO_3$	mg / l	400.00	
	M - Alkalinity	*CaCO3*	mg / l		
	Calcium Hardness	*CaCO3*	mg / l	557.00	
	Magnesium Hardness	*CaCO3*	mg / l	437.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	PO_4 *as P*	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J13
Date Sampled	19/09/2003
Drinking water class	4
Sample Number	17686

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	*EC*	mS / m	618.00	4
	Total Dissolved Salts	*TDS*	mg / l	3100.00	3
	pH Value	*pH*		6.96	0
	Turbidity		NTU	5.70	2
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	455.00	3
	Chloride	*Cl*	mg / l	1718.00	4
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	1.10	2
	Iron	*Fe*	mg / l	0.90	2
	Total Hardness	$CaCO_3$	mg / l	1881.00	3
	Magnesium	*Mg*	mg / l	181.00	3
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.75	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	6.90	0
	Sodium	*Na*	mg / l	713.00	3
	Sulphate	SO_4	mg / l	668.00	3
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.02	
	P - Alkalinity	$CaCO_3$	mg / l	439.00	
	M - Alkalinity	*CaCO3*	mg / l		
	Calcium Hardness	*CaCO3*	mg / l	1136.00	
	Magnesium Hardness	*CaCO3*	mg / l	745.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	PO_4 *as P*	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J14
Date Sampled	19/09/2003
Drinking water class	3
Sample Number	17687

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms			0.00	1
	Total coliforms			0.00	1
Physical Properties	Electrical Conductivity	*EC*	mS / m	436.00	3
	Total Dissolved Salts	*TDS*	mg / l	2200.00	2
	pH Value	*pH*		6.99	0
	Turbidity		NTU	1.20	2
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	288.00	2
	Chloride	*Cl*	mg / l	1177.00	3
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	1.20	2
	Iron	*Fe*	mg / l	0.37	2
	Total Hardness	$CaCO_3$	mg / l	1201.00	3
	Magnesium	*Mg*	mg / l	117.00	3
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	1.50	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	4.60	0
	Sodium	*Na*	mg / l	527.00	3
	Sulphate	SO_4	mg / l	364.00	1
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.01	
	P - Alkalinity	$CaCO_3$	mg / l	401.00	
	M - Alkalinity	*CaCO3*	mg / l		
	Calcium Hardness	*CaCO3*	mg / l	719.00	
	Magnesium Hardness	*CaCO3*	mg / l	482.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	PO_4 *as P*	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J15
Date Sampled	19/09/2003
Drinking water class	4
Sample Number	17688

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	*EC*	mS / m	494.00	3
	Total Dissolved Salts	*TDS*	mg / l	2480.00	3
	pH Value	*pH*		7.15	0
	Turbidity		NTU	39.00	3
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	285.00	2
	Chloride	*Cl*	mg / l	1310.00	4
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	1.10	2
	Iron	*Fe*	mg / l	4.60	3
	Total Hardness	$CaCO_3$	mg / l	1247.00	3
	Magnesium	*Mg*	mg / l	130.00	3
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	0.07	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	5.00	0
	Sodium	*Na*	mg / l	641.00	3
	Sulphate	SO_4	mg / l	549.00	2
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.10	
	P - Alkalinity	$CaCO_3$	mg / l	316.00	
	M - Alkalinity	*CaCO3*	mg / l		
	Calcium Hardness	*CaCO3*	mg / l	712.00	
	Magnesium Hardness	*CaCO3*	mg / l	535.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	PO_4 *as P*	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	J17
Date Sampled	19/09/2003
Drinking water class	2
Sample Number	17689

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	EC	mS / m	184.00	2
	Total Dissolved Salts	TDS	mg / l	919.00	1
	pH Value	pH		7.45	0
	Turbidity		NTU	2.80	2
Chemical properties	Arsenic	As	mg / l		0
	Cadmium	Cd	mg / l		0
	Calcium	Ca	mg / l	130.00	1
	Chloride	Cl	mg / l	430.00	2
	Copper	Cu	mg / l		0
	Fluoride	F	mg / l	1.10	2
	Iron	Fe	mg / l	1.06	2
	Total Hardness	$CaCO_3$	mg / l	576.00	2
	Magnesium	Mg	mg / l	61.00	1
	Manganese	Mn	mg / l		0
	Nitrate	N	mg / l	3.10	0
	Nitrate	NO_3	mg / l		0
	Potassium	K	mg / l	3.90	0
	Sodium	Na	mg / l	178.00	1
	Sulphate	SO_4	mg / l	92.00	0
	Zinc	Zn	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.01	
	P - Alkalinity	$CaCO_3$	mg / l	429.00	
	M - Alkalinity	CaCO3	mg / l		
	Calcium Hardness	CaCO3	mg / l	325.00	
	Magnesium Hardness	CaCO3	mg / l	251.00	
	Carbonate	CaCO3	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	Si	mg / l		
	Phosphor	PO_4 as P	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	M5
Date Sampled	30/09/2003
Drinking water class	3
Sample Number	17824

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	*EC*	mS / m	209.00	2
	Total Dissolved Salts	*TDS*	mg / l	1050.00	2
	pH Value	*pH*		7.36	0
	Turbidity		NTU	0.80	1
Chemical properties	Arsenic	*As*	mg / l		0
	Cadmium	*Cd*	mg / l		0
	Calcium	*Ca*	mg / l	117.00	1
	Chloride	*Cl*	mg / l	261.00	2
	Copper	*Cu*	mg / l		0
	Fluoride	*F*	mg / l	2.10	3
	Iron	*Fe*	mg / l	0.10	1
	Total Hardness	$CaCO_3$	mg / l	568.00	2
	Magnesium	*Mg*	mg / l	67.00	1
	Manganese	*Mn*	mg / l		0
	Nitrate	*N*	mg / l	1.40	0
	Nitrate	NO_3	mg / l		0
	Potassium	*K*	mg / l	5.00	0
	Sodium	*Na*	mg / l	267.00	2
	Sulphate	SO_4	mg / l	102.00	0
	Zinc	*Zn*	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.02	
	P - Alkalinity	$CaCO_3$	mg / l	451.00	
	M - Alkalinity	*CaCO3*	mg / l		
	Calcium Hardness	*CaCO3*	mg / l	292.00	
	Magnesium Hardness	*CaCO3*	mg / l	276.00	
	Carbonate	*CaCO3*	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	*Si*	mg / l		
	Phosphor	PO_4 as P	mg / l		

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. Acute effects may occur

Jansenville Groundwater Investigation - Vuba

Borehole Id	S/P
Date Sampled	30/09/2003
Drinking water class	3
Sample Number	17825

					Class
Micro-biological properties	Viable organisms				0
	Faecal coliforms				0
	Total coliforms				0
Physical Properties	Electrical Conductivity	EC	mS / m	435.00	3
	Total Dissolved Salts	TDS	mg / l	2180.00	2
	pH Value	pH		7.57	0
	Turbidity		NTU	0.40	1
Chemical properties	Arsenic	As	mg / l		0
	Cadmium	Cd	mg / l		0
	Calcium	Ca	mg / l	256.00	2
	Chloride	Cl	mg / l	181.00	1
	Copper	Cu	mg / l		0
	Fluoride	F	mg / l	1.30	2
	Iron	Fe	mg / l	0.10	1
	Total Hardness	$CaCO_3$	mg / l	1141.00	3
	Magnesium	Mg	mg / l	122.00	3
	Manganese	Mn	mg / l		0
	Nitrate	N	mg / l	0.97	0
	Nitrate	NO_3	mg / l		0
	Potassium	K	mg / l	4.90	0
	Sodium	Na	mg / l	579.00	3
	Sulphate	SO_4	mg / l	366.00	1
	Zinc	Zn	mg / l		0
Chemical properties (not required for the clasification of domestic drinking water supply)	Ammonia	NH_4	mg / l	0.02	
	P - Alkalinity	$CaCO_3$	mg / l	337.00	
	M - Alkalinity	CaCO3	mg / l		
	Calcium Hardness	CaCO3	mg / l	639.00	
	Magnesium Hardness	CaCO3	mg / l	502.00	
	Carbonate	CaCO3	mg / l		
	Bicarbonate	HCO_3	mg / l		
	Silica	Si	mg / l		
	Phosphor	PO_4 as P	mg / l		

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. Acute effects may occur